NATURE

SATURDAY, FEBRUARY 26, 1927.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

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

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2991, Vol. 119]

Industrial and Commercial Efficiency.[1]

MR. RAMSAY MACDONALD, during the brief existence of the first Labour Government, must have established a record in the number of special committees of inquiry which he appointed. Not the least important was the Committee appointed to inquire into the conditions and prospects of British industry and commerce and to make recommendations in regard thereto, the general scope of the inquiry to include a survey of overseas markets, a survey of industrial relations, and an assessment of British productive capacity and its efficiency. The report of the Committee is being presented in parts; the first part, dealing with overseas markets, was published in June 1925; in February 1926 a volume appeared dealing with industrial relations; and now, after an interval of a year, a third volume has emerged as a first of two contributions to the subject of productive capacity and efficiency.

When this Committee was about to be appointed, it may be remembered that doubts were expressed regarding the capacity of a Committee composed solely of representatives of finance, industry, and trade to deal adequately with the proposed terms of reference. Major Church, speaking in the House of Commons to the resolution which led to the inquiry, urged the inclusion of representative scientific workers on the Committee, pointing out that they would be in a better position to estimate the possibilities of future trade developments and to appreciate the effects likely to be produced on our commerce by the applications of science to agriculture—the foremost industry of the Empire—and those industries the future of which is indissolubly bound up with the progress of scientific research, than representatives of the classes of the community specifically mentioned. But Mr. Sidney Webb, on whose advice the Committee was appointed, held to the theory that those who would be chosen to represent science on such a committee would necessarily be creative workers whose time would be better occupied in discovery: consequently, scientific workers were neither represented on the Committee nor have they been given the opportunity of expressing their views on the present relations between industry and science. The Department of Scientific and Industrial Research has dealt with that aspect of the inquiry.

This third volume is disappointing. It consists

[1] Committee of Industry and Trade. Factors in Industrial and Commercial Efficiency: being Part I. of a Survey of Industries. With an Introduction by the Committee. Pp. v+544. (H.M. Stationery Office, 1927.) 5*s*. net.

mainly of reports and memoranda prepared by various government departments or officials. There are a brief half-page summary of the work of the National Institute of Industrial Psychology based on the evidence of the Director, and a chapter on industrial art prepared by the British Institute of Industrial Art. Without further inquiry or reference to other bodies, the Committee has prepared a long introductory, inconclusive summary of the subjects dealt with and views expressed in the remainder of the volume. No recommendations are made, only rarely a hint of a suggestion creeps in for the improvement of industrial efficiency in Great Britain, a complacent air of Micawberish optimism pervades most of the pages, but above all, a veil is drawn over the operations of the banks and financial houses of the country—for the present at any rate. The report gives the impression that all will be well when Great Britain has recovered from the destruction of the new things it created in addition to its normal needs during the War, rather than when it has decided to apply the newest advances in scientific knowledge to industry, under the comparatively unfettered direction of those who understand the creative ideas and forces with which they are dealing.

Whether the Committee is dealing with industrial structure, the training and recruitment of manual workers and higher technical and professional staffs, standardisation of units of measurement and materials, the function of scientific research, the encouragement of industrial arts, State measures for encouraging home industries and overseas trade, the effect of national and local taxation on certain industries, with all of which this volume deals, it remains entirely non-committal, and the report could be used equally well as a brief either for those who wished to take no action or for those who wished to attempt to improve British industry and trade.

Nevertheless, the memoranda submitted by State departments and other bodies and embodied in this report are of the greatest interest: those on "Industrial Structure" furnished by the Board of Trade, on "Technical Education" by the Board of Education and the Scottish Education Department, and "Industrial Art" by the British Institute, being particularly noteworthy contributions. The chapter dealing with industrial structure gives an account of the marked trend during the last quarter of the nineteenth century towards the limitation of competition in each of the highly industrialised countries and its later development. The information given is already in the possession of certain sections of the community, but it is the first time, we believe, that it has been summarised in an official publication.

One of the most disquieting features in modern industry is the loss of skill which accompanies the growth of large-scale machine production. The old traditional crafts, in which the individual carried an article through all stages of its manufacture, are now fast being displaced by mass-production, where the individual is responsible for one of the various processes of manufacture. The problem of creating and maintaining skill in craftsmanship is one of the crucial problems of modern industry. For this the Committee supports the view of the Board of Education that we must look to the schools rather than to the workshop. The subject of technical training is dealt with at some length. In view of the clamour among certain classes of employers for early vocational training, the Committee is to be congratulated on expressing its conviction that education is a preparation for life, and its wider aims and functions should not be sacrificed or subordinated to the demands of industry and commerce.

A somewhat gloomy picture is given of the dependency of Great Britain on the Continental designers for art applied to industry. Too many firms rely entirely upon Paris for their designs and thus tend to limit more and more the creative potentialities of their own designers. Yet, as it is stated, the artist does not flourish in the ugliness of a northern manufacturing city. "Frenchmen working in Manchester are said to lose their native gifts after three or four years." The British artist evidently suffers, like the scientific worker, from lack of an environment congenial to his task and the narrowness of outlook of industrial leaders. He suffers from the further disadvantage that the developments of the great machine industry had at the outset "the most disturbing and often disastrous effects on industrial art by breaking up the old craft traditions, revolutionising technique, and weakening or severing the close relations which previously existed between designer and executant." Emphasis is laid upon the growing complexity of modern commerce and the obvious need for systematic training in economics and finance. "The fact that the demand for higher commercial teaching of University rank has emanated from economists and educational observers rather than from the representatives of commerce, does not substantially weaken the case for such education, for almost exactly the same observation could have been made

a generation ago with regard to forms of technical and scientific instruction which have now become firmly established."

In dealing with the subject of scientific research the Committee has relied upon the memorandum furnished by the Department of Scientific and Industrial Research. Other government departments which might have made equally useful contributions to the subject have not been given the opportunity of presenting their views, and apparently the views of leading manufacturers have not been independently ascertained. The Committee states what scientific workers have long known to be the case, that there is still a very imperfect recognition by the industries of the need for the continuous and systematic application of scientific methods both to the invention and improvement of particular methods and processes of production, and to the enlargement of the boundaries of knowledge with regard to the fundamental underlying principles. Most of the scientific workers engaged in industry are absorbed in "tactical research," that is to say, the improvement and development of existing processes, and very few in "strategical research," *i.e.* the search for new products or processes or to the investigation of fundamental laws. The cost of strategical research is usually beyond the means of individual firms, and only the great combinations can afford to embark on such enterprise. The Committee is forced to the conclusion that "freedom and flexibility are essential conditions of fruitful research" and urges the need for the demarcation of functions in the matter of research between the State, which could and should encourage this freedom, and private enterprise, which will usually have a tendency towards secrecy.

It is unfortunate that the Government which appointed this committee did not adopt the suggestion made to bring the representatives of science in intimate contact with the leaders of industry and finance. Had this been done, the chapter on research might have concluded with definite recommendations instead of vague generalities and aspirations. But the fault lies with scientific workers. They fail to realise the urgent need of putting themselves in a position to demand representation on all such bodies. Though faced with every form of combination among financiers, employers, and manual workers, they neglect to combine themselves for the furtherance of their legitimate interests; and while they remain unorganised they can scarcely expect to be considered as a driving or united force in public affairs which affect them as well as the nation.

Evolutionary Philosophy.

Holism and Evolution. By General the Right Hon. J. C. Smuts. Pp. ix+361. (London: Macmillan and Co. Ltd., 1926.) 18*s.* net.

THE advance, and indeed the proper comprehension, of evolutionary philosophy is to-day suffering greatly from the increase of specialism. This specialism is to a great extent inevitable, but it is at least in part due to an unfortunate by-product of the spreading appreciation of the value of research. The educationist realises that there is no finer training than that which is gained by the conduct of a piece of original investigation. The community as a whole, too, is beginning to appreciate, even though dimly, the extent to which scientific research enters into the foundations upon which rest the health and comfort and prosperity of the modern civilised state.

While this growing appreciation brings with it advantage to the cause of science and to the welfare of mankind, it is not without its disadvantages. Young men without conspicuous natural qualifications are turned on to do a bit of research for their own personal advantage. This is all to the good: they are bound to benefit greatly by being put through the necessary discipline. The harm comes when such prentice efforts are published without due consideration. The work may be simply of inferior quality, or if sound it may be that poor kind of research which consists merely in the transference of certain facts in Nature, of no apparent significance, to the pages of a printed book or journal. Above all, there is the natural tendency, and not merely for beginners, towards intensive research in some very restricted field. The myopia induced by such intensive study necessarily involves disability to broader vision—a disability of which the patient is often completely unconscious—and we find the narrow specialist laying down the law as regards the problems of evolutionary philosophy in a way which even an elementary grasp of those portions of the subject lying beyond the limits of his own speciality would restrain him from doing.

In General Smuts we have a visitor to the domain of biology from very different fields of activity, and as he comes armed with credentials of the highest order—testifying to his intellectual power, to his honesty of purpose, and to his remarkable freedom from prejudice—it becomes of extraordinary interest to scan his vision of evolutionary philosophy, free as it is from the distortion and disturbance of true proportion which specialist concentration on little bits of the subject is so apt to induce.

The first four of the twelve chapters of "Holism and Evolution" are devoted to those fundamental concepts which underlie the general theory of evolution, to the ideas of space and time and matter, and to the cell and the organism. To the present reviewer, who believes that the lapse of time—with the truer proportions that distant vision gives—will show the figure of Charles Darwin towering alone above all others in the history of philosophy, it is particularly agreeable to see that General Smuts appreciates, in a way that the biological specialist so often entirely fails to do, the unique position occupied by Charles Darwin.

While emphasising in this introductory portion of the book the importance of increased precision of nomenclature, it is perhaps disappointing that the author has not handled the tangle in which so much modern discussion has become tied up in the misuse of the word 'space.' The conception of space is derived by a simple step from the sensory perception of the extension of material objects, by merely ignoring the material substance of which they are composed. That gives us the primitive idea of space, and this space is in its essence tridimensional. When the pure mathematician for his own purposes modifies this idea by removing or adding one or more dimensions, we are apt to forget that in doing so he has interfered with the fundamental conception of space as derived from our sensory experience of the material world. No harm is done in the realms of pure mathematics: the danger comes when such expressions as 'space' of one, or of two, or of n dimensions, are brought back into speculations regarding the material universe, for confusion of ideas is the immediate and inevitable result.

In the following chapters of his book the author develops his philosophy of Holism. "The close approach to each other of the concepts of matter, life, and mind, and their partial overflow of each other's domain, raises the question whether back of them there is not a fundamental principle of which they are the progressive outcome."

Evolution to the author is not the process expressed by that word taken literally—a mere unfolding of complexities already present—but is actually creative: "it creates both new materials and new forms from the synthesis of the new with the old materials." Surveying the world of Nature, the author sees its great characteristic in the tendency to the development of 'wholes.' To illustrate what he means by wholes, he cites the case of living organisms, each made up of constituent parts but yet possessing an individual specific character of its own. Although particularly obvious in the case of animals or plants, such wholes pervade all Nature—not merely the material world with its atoms, molecules, and chemical compounds, but also the immaterial world which includes human ideals and performances. Everywhere we find 'wholes' basic to the character of the universe, and "Holism as the operative factor in the evolution of wholes is the ultimate principle of the universe."

This, then, is the kernel of General Smuts's philosophy—that the universe is vitalised by a great driving force—its inherent tendency towards integration into more and more highly developed wholes, into the more lowly types seen in inorganic Nature, the higher types seen in living creatures, and finally the highest types of all on the artistic and mental and spiritual plane of existence. "Holism in all its endless forms is the principle which works up the raw material or unorganised energy units of the world, utilises, assimilates, and organises them, endows them with specific structure and character and individuality, and finally with personality, and creates beauty and truth and value from them." A great idea surely, and one which justifies the author in putting forward his claim that it brings us nearer "the monistic conception of the universe which is the immanent ideal of all scientific and philosophical explanation."

In a series of interesting chapters the theory just outlined is elaborated, one of the most interesting being that entitled "Darwinism and Holism." Here again full tribute is paid to the greatness of Darwin: "He has changed our whole human orientation of knowledge and belief, he has given a new direction to our outlook, our efforts and aspirations, and has probably meant a greater difference for human thought and action than any other single thinker."

Perhaps still more remarkable than the author's appreciation of Darwin is the fact that he has succeeded in maintaining his balance in regard to Mendelism, and has firmly placed it in proper perspective in relation to the general theory of organic evolution.

An acute discussion of Weismann and his work leads to the much-debated question of the inheritance of impressed characters, in which the author shows a distinct leaning towards accepting their transmissibility, incidentally testifying to the impression made upon him by Bower's discussion of the matter in relation to evolution in the vegetable kingdom. Repeatedly we come across the suggestion that such impressed or 'acquired'

characters *may* be inherited. The position taken up, however, by those of us who feel constrained to keep such characters outside our evolutionary speculations, is not that we dogmatically deny that they *may* be inherited, but rather that we deny the existence of the overwhelming body of evidence that they *are* inherited, which we believe would inevitably be forthcoming were this the case.

An interesting feature in this chapter is that the author shows that he fully realises the prevalent error of thinking of small variations in detail by themselves, and stumbling over their selective value, instead of bearing in mind that these details are merely parts of a physiological whole and that the actual selective process deals with such complete individuals.

It is very true, and it is, in these days, really necessary to drive it home, that "there is no doubt that experimental evolution has, through its unavoidable limitations, greatly blurred the great Darwinian vision of organic evolution," and "natural evolution as distinguished from experimental evolution is a process, not of the hour or the day, but of geological time, and the results, consolidated through immemorial periods, cannot be repeated or rehearsed by short-dated laboratory experiments."

What Darwinism does not explain, or purport to explain, is the origin of the variations which form the raw material upon which natural selection works. To the present reviewer that raw material is provided by the instability or variability which is essential and inherent in the nature of life itself. To the author of Holism it is given by a universal tendency to undergo change in the direction of higher and higher integration.

As regards the general thesis of Holism, probably most men of science will find themselves in agreement with the author so far as the evolution of the universe as a whole, meaning by that the sum of all existence, is concerned. There must have been inherent in that from the beginning a creative power which has found its expression in all subsequent developments. Some, with General Smuts, will spell it Holism : some will spell it God.

Many, however, while accepting the argument for the universe as a whole, will feel doubts as to their being constrained to do so for its constituent parts. When dealing with any one of these we are no longer dealing with something that is absolutely self-contained : it now has an environment ; and the doubt arises whether the environment, taken in conjunction with the instability which modern physics would appear to extend even to the minutest particles of 'dead' matter, may not have a moulding influence sufficient to account for evolution.

Enough has perhaps been said to achieve the purpose of this review—to direct attention to a remarkable and important work which should be read by all interested in the philosophy of the world in which they live. As will have been gathered, General Smuts' book is a step towards that merging together of science and philosophy which is bound to come at no distant date. Men of science and philosophers alike are aiming at the same objective—the unravelling of the meaning that lies behind phenomena.

Such basic ideas as space and time are no longer placed apart as *a priori* in their nature : it is realised that each is a simple development from sensory experience. The man of science believes that, with the foundations of his philosophy laid in experience, he is logically bound to keep in touch with experience throughout the whole process of building up that philosophy of the universe in which he lives. He realises that as he builds he must make use of every possible refinement of technique, whether of observation or of mathematical or other methods of working up the data obtained by observation. With both sets of workers striving onwards towards the same goal, it will not do for either to ignore any methods of technique that will help them on their way, and when once this is fully realised and a common technique adopted, we shall have at last a unified army marching onwards to the attack of ignorance, and it will be of little moment whether its banner is inscribed 'science' or 'philosophy.'

J. GRAHAM KERR.

The Geology of Siberia.

Fortschritte der Geologie und Paläontologie. Herausgegeben von Prof. Dr. W. Soergel. Heft 15 : *Geologie von Siberien.* Von Prof. Dr. W. A. Obrutschew. Pp. xi + 573 + 11 plates. (Berlin : Gebrüder Borntraeger, 1926.) 37·50 gold marks.

GEOLOGISTS will be deeply grateful to Prof. Obrutschew for his masterly summary of the geology of Siberia, since so much of its extensive literature is in Russian and therefore inaccessible to most western workers. His book will form a standard work of reference for the geology of northern Asia, owing to its concise summary of the available information, its clear discussion of the chief stratigraphical and tectonic problems, its admirable series of sketch maps, and its full bibliography.

Prof. Obrutschew divides Siberia into seven

geomorphologic units, including the *Scheitel* of Suess, to which he refers as the *kern*, and therefore justifies the translation of the term as core or nucleus. He prefers to call this area the Sayan-Baikal Highlands, but Suess's explanation of its significance is confirmed, as the Jurassic and Kainozoic deposits upon it are horizontal. The most serious modification in Suess's interpretation of the structure of Asia is in connexion with the Altaids; Prof. Obrutschew shows that Suess has included in his Altaid Mountain Systems elements of different ages, trends, and origin. Some of the east Altai folds are Caledonian, and some, such as those of the Saur-Tarbagatai and the Tien Shan, are later. Prof. Obrutschew therefore excludes the Tien Shan ranges from the Altaids and restricts that term to the Altai, the Khirgiz folds, and the Siberian Hercynian movements. Suess's objection to the term Hercynian, however, still stands, and his suggestion of Altaid as the name for the widespread mountain system that was formed toward the end of the Palæozoic and includes American, European, and African as well as Asiatic mountains, remains unshaken by these restrictions.

In the long succession of marine deposits in Siberia most of the geological systems are represented, and they throw light on many problems. Thus, in reference to the current discussion upon climate and continental drift, it is interesting to note that the Siberian marine faunas from the Cambrian to the Upper Kainozoic all have features indicative of a northern zone. The fauna which suggests the warmest conditions is that of the Silurian, which is described as being rich in corals; but they are mostly either simple or Alcyonarian, and do not indicate such warm conditions as rendered possible in England the growth of the contemporary coral reefs and those of the succeeding Devonian. The Tethys once spread northward so far as the Siberian Islands, but its fauna there consisted mainly of ammonites, and was consistent with a moderately cool sea. In the Cretaceous, which is so often claimed as having had an Arctic tropical climate, the marine fauna was rich in Aucella, and the one coral quoted from Siberia is a simple form, a Microbacia, and these fossils might have existed in a sea as cold as the present Arctic Ocean.

The work follows quite different lines from the recent discussion by Prof. Argand of the tectonic of Asia. It is a summary of the facts with such discussion as is required to make them intelligible and interesting, and will be an indispensable book of reference in regard to Asiatic geology.

J. W. G.

Behind the Divining Rod.

The Divining-Rod: an Experimental and Psychological Investigation. By Sir William Barrett and Theodore Besterman. Pp. xxiii + 336 + 12 plates. (London: Methuen and Co., Ltd., 1926.) 18*s.* net.

SPECIALISATION in science, and the organisation of research, undoubtedly lead to rapid advance in the elucidation of particular groups of phenomena; but they are also responsible for systematic neglect of others. Thus there remain dark corners into which the investigators of the last century swept the trifles which they preferred to leave unconsidered.

For a hundred years after Cavendish had shown that a portion of atmospheric nitrogen, after being 'sparked' with oxygen, always remained uncombinable, chemists deliberately ignored this residuum; yet soon after Rayleigh and Ramsay turned their attention to it, the sky-signs of London were advertising by the glory of their colours that there was indeed something in it. When this has been possible in chemistry's diligently cultivated field, may we not hope to find much more lurking in those obscure places where none of the recognised sciences has as yet pegged out a claim?

The use of the divining-rod in the discovery of springs has long been looked at askance by men of science, and not altogether without reason. People who profess to be dowsers, though usually honest folk, are sometimes fools deserving the application of their rods to their own backs, as Prof. C. V. Boys hinted in these columns a quarter of a century ago. Occasionally they are pernicious paradoxers or, rarely, unblushing impostors; yet it must be acknowledged that none of those who essayed to prove that there was nothing but folly, perversity, and imposture in this method of water-finding, has succeeded in explaining the unquestionable facts. Every one who has had to do with the water-supply of country houses knows that dowsers do find water. To ignore problems for fear that their solution might involve methods beyond the domain of conventional physics is no more justifiable than would be the banning of research into protons and electrons lest it should lead the investigator beyond the sphere of Daltonian chemistry.

Many years ago Sir William Barrett defied scientific prejudice and took up the study of dowsing. He devoted so much time to the divining-rod in literature and in practice that a systematic statement of his results has been awaited with interest and curiosity. Unfortunately, he died without completing the classification and discussion

of the mass of data in collecting which he had written, as the preface tells us, between 6000 and 7000 letters. Some months before his death, he had secured the co-operation of Mr. Theodore Besterman, with whom he discussed the whole subject, though for the actual arrangement and writing of the book before us the junior colleague accepts full responsibility.

Although the book makes very interesting reading, its arrangement is far less satisfactory than the orderly subdivision in the table of contents might suggest. Mr. Besterman devotes 250 pages to evidence of the reality of the finding of water (and incidentally other things) by the divining-rod, and only about 50 pages, many of them straying back to the earlier theme, to an attempt to explain the mechanism and rationale of the process. The work is divided into three parts. Part I. is entitled "Historical and Geological." The historical portion, after touching on the rise of dowsing in the fifteenth century, gives interesting details of the performances of three famous French dowsers for minerals and water and the tracking of criminals. It includes the strange case of the Abbé Paramelle, a water-finder who used no divining-rod and disclaimed any super-normal powers, yet the authors have decided that he was a dowser *malgré lui*. Much of the geological discussion strikes us as irrelevant and unnecessary, it being clear that none of the famous dowsers had any geological knowledge whatever and could not have located water by the lie of the sub-surface rocks.

Part II., though entitled "Experimental," consists of descriptions of the exploits of a large number of recent and contemporary water-finders similar to that given in Part I., with details vouched for by numerous well-known or highly respectable authorities. Three appendices cite other cases which might appropriately have come in Parts I. and II. Even the short "Part III., Theoretical," continues to adduce fresh evidence as to successful dowsers while setting forth the explanation of the action of the divining-rod arrived at by the authors. There is an excellent index, which will prove useful to students of the subject, and an extensive bibliography, which might have been improved by providing some indication of the size of the books cited.

As to the value of the whole discussion, Mr. Besterman says in his preface :

"Whether the results justify this labour it is for the reader to decide ; but should it be agreed that the ability to find hidden objects by other than normal means has been established, the question can hardly be answered otherwise than in the affirmative."

This is not happily worded, for it fails to define the critical term *normal*, and by extending the use of the divining-rod from the well-established case of water-finding to the detection of minerals, corpses, and even murderers, it makes room for the intrusion of false issues. Sir William Barrett probably went beyond the comparatively simple case of the divining-rod in water-finding because he hoped to reach in one stride an explanation which should include all kinds of cognition of objects undetectable by the 'five senses.' We agree that the evidence brought forward in the book proves the existence of a power in some people, of both sexes and of every age, race, and social position, of detecting underground springs of water which can neither be seen, heard, smelt, felt, or otherwise perceived by the vast majority of mankind. Further than this we are not prepared to go, nor do we think it necessary to seek more recondite explanations until all reasonable hypotheses for bringing the phenomena into line with the recognised or discoverable processes of Nature have been exhausted. The suggestion that radiation or vibration of some kind issuing from running water underground may be detected by the nervous system of the dowser in virtue of some hyperæsthesia is dismissed too curtly (p. 261) as "terminological perversity." The comprehensive explanation which Mr. Besterman tenders in the names of Sir William Barrett and himself (p. 267) to cover all cases of the dowser's detection of hidden things is :

"The several categories of phenomena surveyed above appear to us to lead inevitably to the conclusion that no physical theory can cover the facts. In our view the phenomena of dowsing are due to the following causative chain of psychological and physiological happenings : a suggestion is received by the dowser's subconsciousness by means of a sensibility as yet unknown to us and therefore admirably named by M. Richet cryptesthesia ; . . . the knowledge thus supernormally obtained can become conscious : . . . (1) if the person is one whose access to, and ability to become conscious of, knowledge in his subconsciousness is more continuous and complete than those of the normal person, the cryptesthetic suggestion received by his subconsciousness can almost simultaneously become conscious. . . . (2) By means of unconscious, automatic movements such as those which provide the phenomena of automatic writing. . . . Intermediately between these alternatives may be placed (3) those reactions of the subconscious suggestion which cause the phenomena which may be comprehensively described as the *malaise* of the dowser."

Here a fallacy may lurk, for if "a sensibility as yet unknown to us" is conjectured as conveying cognition to the subconscious whence it obscurely wriggles into the conscious mind, could the unknown sensibility not be as easily conjectured to appeal direct to the conscious mind? If cryptæsthesia is a "sixth sense," as M. Richet suggests, may it not be a sense capable of appreciating directly some physical property of the hidden object? This appears to be Prof. Richet's own view if we translate rightly his letter in NATURE for Dec. 18 (p. 876) on the explanation of "spiritualistic" phenomena:

"The hypothesis of unknown *vibrations* seems to me preferable. After all, why not suppose that reality emits vibrations? Do we not know of innumerable powerful vibrations such as electric and magnetic waves which are only revealed by special detectors and would pass unperceived without the use of these detectors?"

Thus Prof. Richet seems to countenance the idea which occurred to us, before his letter appeared, in reading Sir William Barrett's book, that the *malaise* of cryptæsthesia may be akin to that experienced by some people in thundery weather, which can reasonably be attributed to the action on the nervous system of the electric waves announced by wireless 'atmospherics' in advance of thunderstorms. Investigation must prove whether this is so, or if the recognised senses may in some people attain a state of hyperæsthesia and become capable of acting much more powerfully than under usual conditions. May not some people have a sense of smell (if it is smell) as highly developed as that of the dog which perceives in the dark outside a house the room in which his master is; or a sense of hearing or touch as fine as that of the bat, if that animal indeed navigates dark winding caverns by means of a natural power of echo-sounding?

It may be the prejudice of the student of measurable and calculable things which makes the hypothesis of cognition through the unconscious mind repugnant as an instrument of scientific research, or it may be ignorance of psychological methods which makes us incapable of being convinced by the arguments, while accepting the facts, brought forward in this book. Whether his explanation is right or wrong, Sir William Barrett deserves to be held in grateful memory for accumulating by his enthusiastic labour such a rich store of obscure facts. It is to be hoped that the book will inspire some open-minded investigator versed in physiology and adequately instructed in physics and psychology to make an exhaustive experimental study of the mechanics of the divining-rod and the concurrent physical and mental state of the dowser, with the sole object of seeing how it is done. Observers who take up the subject determined to prove that the whole thing is a piece of humbug, can of course discover nothing.

HUGH ROBERT MILL.

Our Bookshelf.

The Subject Index to Periodicals, 1922. Issued by the Library Association. *K: Science and Technology.* Pp. 136. (London: Grafton and Co., 1926.) 21*s.* net.

WE welcome the appearance of this new part of the "Subject Index to Periodicals" dealing with periodical literature relating to science and technology published in the year 1922. The delay in issuing the volume, however, is very regrettable, the more so since there appears to be little improvement in this respect as successive volumes are produced. The interval of from four to five years which has to be made good by the user of the "Index" to bring his search up-to-date means a serious addition to his labours, and from the point of view of the publishers must undoubtedly tend to hinder an expansion of the subscription list to a degree commensurate with the value of the work offered. Since the interval is now so large, we are inclined to think, provided, of course, that the necessity of bridging the gap as soon as possible be kept steadily in view, that it would be better for the editors to proceed at once with the work on last year's journals so that this could be issued during the current year, and the annual volume thereafter be kept close on the heels of the material covered.

Apart from this, the present volume worthily maintains the reputation of former issues. Some 250 journals are indexed, and the entries are allotted to a very large number of headings covering a wide field, and arranged, as usual, in alphabetical order. Some readers may perhaps derive amusement from the juxtaposition of such headings as *Omnibuses* and *Onions*, but there is no doubt that an index of this description provides for much quicker reference than one arranged on any other system, and when the choice of headings, the allotment of the different entries, and the provision of cross-references, are carried out as carefully as they are in these excellent volumes of the Library Association, there is room only for satisfaction. The inclusion of a list and particulars of the journals indexed would be a great convenience.

Agricultural Research in 1925. Pp. vii+174. (London: Royal Agricultural Society of England, 1926.) 2*s.* 6*d.* net.

THE scope and purpose of this work is sufficiently explained by the following extract from the preface: "There is need for a new publication

which would record, in a concise form, and in language easily understood by the non-scientific, but practical, man all the results of scientific work carried out, not only in Britain, but in other parts of the world, so far as it has bearing on agricultural practice at home." This preface is signed "Devonshire, Chairman Research Committee, Royal Agricultural Society of England." There follow five compilations by recognised authorities on each subject, dealing specially with research 'results' in veterinary medicine, soils and manures, animal nutrition, dairy husbandry, agricultural economics, and agricultural engineering.

No one can quarrel with the merits of the work; each section will certainly prove of interest to research workers in each particular field. But doubts may be expressed as to its intelligibility to the "non-scientific *but* practical man" (the italics are ours—the antithesis is, we hope, unintentional). Much of the language used implies some knowledge, not only of strictly scientific terms (such as metabolism), but also of ideas expressed in an ordinary language (*e.g.* energy) with which the 'practical' man is not familiar. Be that as it may, the names at the head of each section are a sufficient guarantee that the information given is trustworthy and that the praiseworthy objects of the leading agricultural society in Great Britain have been worthily achieved.

A Road to Fairyland. By Erica Fay. Pp. vii + 219. (London and New York: G. P. Putnam's Sons, Ltd., 1926.) 5*s.* net.

"A ROAD TO FAIRYLAND" is dedicated to "all children between the ages of seven and seventy," and the author has indeed provided a variety in her twelve stories in which something should please her clientèle at every stage within these limits of their years. Here and there we catch an echo of the folk tale; but the author has a subtle power of invention and a felicity of phrasing, as well as a humour, now delicate, now broad, which have carried her well on the way to success in the bold and risky undertaking of writing fairy tales. One feature in these stories may be held by some to be open to question. In most of them a moral is to be discerned, and sometimes it is explicitly stated in the good old-fashioned way at the end. The moral has long been condemned; but the healthy normal child does usually love a moral. It is infancy's equivalent to the triumph of virtue in the melodrama of days gone by. Of individual stories, the one with which the book opens, "The Princess," is perhaps the best. It exhibits a knowledge of human nature and a philosophy which makes the best of things that lift it to a higher plane. Palæontologists and metaphysicians with a sense of humour—if there are such—will appreciate the picture of a sabre-toothed tiger in Kent's Cavern being helped to his human dinner by a stalactite, which in so doing sacrifices its devotion to the absolute to gratify a desire for revenge on the human race. It will be seen that the author is something of a philosopher in the style of Andersen—no mean model.

Lime in Agriculture. 1: in Plant Nutrition, 2: in Animal Nutrition; a Handbook for Practical Farmers, Students, and Others. By Frank Ewart Corrie. Pp. xi + 100. (London: Chapman and Hall, Ltd., 1926.) 3*s.* 6*d.* net.

LIME deficiency is generally recognised as one of the main factors causing poor crop yields, but unfortunately in too many cases little or no attempt is made to remedy matters. This is partly due to a failure to realise the considerable improvement that is likely to be made by a judicious lime application, and partly to a lack of knowledge as to the best and most economical materials to use. The author has endeavoured to outline the problem in the simplest manner, emphasising the need for lime in both plant and animal nutrition, and supporting his remarks by reference to the results of modern research work. A very useful feature is a descriptive list of the various forms in which lime may be applied, as the expenses of carriage usually compel the use of the nearest source of supply. The benefits that crops derive from adequate lime are given, but no mention is made of the effect of chalk on heavy land in reducing the resistance offered to the passage of cultivation implements. On the animal side, the nutritive requirements of various classes of stock for lime are considered, together with the sources of supply, as milk, hay, and green fodders, meat and bone meals and fish meals.

An appendix gives a series of illustrative analyses, including some of soils deficient in lime, various types of lime that may be used, lime deficiencies in rations, and the lime and phosphatic acid contents of foods.

Practical Photo-Micrography. By J. E. Barnard and Frank V. Welch. Second edition. Pp. xii + 316. (London: Edward Arnold and Co., 1925.) 18*s.* net.

FOURTEEN years have elapsed since the first edition of this book was published, but it is noteworthy, as the authors point out, that photo-micrography itself has made little advance during this period, though there have naturally been various modifications in the apparatus employed. The reason for this standstill is that microscopy has not advanced, for the best microscopes and miscroscopic objectives of twenty or more years ago are equal to any produced to-day.

After a brief summary on the microscope and its optical parts, illumination is dealt with. It seems scarcely necessary now to enter into such full detail respecting calcium carbide as is done, and no mention is made of paraffin and petrol mantle lamps, which in country districts may be of some service and are useful for printing on 'gas-light' papers in the absence of gas and electric light. The chapters on cameras, the use and manipulation of the microscope, colour screens and exposure, and photographic processes, are excellent, and the authors are able to incorporate many useful 'tips,' the result of their experience. Finally, the illustrations are adequate and clear, and a series of beautiful plates show what may be done by means of photo-micrography.

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 Future of the Natural History Museum, South Kensington.

IN reference to the expression on the part of Prof. Stanley Gardiner and others (see the *Times*, Jan. 13) of a desire for the assignment of an increased grant of public money to the institution known as "the Natural History Museum" (or more correctly as "the Natural History Departments of the British Museum"), will you allow me to say that whilst I share their wish and hope for this increased expenditure, I am strongly of opinion that no such increase should be made until the status, purpose, and organisation of this museum and other related institutions have been made the subject of a thorough and authoritative inquiry, and consequent recommendations by a Royal Commission appointed for the purpose? One or two matters which require the attention of such a commission have long occupied my thoughts, and I should like to indicate briefly what they are without entering at this moment into a discussion of details.

1. The most important point for such a commission to consider is, I think, the establishment of the Natural History Departments as an independent organisation—the "Natural History Museum" or "British Museum of Natural History"—under its own Council, 'Director,' and heads of departments, receiving an adequate grant from the Treasury, and reporting directly to a Minister of State and not to the 'Trustees' of the National Library and departmental collections of ancient and medieval art and anthropology.

2. Such a commission should give an authoritative statement of the scope of the Natural History Museum with a view to its immediate organisation and its future growth and development. No such agreed statement exists. There are two distinct purposes which should (it seems to me) be made by statute equally binding on the administration of the Natural History Museum, namely, (*a*) the 'edification' and instruction of the public by means of exhibition of carefully chosen and prepared specimens, and (*b*) the safeguarding and increase of the vast series of specimens of all kinds of living things from all parts of the world which are the indispensable 'documents' by reference to, and study of, which the biological sciences acquire far-reaching importance.

3. By judicious selection of the specimens to be permanently exhibited to the public with the most effective illumination and display, accompanied by skilful labelling and explanatory illustration, the actual floor-space now occupied by the public exhibits in Cromwell Road could be reduced to one-half of its present dimensions and the enjoyment afforded to the public in no way diminished. At the same time, the space thus set free could be used for the better accommodation of the reference collections and for the necessary 'work-rooms' required by the experts who continually add to the collections and maintain them in a proper state of conservation and order. They publish (under the Museum authority) accounts of new and important additions to knowledge. These publications are made by the staff of the Museum, and also by voluntary workers whose co-operation is welcomed by the official staff.

4. I will venture no further at the present moment than to suggest in the briefest terms some developments of the activities of the Natural History Museum which a Royal Commission might be asked to consider. Thus, for example, since there is, in the judgment of leading zoologists, a need for increased accommodation and expenditure in order to give needful help to the various branches of zoological science at the Natural History Museum, one is led to inquire as to whether it is reasonable to maintain there a Department of Botany, when so splendid an institute of botany is also maintained at the public expense at Kew Gardens. I will not attempt to state either the history or the justification of the existing arrangement. But it is obvious that, were the Botanical Department removed from the Natural History Museum to Kew, a very considerable space would be available for the expansion of the other departments of the Museum. Probably somewhat complicated legislation would be necessary to bring about the completion of Kew by the fusion with it of the Botanical Department of the Natural History Museum. The question worth consideration is whether such a fusion would promote the growth of botanical science.

5. A few words will serve to indicate some other developments which might be submitted to a commission. There is no truly *geological* museum in London. The Geological Department of the Natural History Museum has magnificent and invaluable collections of fossil vertebrates and invertebrates. But they are not there to serve the purposes of the investigator of geological phenomena. They are the records of palæontology. Many men of science would like to see a real museum of the 'geology' of the world, topographical and stratigraphical (not limited as is that of the Geological Survey), fully set out at the Natural History Museum. Another collection which has, by the chapter of accidents, been insufficiently developed at Cromwell Road is that of osteology—the skeletons of vertebrate animals. The fact that the Royal College of Surgeons has a fine series of osteological specimens has led to the relative neglect of this important branch of study by the Natural History Museum. Of late years efforts have been made to remedy this, but space, money, and time are necessary for the assemblage of such a comprehensive collection of osteological specimens as are needed by the modern zoologist, and could only be secured and preserved for reference and study by a great and wealthy museum.

I may just raise another question. Should there not be within the walls of the Museum a lecture-theatre to hold some 200 visitors, where lectures and demonstrations, by means of photographs and lantern, could be given at regular intervals by the Director and lecturers called in by him? The purpose of the lectures would be specially to illustrate and explain the contents of the public exhibition galleries. Copies of the photographs made for the lectures might be sold at the book-stall of the Museum. The lectures would deal with such subjects as "The Classification of Animals," "The Origin of Species," "Geographical and Geological Distribution," "Variation," and "Heredity." Also "Recent Additions to the Museum" should be shown to the public at regular intervals by special lectures.

Lastly, as to expenditure on expeditions and collecting. The Natural History Museum has for many years given assistance to travellers and explorers by "working out" their collections, and often by purchasing specimens or whole collections. Prof. Stanley Gardiner is anxious to extend this line of activity. It is a difficult matter to deal with, since official and private interests and purposes are involved. There is

an obvious way by which important new collections and special specimens may be obtained for the Museum and for the public benefit. There was in 1912 (and possibly still is) in Berlin a Society of the "Friends of Natural History." They were rich men anxious to obtain new and important specimens for the National Museum of Berlin. In 1912 they put down £10,000 and sent five hundred negroes to Tendaguru, fifty miles from the coast of German East Africa, in order to collect the bones of certain gigantic extinct dinosaurs which had been discovered there. They brought these bones successfully, carefully packed in plaister and soft wrappings, to Berlin. Their discoverer, Dr. Fraas, named the largest of these great reptiles 'Gigantosaurus.' Its femur is ten feet in length. Tendaguru is now British, and further collecting of dinosaurs' bones is being carried on by an English party. It seems to me that zoologists should endeavour to set up a society like that of the German "Friends of Natural History." Such a society exists in Great Britain for the purpose of purchasing works of art for the National Collection. The society, by offering to *help* in expenditure for the national collections, might (and in art matters, I believe, does) induce the authorities to make desirable purchases. Our lovers of natural history should follow the example of the Berlin Society and of the English friends of art.

E. RAY LANKESTER.
44 Oakley Street,
Chelsea, S.W.3.

The Genesis of the Great Nebulæ.

WITHIN the mesh of our local star-system are nebulæ of irregular shape, such as the Orion nebula, which are of only slight cosmogonic interest. Far beyond the confines of this local star-system lie the great nebulæ of regular shapes, spiral, elliptic, circular, etc., each of which is comparable in mass and size with our whole star-system. In the December (1926) issue of the *Astrophysical Journal*, Dr. Hubble paints a most fascinating picture of the system formed by the great nebulæ, and frames it in such convincing observational evidence that it would be difficult to reject it.

As seen in a telescope, the great nebulæ differ widely in shape, size, and brightness. But Dr. Hubble brings a mass of evidence to prove that differences in size and brightness between nebulæ of the same shape are almost entirely due to a distance effect. If all the nebulæ were put in a row at the same distance from us, it would at once be seen that nebulæ of the same shape all had approximately the same dimensions and luminosity, while even nebulæ of different shapes would exhibit only comparatively small ranges of dimensions and luminosity, especially the latter.

This makes it possible to estimate the distances of all nebulæ, even the very faintest, with fair accuracy. The faintest which can be observed photographically in the 100-inch telescope are of about 18th magnitude, and these must be at the amazing distance of about 140,000,000 light-years. Within this distance some two million nebulæ must lie. Dr. Hubble finds that these are fairly uniformly spaced at an average distance of about 1,800,000 light-years apart. To construct a model, take 20 tons of walnuts and space them at about 25 yards apart, thus filling a sphere of about a mile radius. This sphere is the range of vision of the 100-inch telescope; each walnut is a nebula containing matter enough for the creation of perhaps a thousand million suns like ours; each atom in each walnut is a solar system with a diameter equal to that of the earth's orbit.

With minor exceptions, all the different shapes of nebulæ can be arranged to form one continuous sequence, and this sequence is almost certainly evolutionary. Indeed, to my great gratification, it coincides almost identically, as Dr. Hubble remarks, with the evolutionary sequence I predicted for nebulæ, on purely theoretical grounds, in 1917 ("Problems of Cosmogony"). An initial sphere of gas gives place first to an oblate spheroid, and then to a lenticular figure. After this last configuration is passed, gas streams away from the nebular equator, generally in two symmetrical streams or arms. Granulations and condensations next begin to develop in these arms, each condensation ultimately forming a separate star, until finally the whole nebula is transformed into a star-cloud. Thus the great nebulæ prove to be the birth-places of the stars.

Long before I was able to trace out this complete evolutionary sequence, I had been able in 1901 to take a step in the reverse direction, and show that the stars had in all probability been born out of a uniform mass of tenuous gas by a process which I designated "gravitational instability." I calculated first that if all the matter in the present stars were uniformly spread out in space, it would form a gas of density about 10^{-23}. A dynamical investigation next showed that such a medium would be unstable, and that, as a consequence of this instability, it would break up, much as a jet of water breaks into drops, into condensations whose distances apart were a matter for calculation; on making the calculation these distances were found to be about equal to the actual average distance of the stars. Thus the single supposition that the stars had been born out of a uniformly spread mass of gas explained at one stroke the facts that the stars are of approximately equal mass, that they are spaced at approximately equal distances apart, and that these distances are what they are.

Dr. Hubble now finds that the nebulæ also are of approximately equal mass, that they are spaced at approximately equal distances apart, and that these distances are about 1,800,000 light-years. It is natural to inquire whether these facts cannot be explained at one stroke by the supposition that the nebulæ themselves came to birth as condensations produced by the gravitational instability of a still earlier and more tenuous mass of uniform gas. The test of the conjecture is of course by numerical calculation.

Dr. Hubble estimates that if the matter of the nebulæ were uniformly spread through space, it would form a medium of density $1{\cdot}5 \times 10^{-31}$. My theoretical formulæ ("Problems of Cosmogony," p. 219) show that instability would cause such a medium to form condensations at approximately equal distances of the order of 1,000,000 light-years. This is near enough to Dr. Hubble's observed distance of 1,800,000 light-years to make our conjecture seem reasonably probable.

If it is accepted, we have been able, with the help of the new knowledge gained by Dr. Hubble, to trace the evolution of the universe one step farther back than has been done before. We have in succession:

1. A uniform tenuous gas of density 10^{-31} and of diameter at least hundreds of millions of light-years.
2. Condensations developing in this gas at about a million light-years apart, and forming separate nebulæ with masses of the order of a thousand million suns.
3. Condensations developing in turn in the arms of these nebulæ, and forming stars with masses of the order of our sun.

To these, if my 'Tidal Theory' of the origin of the solar system (Memoirs, R.A.S., 1917) is accepted, may be added:

4. Condensations developing in the arms of gas pulled out from the stars by the tidal action of other passing stars, and forming bodies of planetary mass.

5. Condensations similarly developing in the arms of gas pulled out tidally from the planets, and forming bodies of mass comparable with the satellites of the planets.

This scheme covers five complete generations of astronomical bodies, having masses of the order of 10^{48} (or more), 10^{42}, 10^{34}, 10^{29}, 10^{25} gm. respectively, the birth of each generation from the preceding generation being through the agency of "gravitational instability" (*Phil. Trans.*, 199, A (1902), p. 49). It is based on *verae causae*, namely, the law of gravitation and the properties of the gaseous state of matter, and survives at each step the test of numerical computation and comparison.

J. H. JEANS.

Feb. 13.

Wave Mechanics and the Rotation of Homopolar Molecules.

IN a letter to NATURE (April 17, 1926, p. 555), J. C. Slater suggested an explanation of the 'quarter quantum numbers' used in describing the band spectra of homopolar diatomic molecules by assuming that, on the basis of the old quantum theory, the momentum was to be integrated about a half period only, since the molecule repeats itself after a rotation of 180°. This explanation finds its natural analogy in the new wave mechanics of Schrödinger, and leads to an interesting suggestion regarding the general solution of the wave equation.

In its usual form the wave mechanics presents a wave equation $(H - E)\psi = 0$, where H is an operator derivable from the Hamiltonian function and E is the energy constant. It is assumed that only such solutions of the equation have a meaning for which ψ is a regular single-valued function vanishing on the boundaries.

The problem of the diatomic rotator has been solved by Schrödinger and others, who have found the following expressions for the energy and for Y where Y is that part of ψ depending solely on the space co-ordinates, in the present case upon the spherical co-ordinates θ and ϕ,

$$(1) \quad E = \frac{h^2}{8\pi^2 I}(j^2 + j), \quad j = 0, 1, 2, 3, \ldots$$

$$(2) \quad Y = P_{jm}(\cos\theta).(a_m \cos m\phi + b_m \sin m\phi), \quad m = 0, 1, 2, \ldots j,$$

where $P_{jm}(\cos\theta)$ is the Legendre function of the mth order.

To extend this solution to the case of a homopolar diatomic molecule, we have only to remember that by such we mean a molecule the two atoms of which are identical in mass and charge, that is, a molecule which repeats itself when it is rotated through 180°. In the wave mechanics this is clearly equivalent to the condition that only such solutions of the wave equation are to be accepted for which Y remains unchanged when $\theta \longrightarrow \pi - \theta$ and $\phi \longrightarrow \pi + \phi$. This will be the case when j is an even integer ($j = 0, 2, 4, \ldots$), m being as before any integer odd or even.

The energy and wave function are still given by equations (1) and (2) subject only to the limitation that j shall have even integral values. It may be remarked that while we have treated the molecule as a rigid rotator, no new features are presented by taking into account the vibration of the nuclei, since such vibration does not alter the homopolar character of the system.

In applying the result just obtained to the band spectra of homopolar molecules, we notice that only bands involving a change in the electronic energy will be observed, and that if these are of the usual type possessing positive and negative branches, either the initial or the final state of the molecule must be non-homopolar. For example, if we take the excited state to be non-homopolar, we have for the energies

$$E_i = h\nu_0 + hA'(j^2 + j), \quad j = 0, 1, 2, 3, \ldots,$$
$$E_f = hA(j^2 + j), \quad j = 0, 2, 4, 6, \ldots.$$

The selection rule is as usual $j \longrightarrow j \pm 1$ or $j \longrightarrow j$, and the transition probabilities are given by the usual formulæ for dipole molecules. This leads to a set of band lines which correspond directly to those obtained previously by the use of quarter quantum numbers. While this is very satisfactory, a closer inspection shows that the theory is not in agreement with other features of the observed bands. Thus we should expect the zero branch to be given by the formula

$$Q_j = \nu_0 - (A - A')(j^2 + j), \quad j = 0, 2, 4, \ldots,$$

whereas, for example, in the helium bands found by Curtis and Long (*Proc. Roy. Soc.*, A, 108, p. 513, 1925) the zero branch is very accurately represented by another relation, namely:

$$Q_j = \nu_0 - (A - A')(j^2 + j), \quad j = 1, 3, 5, \ldots.$$

Furthermore, when j is allowed to have only even integral values, we obtain a specific heat curve which seems to be quite impossible, since the value of Cr/R rises to an abrupt maximum of about 1·5, thus giving a curve which in no way resembles the observed specific heat curve of H_2.

A way out of these difficulties may be found by employing a new postulate in the wave mechanics, namely, that, given the wave equation of Schrödinger, we shall seek such solutions to it for which the function $\psi\bar{\psi}$, rather than ψ alone, shall be a regular single-valued function where $\bar{\psi}$ is the conjugate to ψ.

This assumption, which we believe has also been suggested by Heisenberg, has much to recommend itself by being more nearly in accord with the spirit of the new mechanics, since the function $\psi\bar{\psi}$ seems to represent the electrical density, whereas the function ψ alone has no such physical meaning.

Applying this new assumption to the homopolar molecule, we are led to two independent solutions, the first of which is equivalent to the solution already obtained.

$$\left.\begin{array}{ll} (3) & j = 0, 2, 4, \ldots \\ (3') & j = 1, 3, 5, \ldots \end{array}\right\}, \quad E = \frac{h^2}{8\pi^2 I}(j^2 + j).$$

These solutions, which are each complete in themselves and admit of no intercombination, seem to correspond respectively to the symmetrical and anti-symmetrical solutions found by Dirac and Heisenberg for systems composed of two or more identical parts.

The empirical relations found to exist among the lines of the helium bands by Curtis and Long (*l.c.*) may now be shown to be just those consistent with solution (3′), although the numerical values of the moments of inertia given by them must be increased by a factor of four.

S. Werner (*Proc. Roy. Soc.*, A, 113, p. 107, 1926) has observed recently a band spectrum of H_2 in the far ultra-violet. We find that the majority of the band lines may be arranged in P, Q, and R branches the positions of which agree with the lines derived from (3′) when we assume the final or unexcited state to be homopolar, an assumption which appears very satisfactory,

since Werner's H_2 bands evidently correspond to the Lyman series of the H atom.

The band constants vary somewhat from band to band, but lead to a moment of inertia for the excited molecule of about 10×10^{-41} and for the unexcited molecule of about 6×10^{-41}. The value of the moment of inertia of the excited molecule is of the same order of magnitude as the moments of inertia found from some of the bands of H_2 in the visible region. Since the visible bands correspond to transitions in which both states of the molecule are excited, it is probable that in both states the molecule is non-homopolar, in which case we should continue to employ the usual formula for the diatomic molecule.

Equation (3′) leads to a specific heat curve for the homopolar molecule, which rises without a maximum asymptotically to the value $Cr/R = 1$. In the case of hydrogen the curve fits the experimental data rather well, although it rises somewhat too steeply in the region between 150° and 250° absolute and gives as the value of the moment of inertia of the molecule $6{\cdot}7 \times 10^{-41}$, in substantial agreement with the moment of inertia for the unexcited molecule found from Werner's bands.

We shall now give briefly the results we have obtained for other rotator systems by accepting those solutions to the wave equation for which $\psi\bar{\psi}$ is a regular single-valued function. For the simple dipole diatomic molecule two solutions present themselves:

$$\left.\begin{array}{ll}(4) & j = 0,\ 1,\ 2,\ 3,\ \ldots \\ (4') & j = \frac{1}{2},\ \frac{3}{2},\ \frac{5}{2},\ \ldots\end{array}\right\}, \quad E = \frac{h^2}{8\pi^2 I}(j^2 + j).$$

As is well known, only the first solution (4) leads to a set of band lines in agreement with the observed band spectra of such molecules. A closer investigation seems to show, moreover, that (4′) has only a formal character and could only apply to molecules for which one could exclude *a priori* the possibility of their ever possessing an electronic angular momentum about the figure axis.

We have also considered the case of the symmetrical top molecule (*i.e.* a polyatomic molecule with moments of inertia $A = B$ and C) and find that the wave equation leads to two independent solutions for which $\psi\bar{\psi}$ is a regular single-valued function.

$$\left.\begin{array}{ll}(5) & \left\{\begin{array}{l} j = 0,\ 1,\ 2,\ \ldots \\ n = 0,\ \pm 1,\ \pm 2,\ \ldots\ \pm j\end{array}\right. \\ (5') & \left\{\begin{array}{l} j = \frac{1}{2},\ \frac{3}{2},\ \frac{5}{2},\ \ldots \\ n = \pm\frac{1}{2},\ \pm\frac{3}{2},\ \pm\frac{5}{2},\ \ldots\ \pm j\end{array}\right.\end{array}\right\},$$

$$E = \frac{h^2}{8\pi^2}\left[\frac{1}{A}(j^2 + j) + \left(\frac{1}{C} - \frac{1}{A}\right)n^2\right].$$

These solutions are each complete and allow of no intercombinations, and so far as can be seen the energy of a molecule of this type might be given by either (5) or (5′) but not in any case by a combination of the two. Equation (5) is exactly that already given by F. Reiche (*Zeit. für Phys.*, 39, p. 444, 1926) and by R. de L. Kronig and I. I. Rabi (NATURE, Dec. 4, 1926, p. 805) for the symmetrical top molecule, on the basis that the function ψ was to be regular and single-valued. On the other hand, by means of the Born-Heisenberg matrix mechanics, I have obtained two solutions to the problem which correspond exactly to the solutions given above (*Phys. Rev.*, 28, p. 318, 1926).

In the foregoing discussion of the symmetrical top molecule we have assumed that $\psi\bar{\psi}$ will remain unchanged for a rotation of the molecule of 360° about the figure axis as well as for a complete rotation about the precision axis.

If, however, the molecule has a symmetry element in the position of its particles, we must introduce further conditions. For a molecule which repeats itself after a rotation of $2\pi/k$ about the figure axis we find the two independent solutions,

$$\left.\begin{array}{ll}(6) & \left\{\begin{array}{l} j = 0,\ 1,\ 2,\ \ldots \\ n = 0,\ \pm k,\ \pm 2k,\ \ldots\end{array}\right. \\ (6') & \left\{\begin{array}{l} j = \frac{1}{2},\ \frac{3}{2},\ \frac{5}{2},\ \ldots \\ n = \pm\frac{k}{2},\ \pm\frac{3k}{2},\ \pm\frac{5k}{2},\ \ldots\end{array}\right.\end{array}\right\},$$

$$E = \frac{h^2}{8\pi^2}\left[\frac{1}{A}(j^2 + j) + \left(\frac{1}{C} - \frac{1}{A}\right)n^2\right]$$

where the absolute value of n is less than or equal to j in both cases.

It is with great pleasure that I thank Prof. E. Schrödinger for many suggestions and for many helpful criticisms during the course of the work. I hope to publish in the near future a more detailed paper covering the calculations.

DAVID M. DENNISON.

Zürich, Dec. 23.

Refraction of Electromagnetic Waves round the Earth's Surface.

J. A. FLEMING (*Proc. Phys. Soc. Lond.*, 26, 318-333, 1914) reached the conclusion that the variation with height of the dielectric constant of the atmosphere would bend a ray sent out tangentially to the earth's surface so that its radius of curvature would be about four times that of the earth. Furthermore, he found that, if the atmosphere were constituted wholly of krypton, a horizontal ray would have a radius of curvature equal to that of the earth, on account of its greater density.

As the radius of curvature in air is comparable with that of the earth, we thought it possible that the angle of incidence of the wave on the Heaviside layer would be so affected as to make the apparent height of the layer too great. Although we find this effect to be quite negligible, we came across a point which may be of interest—namely, if electromagnetic waves sent upwards are to return, the effective value of the dielectric constant must change with height in a definite manner.

From recent investigations it appears that from 40 km. to 150 km. above the earth's surface the temperature rises from 220° A. to 300° A. We assume that this change is linear and that the constitution of the atmosphere remains unchanged. These two assumptions, combined with the values of density and height tabulated on p. 72 of Humphreys' "Physics of the Air," give to a fair approximation the following empirical law connecting density d and height h in kilometres:

$$d = 0{\cdot}0013\, e^{-0{\cdot}14h}.$$

The well-known relation between dielectric constant K and density, that

$$(K - 1)/(K + 2) \propto d,$$

combined with the equation for d, gives the empirical relation

$$K = K_0 + \rho e^{-\alpha h},$$

from which the value of ρ is $0{\cdot}59 \times 10^{-3}$, taking $\alpha = 0{\cdot}14$, and $K_0 = 1$.

Considering the earth as plane, it can easily be shown that a ray starting from the earth's surface at an angle of elevation ϕ_0 will become horizontal at a height y given by

$$-\alpha y = \log_e [(\rho \cos^2 \phi_0 - \sin^2 \phi_0)/\rho].$$

This cannot hold unless $\tan^2 \phi_0 < \rho$, whatever may

be the value of α. This means, in the case of the earth, that a ray starting at an angle of elevation of more than 1°·5 cannot return to the earth if the above law for K holds. If, on the other hand, the signs of both ρ and α are changed, rays at any angle would eventually return.

The equation, when we take account of the earth's curvature, is

$$\cos\phi/\cos\phi_0 = R[1+(1-e^{-\alpha y})\rho/2]/(R+y),$$

where ϕ is the angle of elevation of the ray at any point, y the distance of the point from the surface, and R the radius of the earth.

When the ray is parallel to the earth's surface $\phi = 0$. Therefore

$$\sin\phi_0 = 1 + y/R - (1-e^{-\alpha y})\rho/2.$$

From this equation conclusions can be drawn similar to those obtained above when considering the earth's surface as plane.

We thus arrive at the result that the general condition under which a ray can return from the upper atmosphere is that the second differential of the dielectric constant with regard to height should be negative. In the case of the earth's atmosphere the density, according to the assumption given above, varies in such a manner that this differential is positive. The conclusion does not hold for rays at angles of elevation of less than 1° or 2°.

J. STUART MCPETRIE.
RAYMOND M. WILMOTTE.

National Physical Laboratory,
Teddington, Middlesex,
Jan. 28.

Melanism in the Lepidoptera and its Evolutionary Significance.

IN the interesting article by Dr. J. W. Heslop Harrison in NATURE of Jan. 22 on experiments with Lepidoptera, there appears the following: "Thus we are dealing with a case of evolution directed by the environment, and presumably, therefore, of the Lamarckian order. Naturally, this view has been strongly contested by the opponents of the Lamarckian position, but, let it be emphasised, not one of those so opposed has studied the subject in the field. On the other hand, field workers are unanimous in giving it vigorous support."

I do not underrate the importance of the work of Dr. Harrison, nor do I question the accuracy of his fascinating experiments. But I must confess that I cannot understand the reference to field workers in the passage quoted. Does not the question at issue here concern the interpretation of laboratory experiments? Let us admit that in the industrial areas a tendency for certain Lepidoptera to become melanotic has been clearly demonstrated. Harrison and Garrett have shown that feeding the caterpillars with metallic salts produces the same effect, and that this induced melanism is inherited. There is, however, no evidence in the experiments that a somatic change has produced a germinal change. On the contrary, the melanotic changes did not appear in the first generation treated, but in succeeding generations. It seems just as likely, therefore, that the germ plasm has been influenced before the soma. As Harrison states near the end of his article, the experiments "demonstrate . . . that the germplasm can be influenced by external agencies." They do not supply any further evidence in support of what is usually understood by the term "Lamarckism," although their importance in other directions will be far-reaching.

W. J. DAKIN.
The University, Liverpool,
Jan. 24.

IF reference is made to my original article, it will be found that in his letter Prof. Dakin simply repeats my own views, as he himself realises when he quotes from my concluding remarks.

This position I emphasise further in a paper with the title "Experiments on the Egg-laying Instincts of the Sawfly, *Pontania salicis* Christ., and their Bearing on the Inheritance of Acquired Characters; with some Remarks on a New Principle in Evolution," which appears in the current *Proceedings of the Royal Society* (B), the 'new principle' being seen in a differentiation of that governing the melanism work from those covered by the term 'Lamarckism.' In that communication, without any possibility of misunderstanding, I state: "Clearly such evolution as is pictured at work here is not of the Lamarckian order; most likely the influences at work act directly and simultaneously on soma and germ alike, or even on germplasm alone, and, indeed, the latter view obtains concrete support from the *Selenia bilunaria* work."

However, in my opinion and in that of many other workers, if a chemical substance ingested with the food can influence the germplasm, then the germplasm can be affected through the soma. In connexion with this I ask Prof. Dakin to consider, in particular, the relation between the two existing in plants, as demonstrated in plants raised from leaf-cuttings and by other vegetative means.

J. W. HESLOP HARRISON.

Changes in the Length of the Day.

THE article by Dr. E. W. Brown on "Changes in the Length of the Day" in NATURE of Feb. 5 cannot fail to attract attention. To avoid any possible misunderstanding I think I ought to explain that the references which Dr. Brown makes to my results refer to my paper, "A Solution of Ancient Eclipses of the Sun," published in the *Monthly Notices of the Royal Astronomical Society*, Dec. 1920, not to my paper entitled "Trepidation" in *Monthly Notices* for Dec. 1926, which Dr. Brown had not seen at the time of writing. In the latter paper I show that if we adopt 4″·8 as the change in the apparent longitude of the moon in a century, due to any acceleration not recognised in the existing gravitational theory or to changes in the length of the day, the Greenwich meridian observations give $1''\cdot36 \pm 0''\cdot15$ as the corresponding change in the apparent longitude of the sun, thus confirming the result which Dr. Brown cites from my work on ancient eclipses. I also find that any correction to the assumed century accumulation for the moon requires a correction of 1/9·5 as much to the deduced accumulation for the sun, so that the latter term is very little dependent on the value obtained for the lunar term.

In the same paper I show that the fluctuations to which Dr. Brown refers are found not only in the longitudes of sun, moon, and planets, but also (1) in the amplitudes of the inequalities produced by the action of Venus in the motion of the earth and of Mars, and (2) in the motion of the equinox. These results are inconsistent with the theory which attributes the fluctuations to a variation in the rate of the earth's rotation. I also find that the Greenwich meridian observations give not 1 in 13·3 as Dr. Brown has assumed, but 1 in 9·5 as the ratio between the fluctuations of the sun and moon.

It is probably too early to give a final explanation of these interesting fluctuations, but it is clear that there is a fluctuation in the total action on the earth, which determines its mean motion, amounting to between one-third and one-fourth of the fluctuation in the action of Venus, but in the opposite direction, so that an increase in the action of Venus is

accompanied by a diminution in the total action, and vice versa. This seems to imply something like an interchange of mass between the sun and Venus and perhaps between the sun and other planets. In other words, I think Dr. Brown was right when in 1914 ("Report of the British Association," pp. 319-21) he attributed the fluctuations to a surge spreading through the solar system, and I think he has too readily adopted the theories of others who have tried to explain them as changes in the length of the day.

On this subject I have expressed the conclusion: "We may therefore declare with confidence that while the earth's rotation may be affected by a secular retardation, it is certainly not affected by a fluctuation" (*Monthly Notices*, Dec. 1926, p. 163).

J. K. FOTHERINGHAM.

University Observatory, Oxford, Feb. 9.

Rotation of Dielectric Bodies in Electrostatic Fields.

THE phenomenon of rotation of dielectric-surfaced cylinders between the poles of a Wimshurst machine, described by Dr. Richardson in NATURE for Feb. 12 (p. 238), and recently demonstrated by him, does not appear to differ in any essential feature from that exhibited by the old toy "electrostatic motor," consisting of several insulating spokes radiating from an axle, and each surmounted by a light celluloid or other ball. This rotated between oppositely charged knobs. The cause of rotation is presumably identical in both cases. The same result could doubtless be obtained by using a conducting surface broken up by insulating strips, as on the commutator of an ordinary D.C. motor.

CHARLES RECORD.

Technical College, Huddersfield.

Biological Fact and Theory.

I HAVE noticed that people who are good at solving cross-word puzzles are also very good at understanding those complex statements of Mendelian results. I am distressed at my inability to worry out cross-word exercises and also those F_1, F_2, etc., synoptical charts, for I feel I may be missing something that will help in an understanding of genetical problems. It would be comforting to know if there are other biologists who admit the same disability.

What, however, are the 'fundamentals of genetics,' and what is this 'whole discipline of biology' that is going to give us the key to the processes of development? Is breeding cats, and cocks and hens, and flies, and so on, such fundamental research? A 'gene' is, I suppose, a physico-chemical entity: at least, it *ought to be* such so long as we study development by chemical and physical methods. We know that it is something that grows, like a crystal of alum selects molecules of alum from its mother-liquor, or 'environment'—the two kinds of growth differ, of course, but let that pass. It selects materials from the nutritive environment and then it reassembles these materials in new chemical forms, but it also reassembles the chemical products in typical morphological constellations. How? This is *the* fundamental genetical problem.

Then a 'gene' has a quasi-independence even if it is 'linked.' It is interesting to see how genes retain their quasi-independent activities so as to continue to give us 'bar-eye' and 'spot' and 'plain' and 'red-eye,' for example, but still a red-eyed Drosophila is always a Drosophila, and so also with the four hundred other characters which presumably express the activities of as many genes. All the time we are looking at the morphological entity that we call Drosophila and 'bar-eye,' or 'red-eye,' or whatever it be, is always related to nervous system and muscles and wings and so on in a typical manner. Can there be a 'super-gene'; in other words, what is the physico-chemical mechanism that results in the development of Drosophila? This, I take it, is really what is fundamental to a knowledge of the developmental process. The appearances in the cell nucleus do not help us much, for no one now takes the crude view that the parts of the chromosomes *are* the genes. It is difficult to see how we shall advance along these lines by "building on the ample foundation already obtained by tens of thousands of breeding tests."

JAS. JOHNSTONE.

The University, Liverpool.

Illinium.

IN a copy of *Gaz. Chim. Ital.* (56, 862; 1926) received a few days ago, Prof. Rolla, of Florence, claims priority for the discovery of element No. 61, and proposes for it the name Florentium on the basis of a "Plico Suggellato" filed in June 1924. Prof. Rolla began his search for the element early in 1922 (see *Z. anorg. allgem. Chem.*, 157, 571; 1926). In making his claim for priority he was, apparently, not aware of the following facts:

In 1919 the University of Illinois and the U.S. Bureau of Standards entered on a joint investigation of the arc spectra of rare earth elements, using materials resulting from long-continued fractionations carried out at the University of Illinois. The results of this investigation were published in the U.S. Bureau of Standards Scientific Papers, 421 (1921), 442 (1922), 466 (1923). In the second of these papers, published at about the time that Prof. Rolla began his work and two years before his "Plico Suggellato" was deposited, Dr. Kiess, who carried out the spectrometric studies, reported 130 spectral lines which were common to the spectra of neodymium and samarium, in the samples submitted to him by Prof. Hopkins, and says, "These lines are of unknown origin and may belong to the missing element of order No. 61, coming between neodymium and samarium."

In January 1924, again five months before the deposit of Prof. Rolla's document, L. F. Yntema published an article, "Observations on Rare Earths. XV. A Search for Element 61," in which he gives five additional lines in the ultra-violet region, and repeats the statement that these probably belong to Element No. 61 (see *J. Amer. Chem. Soc.*, 46, 37; 1924). Finally, on the basis of still further work, including the finding of two X-ray lines of the *L* series, J. A. Harris with B. S. Hopkins announced the discovery of element 61 and proposed the name Illinium (see *J. Amer. Chem. Soc.*, 48, 1594; 1926).

In the light of these facts it would seem that the honour for the discovery of No. 61 belongs primarily to Prof. Hopkins, and that the element should be called Illinium rather than Florentium. This does not detract from the credit which Prof. Rolla should receive for his independent discovery of the element. Both Prof. Rolla and Prof. Hopkins realise that a large amount of additional work must be done before the element can be fully accepted.

W. A. NOYES.

Urbana, Ill., Jan. 29.

ERRATUM.—We regret that the inscription appearing below Fig. 1 in Prof. John Percival's letter in our issue of Feb. 19, p. 280, was incorrectly printed. It should read: "Grains of wheat found in a vase on the site of a Sumerian house (3500 B.C.). Below are two rows: the upper row of the Sumerian grain, the lower of modern grains of Rivet wheat (*T. turgidum*) for comparison. (Natural size.)"

The Dinosaurs of Tendaguru.

By F. W. H. MIGEOD.

THE expedition sent out by the British Museum in 1924 to Tanganyika Territory to explore the dinosaur remains at Tendaguru broke down in the following year on the death of Mr. W. E. Cutler, the leader, in August 1925.

I was appointed leader in his place, and work was resumed on my arrival in November of the same year. Although the rainy season was coming on I decided to begin at once, and was glad to find that the rains were not heavy enough to be a serious impediment. Occasionally a digging might be flooded if the possibility of drainage was not very good; in which case it had to be baled out. I reckon that in this region continuous work all the year round is possible, and when I left to return to England in November last, I made arrangements for the digging to be continued in my absence. This naturally ensures a much bigger output in the twelve months.

FIG. 1.—Excavating a small dinosaur at Tendaguru.

Nevertheless, prospecting is limited to the dry season. One has only to walk about the country in the neighbourhood of Tendaguru hill after the grass is burnt to see how vast is this graveyard of dinosaurs. There is an area of perhaps three miles width east and west and ten miles north and south where they may be found. Denudation in the course of ages has removed the many strata of rock that ages piled up on their remains immediately after their extinction; and once again these bones lie close to the surface. Most of the damage to them has been done in quite recent years through the penetration of the roots of plants and trees. At the present day they lie at an average level of 700 ft. above the sea, and fragments on the surface commonly, though by no means always, give an indication of where bones may be dug for. Yet further, the stratum is not always an indication, for the dinosaurs I collected lay in several different kinds of ground, as in clays of more than one kind, some stratified and some much contorted, in loose sand and in harder sand rock.

Exploration in the twelve months under review was made in thirteen different sites round Tendaguru hill, and the yield of fairly complete dinosaurs was considerable. There is possibly enough material partly to reconstruct some two dozen skeletons representing a considerable number of different species, and work has been begun on them in the Natural History Museum at South Kensington.

Some of the specimens are naturally more interesting than others. My first dinosaur excavated was a small one (Fig. 1), but near it lay the skeleton of another which eventually required eighty carriers to take it down to the port of Lindi for final packing and shipment. This one when examined may prove to be a brontosaurus. As an indication of its size I may mention that the scapulæ were 48 inches long by 28 inches at the widest part. The greater part of the body had lain on a bank, but a small stream of the distant age, of course, when that dinosaur lived and died, flowed by and had disturbed the remains on one side, some of the bones showing strongly the destructive action of this water. The pelvis, dorsal vertebræ, and upper-limb bones were mostly clear of this stream, though at no great height above it; but mixed with the lower bones were numerous river-worn pebbles, and in the case of one rib two smooth pebbles were tightly jammed under it, causing it to bend and of course break, which could only have taken place after the flesh was decomposed.

Another skeleton, that of a slender animal perhaps forty feet long, was interesting from the fact that the tail when excavated lay out on the ground complete. It was fifteen feet in length, and near the body it had been pressed down into the mud some two feet deep. It had not been completely severed, but two vertebræ nearest the pelvis were hanging vertically, there were two or three at the bottom, and one or two nearly vertical again, the upper one joining the unbroken part of the tail. It was as if at death, or shortly after, some other huge dinosaur had set its foot on the tail in passing and pressed that part of it down into the mud. The dimensions of some of the bones of this dinosaur were: femur 51 inches, scapula 44½ inches, humerus 33 inches. The fore part of the body was on a slightly lower level than the hind part and tail, and the head and neck, which were displaced, were in such a position as if it had died in drinking or trying to drink water. The body lay generally on a very dark-brown clay which I found nowhere else, and a feature, unique

so far as my own excavations were concerned, was that, enclosing the bones, was a green matrix which did not exist apart from the bones (Fig. 3).

Of the sites which I worked two were cuttings into hillsides, and accordingly progress was slower here than on the flat. The hillside excavation that was especially interesting in its results was the one which I made into the side of Tendaguru hill itself. This hill stands on the top of the deposits, and represents a piece of old land left rising up like an island, and undenuded comparatively. By getting well into the lower slopes I hoped to reach bones that had not been attacked by the roots of plants and trees. Two strata of bones revealed themselves here. The upper, in the greenish-grey clay, held some bones of large size belonging to a four-footed dinosaur with the fore limbs longer than the hind ones apparently, and which was possibly a brachiosaurus. A femur in excellent preservation measured 67 inches and weighed nearly 4 cwt. when plastered and ready for removal (Fig. 2). A humerus measured 60 inches with the ends incomplete. This grey stratum rested on another of sand, and here, at the meeting of the two strata, other bones, of an apparently different type of dinosaur, were found. On this lower level and near these latter bones lay a tree trunk 26 feet long, with peat adhering, and other finds on this lower level were numerous bi-valve shells of small size, and traces of lignite, as well as impressions of leaves.

FIG. 2.—A femur 67 in. long, plastered and ready for removal.

FIG. 3.—Tail of a dinosaur in the foreground.

One of my sites furnished, in a space of 88 feet by 64 feet, a vast accumulation of bones which may prove to represent as many as twenty dinosaurs; and beyond these limits there were indications of many more. There was here what had the appearance almost of a battle-ground. We may figure to ourselves a region suffering a process of desiccation such as is going on in lands bordering on the southern Sahara at the present day, and coming on again in the Tendaguru region too. All living things flocked to the remaining pools of water for vegetation to eat and such water to drink as was left in the bed of a dried-up river; and they perished miserably one on the top of the other. A subsequent good rainy season could not help them as all was over. Sand swept over them and covered their remains, and the brief annual flow of the river in later years buried them in mud and sand. Here, as a matter of fact, there was very little clay. The deposit was principally sand, varying from a hardish yellow sandstone to loose and clean white sand.

Though this site did not furnish any bones of outstanding size, the biggest femur being 55 inches and biggest humerus 40 inches, it was interesting to find bones of quite young dinosaurs, one pair of femora measuring only 14 inches.

The position of the bones inclines one to the opinion that the dinosaurs here did not all lay themselves down to die in peace. There was much trampling by reptiles weighing several tons on others already dying or dead, which would cause some breakage of bones. There were bones which seemed to show breakage at or immediately after death, and while the muscles were still operative, one being a femur. Other bones, too, seemed to show fractures made during lifetime which healed without being set. The difference between these fractures and the clean ones made after fossilisation and due to earth tremors or

stresses or to the recent action of vegetation, are readily apparent.

The dinosaur field of Tendaguru is by no means yet worked out. One might almost say it has only been scratched. That future work will yield many duplicates of the species already found is only to be expected, but it would be a serious scientific loss to the world if the area were exploited on lines of only taking certain bones and abandoning all others to perish from exposure simply because no immediate use can be made of the output. To cover up the bones again is not the same thing as leaving them untouched. In the circumstances, in view of the already considerable output, the preparation of which will take the British Museum some years, future field work at Tendaguru will be of a limited nature, and be carried on only in places where there is reason to believe in a possibility of different species being found.

Interionic Forces in a Completely Dissociated Electrolyte.[1]

By H. HARTLEY, C.B.E., F.R.S.

ONE aspect of the solution problem which has lately come into prominence is the effect of the forces acting between electrically charged ions. Faraday was much impressed by what he called "the enormous electric power of each particle or atom of matter," that is, the large size of the ionic charge. Helmholtz in his Faraday Lecture gave a calculation showing that the attractive force between the electrical charges associated with equivalent quantities of oxygen and hydrogen is 71,000 billion times greater than the gravitational attraction between these masses. It would seem obvious that such forces as these must affect the behaviour of ions. However, the difficulties in the way of a mathematical analysis of the effects of the electrical forces between ions in solution were considerable, and the problem was not attacked successfully until thirty years later.

Sutherland in 1907 was the first to suggest that electrolytes were completely ionised at all concentrations and that the interionic forces were in part responsible for the change in equivalent conductivity with concentration. In 1909, Bjerrum found that the molecular colour of chromium solutions was independent of dilution in the absence of complex ions, and explained his results on the basis of complete dissociation. He pointed out that the old difficulty with regard to the Mass Law would be removed if the interionic forces were entirely responsible for the variation of the equivalent conductivity and of the molecular freezing-point depression with dilution, as there would be no question of any equilibrium between ions and molecules.

The theory was supported by the additive properties of solutions of electrolytes and by the small change in the heat of neutralisation of strong acids and bases with dilution. In 1912, Milner succeeded in calculating the freezing-point depression of an electrolyte at different concentrations on the assumption of complete dissociation, by taking into account the change in potential energy of the ions on dilution. He pointed out that as a result of the electrical forces between them they would be so distributed that on an average unlike ions would be closer together than like ions, and that consequently work must be done in separating them on dilution. His results showed that in dilute solutions the change in the freezing-point depression with dilution could be ascribed entirely to the effect of interionic forces with a completely dissociated electrolyte.

In 1922, Debye and Hückel attacked the problem by fresh methods, starting from the same assumption of complete dissociation. By taking into account the unequal distribution of the ions, they were able to calculate approximately the freezing-point depression of salts of different valency types in very dilute aqueous solutions, although the calculated and observed values diverged at higher concentrations. But a matter of more immediate interest to us is their treatment of the conductivity problem on the basis of complete dissociation. They start from the same point of view as that of Milner, namely, that owing to the electrical forces between the ions there will be an excess of ions of opposite charge in the immediate neighbourhood of any single ion, as in the structure of a crystal of sodium chloride. Owing to the finite time which is necessary for the redistribution of the ions to take place round an ion that is in motion, there will always be an excess of ions of opposite sign in its rear, and hence it will be subject to a retardation when moving in an electric field. Further, as ions of opposite sign are moving in opposite directions and as both are supposed to carry with them a certain amount of solvent, the viscous resistance to the motion of the ions will be greater than if the solvent were at rest. Thus both these effects act in such a way as to reduce the speed of the ions. Assuming that at infinite dilution the ionic mobilities obey Stokes's equation, Debye and Hückel arrive at the expression

$$\frac{\lambda_o - \lambda_c}{\lambda_o} = \left(\frac{K_1}{D^{\frac{1}{2}}} w_1 + \frac{K_2}{D^{\frac{1}{2}}} w_2 b\right) \sqrt{\nu m},$$

where the term $\frac{K_1}{D^{\frac{1}{2}}} w_1$ represents the fall in conductivity due to the electrical retardation and $\frac{K_2}{D^{\frac{1}{2}}} w_2 b$ that due to the electrophoresis of the solvent.

K_1 and K_2 are universal constants for all solvents at the same temperature.
D is the dielectric constant of the solvent.
w_1 and w_2 are valency factors.
b is the average radius of the ions.
ν is the number of ions per molecule.
m is the molecular concentration of electrolyte.

[1] Extract from the presidential address on "The Ionic Theory of Electrolytic Solutions," delivered at Oxford to the Science Masters' Association on Jan. 4.

Values of w_1 and w_2 for different salt types in which the anion and cation have equal mobilities are given in the following table. w_1 varies with the relative mobilities of the two ions; w_2 is independent of them.

VALUES OF VALENCY FACTORS.

Salt Type.	w_1.	w_2.
KCl . . .	1	1
K_2SO_4 . . .	4·24	1·41
$MgSO_4$ . . .	8	2

It will be seen that the above equation is in general agreement with the experimental results for strong electrolytes, as the fall in λ is proportional to the square root of the concentration, and is dependent on the dielectric constant of the solvent and on the valencies of the ions. The best test of the theory is to see how nearly the equation enables us to calculate the conductivity of a salt in different solvents. The observed and calculated

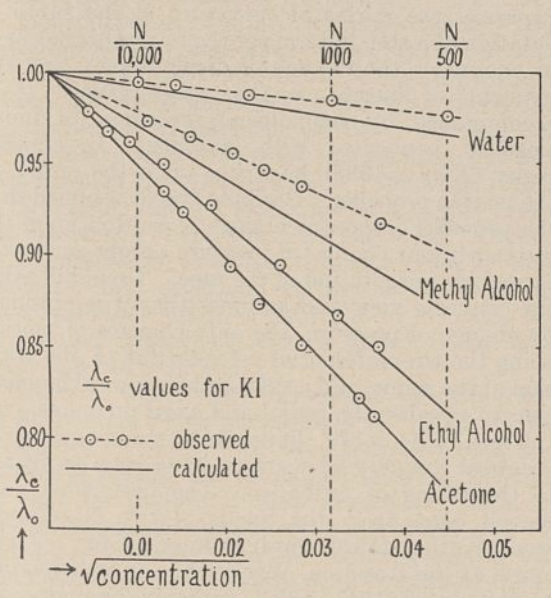

FIG. 1.

results for potassium iodide are plotted in Fig. 1, the values of b required being calculated by means of Stokes's equation from the mobilities of the ions at infinite dilution. In water and methyl alcohol the calculated slope of the λ_c/λ_o curve is greater than the observed slope; in ethyl alcohol and acetone the agreement is very close. The salt was chosen at random; others would have given better agreement in some solvents and worse in others, but looking at the results generally, it is a striking achievement that Debye and Hückel's theory is able to predict so closely the variation of the equivalent conductivity in dilute solutions in different solvents from a knowledge of the physical properties of the solvent and the mobilities of the two ions at infinite dilution.

The mathematical theory is not yet in a final form even for dilute solutions; it takes no account of the changes in the solvent due to the high pressures produced locally by the electrical attractions between the ions, or of the change in the dielectric constant with the concentration of electrolyte. There is, too, some uncertainty as to the exactness with which Stokes's equation is obeyed; nevertheless, in its present form it gives us ample support for the belief that strong electrolytes are completely dissociated in dilute solution, and that the interionic forces may be responsible for their changes in properties with dilution.

Even, however, in dilute salt solutions, specific chemical interaction between the ions may be of importance, in addition to the normal electrical attraction between them. It is true that in dilute aqueous solutions there is a surprisingly close agreement between the behaviour of salts of the same valency type, although the salts of mercury form a striking exception to the rest, but when we pass to non-aqueous solvents with a lower dielectric constant, the purely physical aspect of the ionic relationship becomes more limited in its application, while the specific interaction of the ions begins to play a more important part. For example, in water the slopes of the equivalent conductivity curves of uni-univalent salts are nearly the same, while in methyl alcohol the results are far less regular; most nitrates have a different slope from that of the chlorides, and the values for silver nitrate fall much more rapidly than those for any other salt.

These differences are too great to be accounted for, on Debye's theory, by differences in the sizes or relative mobilities of the ions; and they indicate in some cases incomplete dissociation owing to interaction between the ions. With divalent ions the discrepancies in non-aqueous solvents are still more marked. In methyl alcohol, calcium chloride and perchlorate are normal in slope while calcium nitrate behaves like a weak electrolyte; with zinc, on the other hand, the perchlorate and nitrate are normal while the chloride is abnormal. Whether this is due to the formation of complex ions or of molecules is not yet known, but it is evident that in dilute non-aqueous solutions the specific interactions of the ions—in fact, their chemical affinities—may dominate the situation.

Obituary.

SIR GEORGE GREENHILL, F.R.S.

THE death of Sir George Greenhill will be greatly regretted by some generations of Artillery officers who were instructed by him in the mathematics of their profession as they passed through the 'Advanced Class' of the school at Woolwich which has had several names but is now known as the Artillery College. When the present writer joined that class in the spring of 1880, Greenhill had already been the mathematical professor there for several years. He went there after a short service at Coopers Hill and followed in succession Bashforth, Hirst, and Niven.

Good judges have been of opinion that Greenhill

excelled in the application of dynamics to the problems of everyday life. The questions which, during many years, he contributed to test the candidates for the Mathematical Tripos and other examinations at Cambridge give ample evidence of this. They were concerned largely with the motion of trains and ships, and were recognised as being more in correspondence with actual facts on the engineering side than the academic type of question that had been previously in vogue. He was thus, clearly, the right man in the right place at Woolwich. He was able to treat artillery problems from the engineering point of view and to inspire his pupils to get as far as possible down to the actual facts of gunnery.

During the whole time that Greenhill was at Woolwich, more than thirty years, he was engaged in original investigations both pure and applied. In pure, he had a great liking for the elliptic functions, based on admiration of the classical works of Abel and Jacobi. His best work here had to do with the difficult subject of complex multiplication. In this and in similar investigations he was never satisfied with *theoretical* solutions. Abel having shown that certain equations could always be solved in radicals, Greenhill laboured actually to exhibit such solutions, and in this he was very successful. This was promptly recognised abroad, and his papers on the subject were translated into foreign languages. He was also concerned with the importance of having tables of theta-functions calculated. One of his last acts was to inspire Col. Hippisley, R.E., to carry out this work, which had been in abeyance since the death of Henry Stephen Smith.

Greenhill's leaning towards numerical results from complicated equations was assisted by uncommon algebraical power, which is constantly in evidence in his long series of papers in the *Proceedings of the London Mathematical Society*. The only book that he wrote that was entirely on pure mathematics was his "Differential and Integral Calculus" (1885). In this he is content to obtain results that are necessary for the practical applications. He had no liking for the modern refinements which are based upon the theory of functions. He was wont to speak of these as being "the morbid pathology" of the subject. He was aware, no doubt, that this "morbid" work had to be done by some one, but he was frankly out for practical applications, and was content to be in the company of many of the mathematical physicists of the day who, for example, use Taylor's theorem in practical questions and have little sympathy with a series of lectures on the cases in which Taylor's theorem fails.

Greenhill's "Applications of Elliptic Functions" is a work which exhibits many new results and much algebraical facility in getting out actual numbers. The "Hydrostatics" (1894) is probably his best book, as it is distinctly a new departure. Before its appearance the text-books were mostly on familiar academic lines and treated hydrostatic machines from a diagrammatic point of view. Greenhill's work deals, on the other hand, with the machines actually in use. He spared no pains to get down to reality. The *Transactions* of various institutions of naval architects were ransacked to supply him with problems old and new and their practical solutions. This material is arranged, described, illustrated, and treated by a consummate master of the subject. The result is a book which is unique and of exceptional value to all those who look for information on practical hydrostatics and pneumatics. It has met, it is believed, with universal approval.

Although he drew much of the material for this book from the work of others, Greenhill himself made considerable contributions to the subject. He wrote the article on hydromechanics for the "Encyclopædia Britannica." He defines it as the science of the mechanics of water and fluids in general, including fluids both in equilibrium and in motion. He made several contributions to the publications of the Institution of Naval Architects. In one of these (*Trans.*, 1894) he gave a remarkable demonstration of the theorem of Leclert which expresses the radius of curvature of the curve of flotation of a ship in terms of the radius of the curve of buoyancy, the volume of displacement, and the moment of inertia of the water-plane. It is accompanied by geometrical theorems, of much elegance, connected with stability. In another paper (*Trans.*, 1888), he writes upon the action of the marine propeller. Rankine (1865) assumed that the propeller impresses change of motion upon the water without change of pressure except such as is caused by the rotation of the race. Greenhill takes the converse view and assumes that it is obtained by change of pressure, the only changes of motion being the circumferential velocity due to the rotation of the screw, and a sufficient sternward momentum to equalise the radial and axial pressures.

Greenhill's most important contribution to practical gunnery appears to have been in regard to the rifling of ordnance. The first rifled gun-barrels came from the hands of two Nuremberg men, Kottee (1520) and Danner (1552). There exists at the Rotunda, Woolwich, a muzzle-loading barrel, dated 1547, rifled with six fine grooves. Robins, Copley medallist in 1746 of the Royal Society, experimented with rifled guns and elongated shot in England, but the question did not come seriously to the front until after the Crimean War, when the increased muzzle-velocities and the high pressures in the powder chambers and barrels caused the subject to be urgent. Armstrong's firm, and in particular Capt. (afterwards Sir Andrew) Noble, was the pioneer, and by proposing an increasing twist in the rifling from the powder chamber to the muzzle, directed the attention of the world of science to the problem. Greenhill worked at the subject independently. He established that the pitch of the rifling necessary to keep a projectile in steady motion is independent of the muzzle-velocity, of the calibre, and of the length of the gun; depending principally on the length of the shell and on its description, so that, for similar projectiles, one pitch would do for all guns. The importance of this work and its value to Great Britain are beyond all question.

In gunnery Greenhill, at Woolwich, did much to improve the application of the results of Bashforth's experimental work. In external ballistics he did not do anything comparable with the pioneer work of the latter, who laid a foundation stone which, through the years, has never been appreciably disturbed by the workers in any country of the globe.

The War, which disclosed many new problems, found Greenhill in retirement. The questions came before other brains and hands, and enormous progress has been made in every branch. The last occasion upon which he was much in evidence was during the meeting of the British Association and of the International Mathematical Congress at Toronto in 1924. On the passage out in the *Coronia* he was observed to be suffering and failing generally. He was a pathetic sight as he moved slowly about the boat. It will be remembered that he could not be found when the company arrived at Montreal. In answer to a telephone call he was not reported at Toronto, and real anxiety at once existed as to what had befallen him. This lasted for several days until it was discovered that he had really gone on straight to Toronto without telling any one of his intention and without reporting his arrival in that city officially. He was one of the few men of science at the meeting who had accompanied the Association in 1884 when it met at Montreal, for the first time in Canada, under the presidency of the late Lord Rayleigh. He had in his possession a photograph of a group of men taken on that occasion, on the outward voyage. It caused much interest, as it put in evidence the antiquated appearance that a group taken forty years ago can exhibit.

Greenhill was always somewhat eccentric, and as he became older increasingly so. Many of his colleagues or pupils who have travelled with him will recall that he was prone just to catch his train, so that he frequently just missed it. This, of course, is not an eccentricity which works well for the fellow traveller. In the earlier years he was distinctly sociable, certainly so at Woolwich. Later he became less so, and other points in his character—such, for example, as not giving a direct answer to a question—were accentuated. These peculiarities of thought and mind, which were constantly in evidence in social circles, appear to some extent in his mathematical writings and letters; also particularly in the reviews for which he was responsible in NATURE and other periodicals. He was obsessed by the idea that mathematicians were not sufficiently engineers and were too much addicted to the philosophical side of their subject. Scientific engineers have been apt to regard him as being unpractical. Undoubtedly he stood somewhere between mathematicians and engineers, and was probably more of a mathematician and less of an engineer than the late Prof. Perry.

Greenhill's mathematical ability was recognised throughout his life. He was second wrangler in 1870, Pendlebury's year, and was bracketed with the latter for the Smith's Prize. He became a fellow of the Royal Society in 1888 and served in the Council in 1896. He received its Royal medal and also the de Morgan medal of the London Mathematical Society. He was corresponding member of the Paris Academy of Sciences and Officier d'Académie, and a foreign member of the R. Accad. Lincei. Young men who evinced a liking for mathematical research always received encouragement from him when he came across them. This was particularly so when it was a case of one who had not been through the usual scientific 'mill.' By such he is gratefully remembered. P. A. M.

DR. C. D. WALCOTT.

GEOLOGISTS and palæontologists mourn the loss of Dr. Charles Doolittle Walcott, who died on Feb. 8. For the last half-century he had occupied a foremost place in research in North America, and his discoveries in the older Palæozoic rocks had excited universal interest and admiration. At an age when most workers begin to need some repose, he continued his investigations with unabated vigour, and he was active in the pursuit of science almost to the end.

Charles D. Walcott was born in New York Mills, Oneida County, New York State, on Mar. 31, 1850, and was descended from New England settlers who had emigrated from Shropshire in the seventeenth century. When still at school at Utica he had already developed an interest in science, and at the age of thirteen he began to collect systematically both fossils and minerals. From school he proceeded to the Utica Academy, and eventually started life as clerk in a hardware store, where he acquired a practical business training which he always felt had been a real advantage in his later career. At the same time all his spare energies were devoted to scientific studies, and his discovery of Cambrian and Ordovician fossils near his home caused him to resolve that he would spend his life so far as possible in investigating the oldest fossiliferous rocks of the North American continent. In 1871, when visiting Indianapolis, he was encouraged in this resolve by Prof. E. T. Cox, who was at that time making a geological survey of the Indiana coalfields. Walcott therefore abandoned commerce, and spent the next five years on a farm at Trenton Falls, where he arranged to do a certain amount of manual labour in return for his board and lodging, and kept the rest of his time for study and field-work. In 1873 he sold his Trenton fossils to the Museum of Comparative Zoology, Harvard University, and would at the same time have gone to pursue a course of study under Prof. Louis Agassiz, had not that great naturalist just died. He had already discussed his plans for future research with Agassiz, and had decided that one of his main endeavours should be to determine the nature of the trilobites. He began by making polished sections of specimens from the Trenton Limestone, and thus discovered the first evidence of the branchial apparatus and the limbs in this group of fossils.

At last, in November 1876, Walcott found a congenial official appointment which enabled him to start his life's work in earnest. He became

assistant to Prof. James Hall, the well-known State Geologist of New York. For three years he continued his researches while discharging the routine duties of this position, and in 1879 he entered a still wider field as assistant in the United States Geological Survey, which was then directed by Clarence King at Washington. He began his new official work by studying the geology of the high plateau of southern Utah and the country so far as the bottom of the Grand Canyon of Colorado. He then joined Arnold Hague in the survey of the Eureka mining district in Nevada, and in investigating the Palæozoic rocks of central Nevada. In 1882 he added to his other duties the identification in the Museum at Washington of all the Palæozoic fossils collected by the Survey; but he still continued his special studies of the Cambrian and earlier fossiliferous formations. After several promotions, he became director of the United States Geological Survey in 1894, and retained this appointment until he was elected secretary of the Smithsonian Institution in 1907. His business aptitude enabled him to reorganise the Survey and associated services on a more satisfactory basis than before, and he so gained the confidence of Congress that the appropriations for scientific work were much increased. For ten years from 1897 Walcott also acted as assistant secretary of the Smithsonian Institution in charge of the National Museum, and from 1902 until 1905 he was chief administrative officer of the newly founded Carnegie Institution of Washington.

Administrative duties never appeared to reduce Walcott's powers of research, and during the whole of his career he published in rapid succession papers and memoirs especially on the early Palæozoic fossils, which were always important—often startling—additions to knowledge. His works on the Cambrian faunas of North America and China are noteworthy as showing how varied was the life of the earliest geological period of which we have any satisfactory knowledge, and they will always remain classic. His discoveries of fossils in the still earlier Algonkian rocks of North America are pioneer contributions to a subject on which palæontologists eagerly await more information. His recognition of fish-remains in the Ordovician rocks of Colorado, at first received with scepticism, has now been confirmed by similar discoveries in other parts of North America.

Walcott was especially successful in finding impressions of soft-bodied organisms in the Algonkian and Cambrian formations—organisms which theoretically must have existed in immense variety before the habit was acquired of secreting hard parts which were capable of preservation as ordinary fossils. So long ago as 1898 he published a memoir on peculiar structures from the Middle Cambrian of Alabama which he regarded as the imprints of medusæ. In 1914 he described other structures from the Algonkian rocks of Montana which he interpreted as representing a very varied assortment of calcareous algæ. Almost every year after he became secretary of the Smithsonian Institution he spent the summer in studying the Cambrian formations of the Rocky Mountains in British Columbia; and in the Burgess shale of Mount Stephen he made a great collection of exquisite impressions of soft-bodied animals, previously unknown, which he described as primitive crustaceans, holothurians, annelids, and medusæ. There are still differences of opinion as to the success with which Walcott interpreted these several remarkable discoveries; but all are agreed that they add immensely to our means of studying the dawn of life on the earth, and make us hopeful of eventually finding at least some really generalised ancestors of several of the groups of invertebrate animals.

Walcott was especially fortunate in his home life, and both his first wife and the present Mrs. Walcott were ever sympathetic and helpful in his work. His unwearied industry was sustained until his last illness, and the joy of research always sufficed as recreation and relaxation from the arduous duties of administration.

Walcott naturally received many honours both at home and abroad. He was president of the National Academy of Sciences from 1917 until 1923, and received the Hayden medal from the Philadelphia Academy of Sciences. He was a foreign member of the Geological Society of London, and was awarded the Bigsby and Wollaston medals by that Society. He was also a corresponding member of the Royal Geographical Society. On his last visit to England in 1909 he received the degree of Sc.D. from the University of Cambridge. He was a corresponding member of the Academy of Sciences, Paris, and was awarded the Gaudry medal by the Geological Society of France. He was also a corresponding member of many other societies and academies on the European continent. The value of his work was indeed widely acknowledged by his contemporaries, and his researches will always be appreciated as remarkable pioneer efforts to understand some of the earliest phases of the geological record. A. S. W.

WE regret to announce the following deaths:

Mr. Francis Campbell Bayard, president in 1898–99 of the Royal Meteorological Society. At his home at Wallington, Surrey, he equipped a meteorological station and maintained regular observations there from about 1890 until last year. He died on Jan. 22, at the age of seventy-five years.

Dr. F. H. Knowlton, geologist on the United States Geological Survey since 1907, known chiefly for his work on the fossil flora of North America, on Nov. 22 aged sixty-six years.

Lieut.-Col. Henry Mellish, president of the Royal Meteorological Society in 1909–10. He maintained a climatological station at his home at Hodsock Priory, Notts., and had an unbroken series of observations for the past fifty years. He died on Feb. 2, at the age of seventy years, immediately after taking the morning observations.

Miss Matilda Smith, associate of the Linnean Society, who contributed many drawings to the *Botanical Magazine*, to Hooker's "Icones Plantarum," and to other works, and was associated for more than forty years with the Royal Botanic Gardens, Kew.

News and Views.

DURING the past few days, considerable prominence has been given in the Press to the appeal issued by the National Union of Scientific Workers to all men and women in Great Britain qualified in science to state their views on the possibility and desirability of building up a body which can claim to be fully representative of their varied interests. They are not asked to join the existing organisation, although they are being given an opportunity of stating if they believe that around the existing nucleus such a body can be built up. The appeal is issued over the signatures of eminent scientific workers, leaders in industry, and public men of differing political views. In addition to the principal signatories, a hundred men and women, representative of every branch of science and nearly every scientific institution in Great Britain, are giving their support to the movement. Such support should go far to remove some of the prejudices which have arisen against this body, mainly due to the title which was chosen by its founders. The words "National Union" are sufficient to arouse in some minds the fear that members of such a body must necessarily contemplate the ultimate use of the strike weapon in enforcing their demands. It is well, therefore, that it is definitely stated in the appeal that recourse to this method of redressing the grievances of scientific workers would be ineffective and absurd. What the society does hope to do, however, if it becomes fully representative, is to mould public opinion to bring about a greater appreciation of potentialities of science and thereby create a greater demand for scientific services, and also to instil the knowledge that this demand can only be met adequately by making the conditions of service sufficiently attractive to bring to the pursuit of science the highest intellectual types in Great Britain. Above all, it aims at producing in scientific workers themselves a consciousness of their functions as citizens, to the end that they will endeavour to take a more active part in the control and the direction of the affairs of a type of civilisation for the evolution of which science is chiefly responsible.

LORD BALFOUR received a deputation on Feb. 16, representative of various societies and authorities interested in the pollution of the rivers and estuaries of Great Britain, which urged the appointment of a central committee with power to co-ordinate the investigations and efforts now being made to cope with this problem. The need for legislation from the aspect of water-supply, inland and esturine fisheries, public health, and the amenities of the countryside was indicated, and a memorandum by a joint committee of the British Waterworks Association and the Salmon and Trout Association submitted. Lord Balfour acknowledged the very complete way in which the deputation presented its case. He pointed out that the central authority would require executive powers to reserve and purify waters and override other conflicting interests. He stated that co-ordination and advice alone would, in his opinion prove insufficient; what is wanted is more knowledge of the various pollutions. With each manufacture producing its own particular type of evil, each requires its own separate remedy, which can only be found by research. The Government is prepared to supply financial resources so that these necessary investigations may be carried out. The need for more knowledge to provide a firm basis for adequate and equitable legislation was emphasised in our leading article of Jan. 1. This is clearly the view now held by the Government. Compared with the issues at stake, the cost of research is minute, and it is the only practicable insurance against wasteful expenditure in attempts to cope with the purification of noxious effluents.

H.M. THE KING has signified his intention of visiting Cardiff during Easter week, accompanied by H.M. the Queen, to open the National Museum of Wales. This will be the fulfilment of a hope expressed by His Majesty when he laid the foundation-stone of the Museum in 1912, that he would be able to open the building then inaugurated. The building which will be formally opened by the King includes the magnificent south front, containing the great domed central hall, and a series of galleries on the east and west sides, erected at a cost of a quarter of a million pounds. It represents but part of the complete scheme. The recent donation of £35,000 by Lord Buckland will enable the council of the Museum to proceed with the erection of a further series of galleries on the eastern side, and it is estimated that the building, when completed, will have cost not far short of a million pounds. The interest which the King and Queen have maintained in the progress of the institution, culminating in their visit for its formal opening, should go far in emphasising to the people of Wales the importance of their national Museum and in stimulating their support to enable the full scheme to be brought to fruition.

AT the meeting of the Royal Astronomical Society in June of last year, the president, Dr. J. H. Jeans, offered to endow an annual lectureship. This was gratefully accepted, and following the wish of the donor, it was called the George Darwin Lectureship. The deed of gift allows considerable latitude in the time of delivery of the lecture and in the choice of the lecturer, although it was suggested that the lecturer should preferably be resident outside the British Isles, and that the gold medallist of the year might often be a suitable lecturer. This year the Gold Medal of the Society was awarded to Prof. Frank Schlesinger, Director of the Yale University Observatory, and at the annual general meeting of the Society on Feb. 11, the president gave the usual address on the award of the medal. Prof. Schlesinger was prevented by illness from attending the meeting, but he has now arrived in England and will give the first George Darwin Lecture at the next meeting of the Society on Mar. 11, when also the Gold Medal

will be presented to him. The title of his lecture will be "Astronomical Photography of Precision."

AFTER a consideration of the quantum theory, Prof. A. S. Eddington, in his fifth Gifford Lecture in the University of Edinburgh on Feb. 18, said it is now generally accepted that in the reconstruction of ideas required to remove the present discrepancy between classical and quantum laws, the quantum laws must form the basis. These grade into the classical laws when the quantum numbers are very large; and it is only then that the classical conception of the physical world—including space, time, electrons, force, etc.—has any application or meaning. In this reconstruction all the determinism is removed from the laws of physics; the apparent determinism is found to be merely high probability. The probability is high (amounting practically to certainty) when averages of large numbers are considered; but in individual processes only moderate odds are concerned. The new quantum mechanics contains only laws which decide the odds; it apparently has no cognisance of any factors deciding what actually will happen. In the old conflict between free will and predestination, it has hitherto seemed that physics comes down heavily on the side of predestination. The quantum theory has entirely removed this bias. Whatever view we may take of free will on philosophical grounds, we cannot appeal to physics against it. The latest picture of the atom contains no mark or factor to decide what *that* atom will do next (although it contains factors deciding the average conduct of a number of such atoms); and whilst further developments in the theory may possibly disclose such a mark, it is on the whole rather against the spirit of the modern conception to expect this.

IN his sixth Gifford Lecture, delivered on Monday, Feb. 21, Prof. Eddington dealt with the nature of the stars. He pointed out that failure of the perfect gas laws begins when the atoms are so closely packed that they begin to jam against one another. Generally this begins when the density approaches that of the liquid state; but that refers to terrestrial atoms fully arrayed with their systems of electrons. In estimating the congestion at the very high temperature in the stellar 'ball-room,' we must remember that 'crinolines' of electrons are no longer worn. Thus the stellar ions will not begin to jam until a much higher density is reached, and stellar material can still be a true gas even when its density is that of water or of platinum. Evidently it is possible for stellar matter to reach a density transcending all terrestrial experience. This conclusion recalls a strange message contained in our observations of the faint 'Companion of Sirius,' which was previously dismissed as incredible. Apparently this star had a mass nearly equal to the sun's mass packed into a globe not very much larger than the earth. Fortunately it has been possible to test this conclusion by a method based on Einstein's theory of gravitation, and Prof. W. S. Adams, at the Mount Wilson Observatory, has confirmed this huge density. It is 60,000 times the density of water, and a ton of the material could be contained in a match-box. It is not a new chemical element; it is ordinary matter under extraordinary conditions, namely, with the atoms so shattered by high temperature that they can be packed into an extremely small compass.

A LECTURE on "Conceptions of the Cosmos from the Times of Copernicus to Galileo" was delivered at Bedford College for Women (University of London) by Sir Frank W. Dyson, the Astronomer Royal, on Feb. 15. Before the sixteenth century the earth, moon, and sun were accepted as globes, the size and distance of the moon from the earth had been roughly calculated, but the theory of epicycles was still used to explain the movements of the stars in a geocentric cosmos. Copernicus (1473–1543), using Ptolemy's records, thought out a heliocentric system. His cosmos was a series of concentric circles, of which the fifth was the orbit of the earth, with the epicycle of its satellite, the moon. He added an unnecessary 'third movement' of the earth to account for its axis pointing always to the same region of the heavens. Tycho Brahe (1546–1601), though a careful observer, refused to accept the Copernican cosmos and imagined a heliocentric grouping of the planets, but a geocentric cosmos; the moon's and the sun's orbits turned about the earth as a centre, but the movements of the heliocentric planet group formed an epicycle. Kepler (1571–1630) rejected Tycho Brahe's theory and completed the Copernican system, founding his theories upon the incomparable observations of Tycho Brahe. He studied the orbit of Mars and established three laws, which include the principle that the orbits of the planets are not circles, but ellipses with the sun as a focus. His work was not immediately accepted. Galileo (1564–1642) developed the use of the telescope and thus discovered a larger number of stars and the nature of the surface of the moon. His main discovery was that of Jan. 7–14, 1610, when he observed the movements of the satellites of Jupiter and thus produced another argument in favour of the Copernican system. By the work of these four men the geocentric conception of Ptolemy was thus replaced by the heliocentric system now accepted.

MR. F. J. W. WHIPPLE, the Superintendent of Kew Observatory, sends us a description of a remarkable deposit of rime observed by him in Arundel Park and the neighbourhood on Saturday, Feb. 12. It will be remembered that the south of England was covered with fog for several days. The fog was exceptionally thick on the South Downs on Friday, Feb. 11. When Mr. Whipple made his observations on the Saturday morning it was misty. The rime in many places was heavy enough to bend the tree branches. In the light breeze the fragments of rime blown from the trees pelted the passer-by in no pleasant fashion. In places the fallen rime lay on the ground to the depth of an inch. Rime on the ground had not the brilliance of fresh snow: it made a rather dirty grey. From a distance the grey patches under the trees and bushes were more conspicuous than the unfallen rime. There was, of course, rime on the grass. The deposit on the wiry grass stalks was curious, however, in that very

frequently it changed sides half-way up. The deposit on the lower half of the stalk pointed into the wind (the N.E. wind which prevailed when the rime was formed on the trees), but on the upper half the deposit was on the lee side. Another unusual phenomenon was the occurrence of pieces of ice embedded in an earth bank. Each of these pieces of ice was encrusted on a fragment of chalk. A chalk fragment about two inches square and half an inch thick might carry a lump of ice or rather a brittle crown of ice about an inch high. There was no ice on the soft earth or on the roadway nearby. The phenomenon occurred close to trees with a very liberal deposit of rime.

AT the anniversary meeting of the Geological Society on Feb. 18, the awards already announced in our columns (Jan. 29, p. 169) were presented by the President, Dr. F. A. Bather. On behalf of Sir Albert Kitson, the Right Hon. W. Ormsby Gore received the Lyell Medal, and the balance of the Murchison Fund was handed to Sir Arthur Smith Woodward for transmission to Dr. Haughton. Alluding to a revival of interest in systematic concepts, in which palæontologists have played a large part, Dr. Bather then discussed the present position and possible future of "Biological Classification." Distinguishing the practical aim from the philosophical, the artificial system from the scientific, he showed the relation of the Key to the former and discussed the stages and various basic ideas of the latter. The phylogenetic mode of approach, and particularly palæontology, have made changes necessary. The phylogenetic method was contrasted with the morphological; the ways of breaking up a phylogenetic tree were discussed, and the concepts of the grade, the genus, the lineage, the gens, the seriation, and the species were expounded. Convergence and polyphyly affect genera and species no less than higher groups. The ordinary species (Linneon) is composed of elementary species (Jordanons); but the true *infima species* of a phylogenetic classification carried to its logical end would be the gene. If, then, a thoroughgoing phylogenetic system is impracticable, might it not be equally scientific to have an adaptational classification? Perhaps this would be more useful and more illuminating; but equally impracticable. Many of our present difficulties arise because the phylogenists have been hampered by a system built on a different plan. In Dr. Bather's opinion the only salvation lies in a compromise accepting the practical intention of binomial nomenclature, and producing a system sufficiently flexible for use by morphologist, ethologist, phylogenist, and stratigraphical geologist.

THE Frazer Lecture in Anthropology for 1927 will be delivered at Cambridge on Mar. 2, the lecturer for this occasion being Dr. R. R. Marett. It will be remembered that this lecture is on a foundation formed a few years ago from a fund raised as a tribute to the work in anthropology of Sir James G. Frazer. It is delivered in rotation in the universities with which Sir James Frazer has been connected—Cambridge, Oxford, Liverpool, and Glasgow. Among those who have previously lectured on the foundation are the Rev. J. Roscoe, Dr. E. S. Hartland, and Dr. B. Malinowski. Sir James and Lady Frazer will entertain a number of friends to dinner in Trinity College on Mar. 1, most of whom will remain in Cambridge for the Frazer Lecture on the following day.

THE well-known seismic district along the Dalmatian coast has lately been visited by violent earthquakes, the first and strongest at 4.19 A.M. on Feb. 14, and a second, also of destructive intensity, at about 2 P.M. on Feb. 16. Though the loss of life seems to have been small, the area of damage was of great size. Along the coast, it extends from Sebenico on the north to Trebinye on the south, towns which are about 150 miles apart; inland, it reaches beyond Mostar, which is about 40 miles from the coast. Several recent earthquakes in this district, such as the Sinj earthquake of July 2, 1898, have been traced to important dislocations; though, on the whole, the exact positions of the epicentres are not well known. The recent earthquake appears to have been connected with a long fault, roughly parallel to the coast, and possibly a short distance to the west.

MICHAEL FARADAY was born in Southwark, London, and his father's forge stood near the well-known "Elephant and Castle" of that place. The Southwark Borough Council desires to commemorate the association of this great pioneer of science with the borough by forming a special collection of standard and current literature on electrical and allied sciences in the Central Reference Library, and by placing in the library a bust of Faraday. It is proposed also to create a Faraday Memorial Library Fund, the income from which would be used to keep the library supplied with the best books upon these subjects. Both object and aim are worthy and appropriate, and we are glad to commend these to readers of NATURE. Any contributions in support of this memorial in Faraday's native borough should be sent to the Town Hall, Walworth Road, London, S.E.17, and be addressed to the Mayor of Southwark.

AN appeal of exceptional interest is issued by the Gravesend Borough Library and the Gravesend and District Scientific and Archæological Association with the object of raising funds towards the reconstruction of Milton Chantry for the purpose of a museum and library of local history. The Chantry, which is the oldest building in Gravesend and one of the most picturesque in the neighbourhood, dates, at latest, from the early fourteenth century, and is of the greatest importance to archæologists, and also, be it said, to the general public from the historical point of view. Much of the original timber of the roof remains. The walls of flint and chalk are mostly three feet thick and have been preserved by a casing of brick erected in Elizabethan or Jacobean times. The total amount required for reconstruction is £2500, of which £550 has already been contributed by the Office of Works and £500 by the Corporation of Gravesend. The latter body has also voted £400 per annum for upkeep in conjunction with the existing Borough Library. The scientific and

educational value of a well-organised and well-arranged local museum needs no emphasis. But the importance of Gravesend as a centre of archæological and historical research, rich in prehistoric, early British, Roman, and Anglo-Saxon remains, already well represented in the collections in the custody of the Library Committee, render this appeal, which has the support of such bodies as the Society of Antiquaries, the Royal Anthropological Institute, and the Royal Historical Society, a matter of national and not merely of local interest.

THE January issue of the *Quest* contains an interesting article by Prof. D. Fraser Harris on "Science and Preconceived Perfection," in which he gives numerous examples from the history of natural science and medicine of attempts to hinder the progress of science by religious doctrines or other preconceptions. One of the earliest examples of this was the opposition which Galileo encountered for his description of the spots on the sun, owing to the preconceived notion of his opponents that the sun was perfect. A similar preconceived idea of perfection led Hoffmann of Nuremberg to attack Harvey's discovery of the circulation, a constant return of blood to the heart being regarded by Hoffmann as an imperfect arrangement. Throughout the Middle Ages the progress of anatomy was checked by the Mohammedan injunction against dissection on the ground that touching a dead body rendered a man ceremonially unclean. The Italian surgeon Tagliacozzi, who introduced a plastic operation for repair of the nose, ears, and lips in the middle of the sixteenth century, was denounced for his impiety in daring to alter the human countenance, and after death his bones were scattered by order of the ecclesiastical authorities. In more modern times, the opposition to inoculation against small-pox, of which Voltaire was so ardent a propagandist, and later to vaccination and the use of chloroform in childbirth, was partly based on the belief that such methods were interfering with the will of Providence.

IN continuation of the excellent series of exhibits dealing with modern scientific research which have recently been on view at the Science Museum, South Kensington, an exhibition has been arranged under the auspices of the British Research Association for the Woollen and Worsted Industries, which will be opened on Mar. 1 by the Earl of Balfour. Dr. F. A. E. Crew, Director of the Animal Breeding Research Department of the University of Edinburgh, is co-operating with the Association and has arranged a biological section designed to show the application of science to the wool industry in all its stages from the sheep to the finished fabric. In this section will be illustrated questions of breeding, feeding, and fleeces. The exhibits will be divided into groups showing research on wool characteristics and processes, technical research, dyes and wool, worsted spinning, woollen carding and spinning physical research. It should be noted that a number of the exhibits have been supplied by the firms connected with the Association. The Woollen Industries Research Association was incorporated in 1918 and has its own chemical, physical, and engineering laboratories at Torridon, Headlingley, Leeds, with more than thirty trained investigators. Its annual budget is about £14,000. The fundamental work of the Association deals with pure research on wool and the processes involved, with the view of increasing the quality and quantity of the fibre, improving and cheapening manufacture, and enhancing the appearance and prolonging the life of the finished fabric.

AT the invitation of the American Association of Economic Entomologists and the Entomological Society of America, the fourth International Congress of Entomology will be held at Ithaca, New York, presumably in the third week of August 1928. A preliminary programme will be issued in the near future.

AT the annual general meeting of the Quekett Microscopical Club on Tuesday, Feb. 8, the following officers were elected: *President*, Dr. W. T. Calman; *Vice-Presidents*, Sir David Prain, Mr. D. J. Scourfield, Mr. J. M. Offord, Mr. C. D. Soar; *Hon. Treasurer*, Mr. F. J. Perks; *Hon. Secretary*, Mr. W. S. Warton; *Hon. Reporter*, Mr. A. Morley Jones; *Hon. Librarian*, Mr. C. S. Todd; *Hon. Curator*, Mr. C. J. Sidwell; *Hon. Editor*, Mr. W. S. Warton.

AT the anniversary meeting of the Geological Society of London held on Feb. 18, the following officers were elected:—*President*, Dr. F. A. Bather; *Vice-Presidents*, Dr. J. W. Evans, Prof. E. J. Garwood, Dr. E. Greenly, Mr. H. W. Monckton; *Secretaries*, Mr. W. Campbell Smith and Dr. J. A. Douglas; *Foreign Secretary*, Prof. J. E. Marr; *Treasurer*, Mr. R. S. Herries; *New Members of Council*, Dr. E. E. L. Dixon, Dr. J. D. Falconer, Prof. V. C. Illing, Mr. Philip Lake, and Prof. H. H. Swinnerton.

AT the annual general meeting of the Physical Society, held on Feb. 11, the following officers were elected:—*President*, Prof. O. W. Richardson; *Vice-Presidents other than Past Presidents*, Dr. E. H. Rayner, Prof. E. A. Owen, Dr. D. Owen, and Prof. F. L. Hopwood; *Secretaries*, Prof. A. O. Rankine, Imperial College of Science and Technology, and Mr. J. Guild, National Physical Laboratory, Teddington, Middlesex; *Foreign Secretary*, Sir Arthur Schuster; *Treasurer*, Mr. R. S. Whipple; *Librarian*, Mr. J. H. Brinkworth; *New Members of Council*, Mr. T. Smith, Prof. E. N. da C. Andrade, and Dr. Ezer Griffiths.

THE Principal Trustees of the British Museum have appointed Dr. W. D. Lang, Assistant Keeper in the Department of Geology, to a Deputy Keepership in the same Department. Dr. Lang was educated at Christ's Hospital, Harrow School, and Pembroke College, Cambridge. He obtained a first class in Part I of the Natural Sciences Tripos in 1901 and his research work gained him the Sc.D. degree in 1919. He entered the service of the Trustees in 1902 as assistant in the Department of Geology. His chief publications have been on fossil Polyzoa, fossil corals, recent insects, philosophical biology, and the geology of the neighbourhood of Charmouth, Dorset.

THE Dyers' Research Medal, offered each year by the Worshipful Company of Dyers for the best scientific research or technical investigation connected with the tinctorial arts which has been submitted to the Society of Dyers and Colourists for

publication in its journal, has been awarded for 1925–1926 to Dr. H. H. Hodgson, for work carried out in the Department of Colour Chemistry at the Technical College, Huddersfield. Dr. Hodgson has had two papers in the Society's journal during this period: (1) "Behaviour of the Sulphides of Sodium in Aqueous and Alcoholic Media" (July 1925), and (2) "The Action of Sulphur on the Monochloroanilines" (Mar. 1926). During the year 1926, sixteen papers have been published in various scientific journals by Dr. Hodgson and his research students.

WE are informed by Messrs. Carl Zeiss (London), Ltd., that a contract has just been signed for the purchase of a Zeiss planetarium for the city of Vienna. The opening date has been fixed for May.

THE January number of *Watson's Microscope Record* (No. 10) contains a practical paper on "Critical Illumination," by Dr. F. J. Brislee; chapter 2 of "The Desmidiaceæ," by Mr. G. T. Harris; and a paper on "Relief Staining of Bacteria, Protozoa, Infusoria," by Dr. A. C. Coles, in which the use of a saturated aqueous solution of nigrosin is advocated as giving apparently permanent preparations showing minute characters and structure not otherwise seen. The *Record* is published three times a year, and will be forwarded free on application to Messrs. Watson and Sons, 313 High Holborn, W.C.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer on public health at the Westminster Hospital School of Medicine—The Dean, Westminster Hospital Medical School, 12 Caxton Street, S.W.1 (Mar. 1). An assistant master at the Redhill Junior Technical School and Technical Institute to teach mathematics, with mechanics as a subsidiary subject—The Secretary, Education Committee, Municipal Buildings, Reigate (Mar. 2). A research bacteriologist at the Low Temperature Research Station, Cambridge—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 11). A junior assistant at the Building Research Station, Garston, Watford—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 11). An assistant lecturer in agriculture under the County of Southampton Education Committee—The Director of Education, The Castle, Winchester (Mar. 11). An assistant in the statistical department of the Rothamsted Experimental Station—The Secretary, Rothamsted Experimental Station, Harpenden (Mar. 17). An instructor in engineering science at the Kingston-upon-Thames Technical Institute—The Principal. A teacher of engineering subjects at a junior technical school of the Wandsworth Technical Institute—The Principal. A graduate for engineering subjects and mathematics at the Workington County Technical and Secondary School—The Principal. A senior laboratory assistant in the department of Pathology and Bacteriology of the University of Sheffield—The Professor of Pathology, The University, Sheffield. A part-time demonstrator of biology at St. Thomas's Hospital Medical School—The Medical Secretary, St. Thomas's Hospital Medical School, S.E.1. A junior physicist under the Linen Industry Research Association—The Secretary, Research Institute, Lambeg, Co. Antrim.

Our Astronomical Column.

A FIXED EASTER.—Mr. J. J. Withers, University of Cambridge, has introduced a bill in the House of Commons proposing to fix Easter as the Sunday following the second Saturday in April, and thus reduce its possible range from five weeks to one week. The matter has been before a special committee of the League of Nations for the last year or two, on which there were representatives of the principal religious bodies, and it was agreed that no insuperable obstacle lies in the way, if there is sufficient consensus of public opinion in favour of the change. The subject was dealt with in an article in our issue of Nov. 27, 1926. It is likely that the present bill is intended merely to strengthen the hands of the League of Nations committee; if so, there is nothing to be said against it. But it would be undesirable to give it legal effect before obtaining general ecclesiastical sanction.

There are millions of people in Great Britain and Ireland who would not admit the power of a secular legislature to fix the date of a religious festival; the public holiday, of course, lies within its competence, but to divorce this from the feast with which it has always been associated would meet with serious opposition.

SPECTROSCOPIC PARALLAXES.—Two papers on the spectroscopic parallaxes of stars are published in the current number of the *Astrophysical Journal* (vol. 64, No. 4). The first, by Adams, Joy, and Humason, gives the parallaxes of 410 *M*-type stars based on recent research into the behaviour of suitable lines in spectra of this type. The list includes all the Boss stars north of −30° declination, together with about 100 dwarf stars of faint visual magnitude; many stars classed as *K*5 at Harvard are also included. For the giant *M*-type stars the lines used were at λλ4207, 4258, 4389, 4489 (Fe); λ4077 (Sr^+); $H\gamma$, and $H\beta$. The reduction curves were based, primarily, on mean parallaxes from parallactic and peculiar motions; these results being corrected by a method of successive approximations. For the dwarf stars the lines found to be most suitable were λλ4318, 4435, 4454, 4586 (Ca); λ4535 (Ti blend); and λ4607 (Sr). The reduction curves were based entirely on trigonometric parallaxes. The results show an interval of more than six magnitudes between the faintest giants and the brightest dwarfs, within which there is an entire absence of stars. The rapid variation in luminosity with spectral type for the dwarf *M*-type stars also suggests the possibility of obtaining parallaxes from this relation alone.

The second paper, by A. V. Douglas, is on *A*-type stars. Two methods of attack were used. The first, depending on the variation in relative intensities of arc and spark lines, resembled that devised by Adams for later type spectra. The pairs of lines found by Douglas to show the necessary variations were: λλ4215 : 4227, 4233 : 4227, 4535 : 4481, and 4549 : 4481. In the second method a relation was discovered between luminosity and the width of the lines λ4481, $H\delta$, and [*K*], so that seven criteria were finally available for determining parallaxes. The reduction curves were based on a combination of group with trigonometrical parallaxes, and were determined separately for stars of sharp and diffuse spectral lines. The final results are given in a list of parallaxes of 200 *A*-type stars.

Research Items.

MALAYO-POLYNESIANS IN AMERICA.—Dr. Paul Rivet again attacks the question of the migrations of Malayo-Polynesians to America in vol. 18, No. 5, of the *Journal de la Société des Américanistes de Paris*. He briefly reviews the evidence of physical anthropology and ethnography with which he has dealt previously. The form of certain types of skull in lower California shows a Melanesian affinity, while the Lagoa-Santa skull is of a type of wide distribution in South America and presents affinities with the hypsistenocephalic type of Melanesia and Australia. In the material culture a large number of objects of typical Polynesian or Melanesian character, of which a detailed list is given, are also found in America. The linguistic evidence—a detailed examination of grammatical structure and comparison of vocabularies—shows a close affinity between the Hoka family which extends, though not continuously, from Oregon to Salvador, and the Malayo-Polynesian family. If we accept Uhle's classification and dating of pre-Inca pottery in Peru, and put the first wave of immigration as contemporary with the proto-Nasca ware, this would give a date at about the beginning of our era, but Uhle's dates are too low and allow an inadequate period for the evolution of the stone age in America. These immigrants met and were to a great extent overwhelmed by the migrations of peoples from Asia who were responsible in the main for the general physical character of the American Indian; but it would be a mistake to regard the part played by the Malayo-Polynesian element in the racial make-up of America as negligible.

INDIVIDUAL DIFFERENCE IN ACCIDENT RATES.—The problem of accidents is still challenging attention. Some time ago a report by Miss E. M. Newbold was reviewed in this journal: in this report a statistical study of the human factor in the causation of accidents was made, and it appeared that, quite apart from the objective causes of accidents, there was a personal factor operating that rendered some people more liable than others to accidents. Since then the problem has been studied from another point of view by E. Farmer and E. G. Chambers, and their findings are published by the Industrial Fatigue Research Board in Report No. 38 (London: H.M.S.O. 2*s*. 6*d*. net). The writers tested workers in various occupations for æstheto-kinetic co-ordination, intelligence, and nervous instability. The results of these tests were correlated with the accident records of the same subjects. While the authors draw but tentative conclusions from a very interesting piece of work, yet, however tentatively expressed, the results are valuable. It appears that it can be definitely asserted that inequality in accident liability is not solely determined by external factors or by chance, but is due to measurable individual differences. A relationship can be shown to exist between accidents and poor æstheto-kinetic co-ordination, but there is no relationship between accidents and the higher intellectual processes. These results afford confirmation of the earlier work as well as adding fresh knowledge. It is perhaps not going too far to hope that the time will come when it will be possible to estimate an individual's accident liability with mathematical accuracy.

ULTRAMICROSCOPIC ORGANISMS AS SYMBIONTS.—In an article entitled "Ultramicroscopic Life," published in the Nov. issue of the *Rivista di Fisica, Matematica e Scienze Naturali* (Naples), Prof. Umberto Pierantoni gives an account of those ultramicroscopic organisms which are used by higher organisms as factors of their normal functions. These so-called ultramicrosymbionts occur at least as frequently as the microsymbionts, and the functioning of organs and tissues by means of such protoplasmic inclusions must be regarded as a normal phenomenon and not as analogous to pathogenic ultramicrobic symbiosis, which constitutes an abnormality of only a few individuals of a species. The penetration of ultramicrosymbionts into the egg of an insect may immediately determine a change in the direction of embryonal morphogenesis leading to the formation of new organs. Investigations on luminous animals have demonstrated that the presence of such ultramicroorganisms in many animals, especially cephalopods, is accompanied by the appearance of highly complicated structures — lenses, reflectors, refractors, analysers of light—due to stimuli exerted by them in the cells in which they become located. The effects which these organisms exert on the cell plasma undoubtedly tend to modify and regulate the activity, and indeed to determine the specific activity, of the plasma. Bioluminescence, with the many indisputable cases in which it is due to symbiosis, has entered a new field of study, and, if it could be proved that luminous ultramicrosymbionts exist, the phenomenon would admit of a definite explanation.

LIFE-HISTORY AND DISTRIBUTION OF LIMNÆA.—Dr. C. L. Walton and W. Norman Jones (*Parasitology*, 18, No. 2, 1926) report the results of observations in North Wales on the life-history of *Limnæa truncatula*, the usual intermediate host of the liver-fluke of the sheep. The average number of eggs in 20 egg-masses of this snail, collected in March 1925, was 9·75, and the hatching period (in the laboratory) was 12–26 days, with an average of 20–21 days for the spring generation. The young snails were isolated and reared, and they deposited eggs during the first week of July, which hatched in the first week of August. *L. truncatula* is therefore self-fertile. Data were obtained which show that two and probably three generations occur between March and October. Dr. Walton and W. Rees Wright (*op. cit.*, No. 4, 1926) find that, in North Wales, *L. truncatula* occurs over a range of *p*H 6·0 to 8·6, *L. peregra* *p*H 5·8 to 8·8, and *L. palustris* *p*H 7·4 to 8·0 (three readings only), and they express the opinion that the hydrogen-ion concentration is not of vital importance to these snails or, on the evidence available, to mosquito larvæ. The differential distribution of *truncatula* and *peregra*—for these species are seldom found together though they may be abundant in contiguous environments and some overlapping may occur—is accounted for by the relatively broader foot and shell of *peregra*, which enables it to travel over the surface of soft mud in which *truncatula* would sink.

FORESTRY RESEARCH IN SOUTH AFRICA.—The Research Station of the Forest Department of South Africa, situated at Deepwalls, Knysna, has made remarkable progress and carried out some important investigation work during the comparatively few years which have elapsed since its inauguration on up-to-date lines. One of the troublesome factors in connexion with forestry work in the Dominion is the restricted area and size of the indigenous forest. The department is seeking to rectify Nature's deficiencies in this respect by the artificial cultivation of conifers, with the view of the gradual reduction of imports of soft woods and the saving of expenditure in this direction. The opinion is held by a section of forest officers that in every country efforts should be made

to safeguard the future of, and even extend when necessary, the indigenous forests; that a total reliance on forests of exotic species is, economically, a mistake. Those holding such views will be interested in the paper by Mr. John Phillips, of the Deepwalls Research Station (*Ecology*, vol. 7, No. 3, July 1926), dealing with the biology of the flowers, fruits, and young regeneration of *Olinia cymosa* Thunb. This is one of the South African forest trees and is known as 'hard pear.' The tree plays an important part in forest succession in the Knysna forest region, and also produces a most excellent timber for constructional purposes. Little has been known of the power of reproduction or facilities for propagation either of this or other important species of these curious indigenous forests. By his close study into the habits of *Olinia cymosa*, Mr. Phillips discloses an extraordinary state of affairs which, if equally true of other species, furnishes a reason for the poor condition of growth of the forests. In spite of an extravagant production of flowers and fruits season by season, by one individual or another, the production of fertile seeds is small, and only a very few natural seedlings actually result from a heavy crop of flowers. The problem of how to assist and increase the natural regeneration of the species is dealt with in some detail, as also the main factors, which require further elucidation.

RUSSIAN EXPLORATION IN MONGOLIA.—Expeditions of the Russian Academy of Sciences were working in Mongolia in 1925 and 1926, studying mainly soils, vegetation, and partly also the fauna of the country. The so-called Gobi 'Desert' has been crossed twice, and this enabled the expedition to state that the whole north-western part of Gobi does not represent a desert, but is a flat steppe, with brown soil with some pebbles, and populated by nomad Mongolians; there occur locally some low ridges and stationary sand-hills; underground waters are everywhere near the surface and the grass cover was generally good. In remarkable contrast with the present steppe landscape of the Central Gobi are groups of large trees (elms) which apparently mark some old valleys now filled in. A special party of the expedition was occupied in detailed studies of local soils, and special attention has been paid to the study of processes of origin and accumulation of soluble salts in the soils.

VOLCANIC ROCKS OF CENTRAL AMERICA.—In the *Journal of Geology* for Nov.-Dec. 1926, P. C. Putnam describes the petrography of the lavas of Central America. In an arcuate zone concave to the Pacific, vulcanism began in the late Cretaceous and Eocene, languished during the succeeding period when folding and intrusion were going on, and broke out afresh with explosive fury in the Miocene. The lava basements of the present volcanoes are thought to be of Pliocene age, while the cones themselves are of later age and have been built mainly of ejectamenta with only occasional lava-flows. Throughout this region half a dozen rock types are widely distributed, both in space and time, ranging from olivine-basalt through latite to rhyolitic pumice. Partial analyses show that all the types are simply related, the most characteristic feature of the province being the richness of the basalts in potash and the complementary abundance of soda at the rhyolite end of the series. This feature suggests that the basalts are not representatives of the layer which gives rise to plateau-basalts, but are rather differentiation products of an intermediate latite magma. The weighted silica percentage is 62, and that of other circum-Pacific provinces ranges from 58 to 63. The explosive phase of eruptivity that followed the Oligocene intrusions gives strong support to Dr. Day's recent recognition of the importance of the gases given off during the crystallisation of an underlying cauldron, and their bearing on local volcanic phenomena.

THE *ELEPHAS ANTIQUUS* OF PIGNATARO.—A large fossil elephant's skull, found at a depth of 8 m. at Fontanarosa, on the southern slopes of the hills commanding Pignataro Interamna, near Cassino, is described by G. De Lorenzo, *Rivista di Fisica, Matematica e Scienze Naturali* (Dec.). The old quaternary soil in which the skull was found has previously yielded fossil mammoths, but the latest find is one of importance as it represents a complete skull of enormous dimensions, measuring 3·50 m. from the frontal protuberance to the apex of the tusk. Moreover, it appears to have been found in its original, and not in a secondary, position, the animal having sunk in muddy ground and been submerged by a further deposition of alluvium. Consequently it is hoped that the whole of the remainder of the skeleton may be found, although difficulties may be expected owing to the decalcification of the bones, possibly as a result of infiltration of water charged with carbon dioxide.

OIL IN BURMA.—An important contribution to the petroleum geology of Burma was made by Dr. L. Dudley Stamp at the meeting of the Institution of Petroleum Technologists on Jan. 11. Since the publication of Pascoe's well-known memoir on "The Oilfields of Burma" in 1912, very little information has appeared concerning work on oilfield developments, much remaining hidden in the archives of the companies responsible for the intensive geological surveys carried out for this purpose. Oil in Burma is not confined to the Peguan beds but, according to the author, may be found at all horizons from the middle of the Eocene to the top of the Peguan (Oligo-Miocene); such petroliferous horizons are definitely associated with intermediate conditions, *i.e.* phases in the history of the Burmese gulf when neither fresh-water nor deep marine environments are implied; a clear understanding of the distribution of oil in the Tertiary rocks follows from a consideration of this gulf as the recipient of river-borne sediment from the north, and marine sediment from the south, and a good case is made out for proving the fallacy of one stratigraphical oil-bearing horizon in Burma. This stressing of essential *facies* rather than essential structure in oil accumulation constitutes a principle often overlooked in other countries than Burma; structure is necessary, but without the right type of rocks being involved, its testing makes an unprofitable and discouraging task. Evidence is adduced in support of the contention that mother- and reservoir-rocks in Burma are identical, *i.e.* that vertical migration is precluded by the rapid alternation of porous sand and impervious clay; lateral migration may have been operative. "Oil is always found in strata in which the majority of fossils are marine, but of shallow water type." This statement naturally leads the author to discuss the coal-oil relationship, which he is inclined to regard as accidental, rather urging that one essential to the formation of petroleum is a concentration of salts in the water of a land-locked lagoon or lake, or on the seaward side of a delta.

LOW TEMPERATURE CARBONISATION.—The Department of Scientific and Industrial Research has issued a report of a test of another process for the carbonisation of coal at low temperatures, in accordance with the scheme in vogue (NATURE, Sept. 20, 1924, p. 441). This report of the Director of Fuel Research deals with the 'Freeman' Multiple Retort of British Oil and Fuel Conservation, Ltd., Willesden. In this plant the coal is fed into the top of a tower built up of

circular compartments separately heated by external gas burners. The coal is mechanically stirred and moved downwards from one compartment to another until it leaves as a mixture of breeze and dust, which is therefore not directly available for use as domestic fuel but might serve for powdered fuel. The striking result was the high yield of tar, 21·1 gall./ton, which is the highest yet observed with any plant tested by the Fuel Research staff. This high yield may be due to the fact that the gas is removed immediately from the plant, each compartment having an offtake. The yield of gas was low, and of ammonia negligible. Considerable mechanical trouble occurred with the plant, and it may be inferred that the process is not technically mature.

THE THERMAL IONISATION OF ELEMENTS.—In their earlier attempts to obtain experimental evidence of the thermal ionisation of elements, the experimental arrangements of Saha and his collaborators have always been open to the criticism that the ionisation potentials of the vaporised elements were less than the potential differences actually existing between various regions in the vapour. In their latest arrangement (*Zeit. für Physik*, vol. 40, p. 648, 1926) Saha, Sur and Mazumdar have used a vacuum oven, similar to King's design, and have heated the elements under investigation in an auxiliary oven made of quartz. The latter was kept at a temperature lower than that of the vacuum oven, and served to regulate the vapour pressure of the elements. The degree of thermal ionisation was determined by measuring the electric current between two parallel graphite plates, which were mounted on molybdenum rods insulated from the oven, when a potential difference of only 1 volt was applied to them. The temperature of the vacuum oven was measured by a Wanner pyrometer, and that of the auxiliary oven by means of a thermo-couple. With this arrangement no current was recorded when mercury, zinc, or cadmium were heated up to 2000° C.; heated magnesium gave only a small current, but heated potassium and sodium gave large currents of the order of some milli-amperes. These results are in complete agreement with the magnitude of the ionisation potentials of the elements investigated.

THE FLUORESCENCE OF IODINE VAPOUR.—It is well known that iodine vapour may be caused to fluoresce by illumination with light of suitable wave-length, and that this fluorescence is markedly decreased by the addition of foreign gases to the vapour. G. Ramsauer (*Zeit. für Physik*, vol. 40, p. 675, 1927) has recently made experiments to determine whether this decrease depends on the wave-length of the light which produces the fluorescence. Pure iodine vapour and iodine vapour containing air were simultaneously illuminated with light from the same source, and the intensities of the fluorescent light from the two samples of vapour were compared by means of a polarisation photometer. Within the limits of experimental error no difference was found when green or yellow light was used to produce the fluorescence. The vapours were also excited by light from an arc of which the anode consisted of an alloy of sodium and cadmium, and the lines of the fluorescent spectra produced by the cadmium and sodium lines respectively were photographed and compared. There was a faint indication that the molecules of air produced a slightly greater effect on the fluorescence caused by the sodium lines than on that caused by the cadmium lines. On the quantum theory it would be expected that the intensity of all the terms of a fluorescence series would be decreased in the same proportion when molecules of a foreign gas are added to the vapour. This was proved to be untrue in the case of measurements carried out on iodine vapour containing oxygen, when the cadmium, copper, mercury, and sodium lines were used to produce the fluorescence. It is suggested that the presence of molecules of a foreign gas causes a change in the probability of transition of the excited iodine molecules.

MICRO-CRYSTALS IN ELECTROLYTICALLY DEPOSITED SILVER.—An X-ray examination of the micro-crystals in electrolytically deposited silver, carried out by H. Hirata and H. Komatsubara, is described in the *Memoirs of the Kyoto College of Science*, Series A, Nov. 1926. The X-ray photographs show that the micro-crystals of silver have a tendency to deposit in a fibrous form, and that the diagonal axis of each cubic lattice is parallel to the axis of the fibre. These results contradict those of Glocker and Bozorth, who suggest that electrolytically deposited silver has no regular orientation.

INSTRUMENTS FOR MEASURING ALTERNATING CURRENTS.—An interesting paper, by Lieut.-Col. K. Edgcumbe and F. E. J. Ockenden, on recent improvements in the design of measuring instruments for alternating current work, was read to the Institution of Electrical Engineers on Feb. 3. Except for radio frequency measurements, the 'hot-wire' type of instrument, once so popular on the Continent, is now 'antiquated.' For measuring electric currents and moderate voltages, the 'moving-iron' type of instrument is coming into general use. For very high voltages electrostatic instruments are employed, and for measuring power, electrodynamic instruments. Practically every scale now used subtends an angle of 120° at the pivot instead of 90° as formerly. But this merely improves the ease with which they can be read. It has little effect on their accuracy. The range of electrostatic condensers can be multiplied to any extent by putting condensers in series with them. It is now also of importance to measure the peak value of the high voltage wave so as to be able to calculate the maximum value of the electric stress on the insulating material. The simplest method of doing this is by means of a neon tube. It is known that a neon tube, if exhausted to the point of minimum impedance, breaks down at a peak voltage which is practically independent of the frequency of the supply and the temperature. The neon tube, shunted by a variable condenser, is put in series with a high-pressure air-insulated electrostatic voltmeter. The 'striking' of the neon tube can be detected in the dark by the luminous effect produced, but it can always be detected by means of a head telephone in series with the neon tube. The accuracy of hot-wire ammeters at high frequencies is sometimes questioned as the 'skin effect' comes into operation. It is stated that the error due to this cause in a good instrument when measuring 3 amp. at a frequency of 5,000,000 does not exceed 1 per cent.

PREPARATION OF HYDROGEN PEROXIDE.—A simple method of preparing concentrated solutions of hydrogen peroxide is described by M. L. Kilpatrick, O. M. Reiff, and F. O. Rice in the *Journal of the American Chemical Society* for Dec. 1926. A 20 per cent. solution of sulphuric acid, cooled in ice, is treated with small quantities of sodium peroxide until nearly neutralised. The crystals of sodium sulphate which form on standing are filtered off, and the adhering hydrogen peroxide washed into the filtrate. Vacuum distillation at 60°-65° yields a 20 per cent. solution which is treated with silver sulphate to remove chloride. After further distillation the solution is concentrated at room temperature over sulphuric acid in a vacuum desiccator for three days. By this means an excellent yield of approximately 90 per cent. hydrogen peroxide is obtained.

The Royal Society Election.

SELECTED CANDIDATES.

THE president and council of the Royal Society have recommended the following candidates for election as fellows of the Society :—

E. V. APPLETON, M.A., D.Sc. Wheatstone Professor of Physics in the University of London. Formerly Fellow of St. John's College, Cambridge. Distinguished for his researches on electric waves, atmospherics, and the Heaviside layer. Author of many papers upon these subjects published in the *Proceedings of the Royal Society*.

T. G. BROWN, M.D. Professor of Physiology, University College, Cardiff. Distinguished for his knowledge of physiology. Author of "Studies in the Physiology of the Nervous System" (*Quart. Jour. Exper. Physiol.*, 1909–1916), and many other papers.

R. H. BURNE, M.A. (Oxon). Curator of the Department of Comparative Anatomy, Museum of the Royal College of Surgeons. Author of many important contributions to comparative anatomy extending from 1892 until 1923, and published in the *Proceedings of the Zoological Society*, *Proceedings of the London Malacological Society*, the *Journal of the Linnean Society*, and *Journal of Anatomy and Physiology*.

J. CHADWICK, Ph.D. Fellow of Gonville and Caius College, Cambridge, and Assistant Director of Radio-Active Research in the Cavendish Laboratory. Distinguished for his researches on radio-activity and atomic structure, especially investigations on the properties of α- and β-particles and on the magnitude of the charge on the nucleus and the law of force around it. Since 1919 he has collaborated with Sir Ernest Rutherford in pioneer investigations of the disintegration of elements by α-particles which have yielded results of fundamental importance.

G. M. B. DOBSON, M.A. (Cantab. and Oxon), D.Sc. (Oxon). University Lecturer in Meteorology, Oxford. Distinguished for his work in meteorological physics. As Major in the R.F.C. was in charge of instrument research for the Air Force at Farnborough and at the Air Ministry, and designed many aircraft instruments now in use. Author of papers in the *Proc. Roy. Soc.* and other journals on conditions in the upper atmosphere, atmospheric turbulence and similar topics.

S. Z. DE FERRANTI, Hon. D.Sc. (Manch.). Electrical Engineer. Faraday Medallist of the Institution of Electrical Engineers. He has contributed in a notable degree to the advancement of electrical engineering, especially by his remarkable pioneering work in relation to the generation and distribution of energy by means of electric current at high voltages. His work on the electric furnace, on the electric energy meter, and in improving alternating current generators and motors, has been of the greatest value.

J. KENDALL, M.A. (Edin.), D.Sc. (Edin.). Professor of Chemistry, Columbia University, New York. Distinguished as an investigator in physical and general chemistry. Has published since 1912, partly with collaborators, more than sixty papers in *Proc. Roy. Soc.*, *Jour. Chem. Soc.*, *Phil. Mag.*, *Jour. Amer. Chem. Soc.*, *Jour. Phys. Chem.*, etc., dealing with the ionisation process, strong electrolytes, correlation of ionisation and solubility in solution, and related subjects.

P. P. LAIDLAW. Investigator at the National Institute for Medical Research, Hampstead. Formerly Dunn Professor of Pathology, Guy's Hospital. Distinguished as a pathologist, pharmacologist, and biochemist.

A. A. LAWSON, D.Sc., M.Sc., Ph.D. Professor of Botany, University of Sydney. Investigator of embryology of Gymnosperms (*Annals of Botany*, 1904–10, and later in Australian publications), seven memoirs; of Gametophytes of Psilotaceæ (*Trans. Roy. Soc. Edin.*, 1915–16); also of cytology (*Trans. Roy. Soc. Edin.*, vols. 47-48); an authority on algal floras of the west coast of America, Jamaica, and Britain.

J. W. MELLOR, D.Sc. Inorganic, physical and technical chemist. Director of the British Refractories Association and Principal of the Pottery School, Stoke-on-Trent; Honorary Secretary of the Ceramic Society. Distinguished as the author of "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," ultimately extending to at least twelve volumes, of which six are now published—a reference work so valuable to chemists that its importance can scarcely be over-estimated. Is the leading authority on the scientific principles underlying the pottery industry, and the author of some fifty original publications on the chemistry and physics of ceramics.

OTTO ROSENHEIM. Distinguished for his investigation into the chemical nature of substances of physiological importance. His work on sphingomyelin and the galactosides of the brain is recognised to be definitive. He discovered, simultaneously with others but independently, the effect of irradiation upon cholesterol. With Dudley he has established the chemical nature of spermine and effected its synthesis.

M. SAHA, D.Sc. Professor of Physics, University of Allahabad. Especially distinguished for his development of the theory of high-temperature ionisation, which has been applied by himself and others to account for many of the principal features of solar and stellar spectra.

J. S. B. STOPFORD, M.D. Professor of Anatomy, University of Manchester. Distinguished for his investigations on the peripheral sensory nervous mechanisms, and particularly for the correlation of the results of his anatomical, experimental, and clinical observations, the one with the other, as well as with those of other workers (*Jour. Anat.*, 1918–21; *Lancet*, 1915–22; *Brain*, 1920); and for his technical achievement in determining the exact distribution of arteries in the brain, and enunciating important morphological principles and clinical applications (*Jour. Anat.*, 1916 and 1917).

H. H. THOMAS, Sc.D. (Camb.). Petrographer to H.M. Geological Survey. Harkness Scholar and Sedgwick Prizeman. Distinguished for his researches in petrology and stratigraphical geology. Author of many papers in the Geological Society publications dealing with the stratigraphy, palæontology, and petrology of South Wales, petrology of the sapphire-bearing rocks of Mull and of the Triassic sediments of Devonshire; also papers on minerals and technology in the *Mineralogical Magazine*.

C. M. WENYON, M.B., B.S., B.Sc. (Lond.). Director of Research in the Tropics to the Wellcome Bureau of Scientific Research. Distinguished for his work in medical protozoology. Author of more than fifty published memoirs embodying the results of his researches on the parasitic Protozoa—especially those causing diseases in man. He has made important contributions to protozoology, and to knowledge of leishmaniasis, malaria, amœbic dysentery, and trypanosomiasis.

Birds of Ecuador.[1]

THIS is a companion volume to the "Distribution of Bird-Life in Colombia," forming vol. 36, 1917, of the *Bulletin of the American Museum*. It differs from many other valuable ornithological books in the fact that at least one-third of it is most interesting reading, and not for specialists in ornithology alone. The introductory chapters, after giving a review of the history of Ecuadorean ornithology, and describing the work done in Ecuador by the American Museum's expeditions, partially under the leadership of the author himself, describes clearly and vividly the general physiography of the country, the distribution of forests, the climatic conditions, and chiefly the life-zones. The author admits four life-zones: the tropical, the subtropical, the temperate, and the Paramo zone, which is the treeless region above 11,000 feet to the snow line.

While the avifauna of the subtropical zone must have derived from the tropical, and that of the temperate from the subtropical one, that of the Paramo, the youngest Andean zone, has acquired its bird-life comparatively recently, not from the neighbouring temperate zone of the Ecuadorean Andes, but very largely from its sea-level equivalent in Patagonia. This is fully explained by numerous examples. In comparing the various regions, numbers of genera are often used; this is not very useful, however, as the limits of genera are so differently defined by various ornithologists, the number of genera generally being greater in American works than in European, with one or two exceptions. It would be better if comparative lists of faunal regions were only given in species and subspecies.

Both books of Dr. Chapman show how wonderfully rich in species the highlands of the Andes are, in comparison with, for example, the elevated portions of Africa; thus, while on Ruwenzori only 95 'zonal' birds, as the author calls them, are known, not less than 412 are recorded from Ecuador, of which about 300 could be found within an area no larger than that occupied by Mt. Ruwenzori. This is doubtless due to the much larger extent of the highlands of the Andes as well as to their much greater height, but also, one may add, to the fact that altogether South America—even the lowlands—is richer in species than Africa. 1508 species and subspecies are included in the list of the birds of Ecuador, a larger number than has before been recorded from an area of similar size. Only 151 forms are treated trinomially as subspecies. The reason for this is that a number of forms have been admitted as species, because it is not known that they intergrade with others. This is still often done in America, but the known existence of intergradations is due to the material available in collections, and it is impossible to say if intergradations occur in the case of rarer birds, of which only a few skins are known. The method of many modern European ornithologists, who regard as subspecies all forms agreeing in the essential characters and only differing in shades of colour, size, or other details, if they strictly represent each other geographically, seems to be more natural.

Dr. Chapman is to be congratulated on his book, which is adorned by maps, photographs of scenery, and by excellent coloured plates of birds, and it is to be hoped that a volume on the birds of Peru may follow before long, so as to give us a still fuller knowledge of the birds of western South America.

[1] *Bulletin of the American Museum of Natural History*. Vol. 55, 1926: The Distribution of Bird-Life in Ecuador; a Contribution to a Study of the Origin of Andean Bird-Life. By Frank M. Chapman. Pp. xiv+784+30 plates. (New York: American Museum of Natural History, 1926.)

University and Educational Intelligence.

CAMBRIDGE.—The following have been appointed as the Council of the School of the Physical Sciences: Mr. A. Berry, Mr. Cameron, Prof. Eddington, Mr. R. H. Fowler, Prof. Hutchinson, Prof. Inglis, Dr. H. Jeffreys, Mr. Landon, Sir Joseph Larmor, Mr. Lees, Mr. McCombie, Prof. Newall, Sir William Pope, Sir Ernest Rutherford, Prof. G. I. Taylor, Mr. L. B. Turner.

Dr. A. C. Haddon has been elected a member of the governing body of the International Institute of African Languages and Cultures. Dr. R. R. Marrett will give the Frazer lecture on Mar. 2 on the subject, "The Diffusion of Culture."

The General Board of Studies has recommended to the University that the readership in geography, about to become vacant by the resignation of Mr. Lake, should be continued.

Honorary degrees are proposed for Brigadier-General E. W. Costello, V.C., officer in command of the University contingent of the Officers' Training Corps, and for Colonel T. C. Hodson, reader in ethnology.

Three Davison scholars will be elected next term for a year's study at Harvard, Yale, and Princeton Universities. Scholars are chosen from undergraduates or bachelors of arts in residence.

THE *Faraday House Journal* for the Lent term shows that there are 83 students in their first year in the college, 51 in their second year, which is spent in mechanical engineering works, 74 in their third year, spent in college, and 71 in their fourth year, spent in electrical engineering works. The names of 45 old students who have obtained appointments since the issue of the Michaelmas number of the journal are given, with the titles of the posts obtained. There are five short scientific articles by staff and old students, amongst them one by the Principal, Dr. A. Russell, showing that the recent experiments which appear to indicate that an electric spark can pass between electrodes near together when the difference of potential between them is less than 350 volts, are probably vitiated by the electrostatic attraction between the electrodes having pulled them together. There are several scholarships and exhibitions offered by the college to be competed for in April next.

THE prefatory note to a pamphlet published by the Universities Bureau of the British Empire (50 Russell Square, London, W.C.1), entitled "Professional Schools, Post-Graduation Courses, Specialist Studies, in the Universities and University Colleges of Great Britain and Ireland, 1926–27," clearly describes its purpose: "Of their [the universities] several fields of study the greater part is common ground, yet each of them has its special plots which it cultivates. . . . The statements which follow indicate the respects in which the universities, individually, specialise, *i.e.* undertake work which is not common to them all." That the pamphlet accomplishes what it promises can best be shown if it be imagined that half-a-dozen students, unacquainted with the "special plots" of universities, desired, respectively, to attend lectures in oceanography, constitutional experiments in the Irish Free State, problems of bi-lingualism, tuberculous diseases, technical chemistry, the leather industry. Twenty minutes' study of this pamphlet would save them hours of hunting through bulky prospectuses and calendars, and would save much preliminary correspondence with registrars.

Calendar of Discovery and Invention.

February 27, 1706.—On this day John Evelyn, the diarist, died. He is commemorated here for his "Silva, a discourse of forest trees," 1664. It was Evelyn's house, Saye Court, Deptford, in which lived Peter the Great. Evelyn is also known as one of the founders of the Royal Society.

February 27, 1812.—Wilhelm von Biela, an Austrian major, on Feb. 27, 1812, discovered Biela, the comet to which his name was given. The comet had a period of 6¾ years, and when it returned in 1846 and 1852 it was seen to have divided into two comets. It then disappeared, but at the end of 1872 showers of shooting stars were observed, and it is believed these were caused by the breaking up of the comet.

February 28, 1838.—A report on Kew Gardens by Dr. John Lindley and two practical gardeners, dated Feb. 28, 1838, recommended that the gardens should be transferred to the care of the nation. They were duly taken over by the Commissioner of Woods on April 1, 1840, and W. J. Hooker was appointed director. It was under his skilful management that the gardens gained the high reputation they now enjoy.

March 1, 1866.—While a journalist in London, Walter Weldon (1832–1885) became interested in industrial chemistry, and though at first ignorant of chemical analysis, on Mar. 1, 1866, he took out the first of several patents connected with the manufacture of soda and chlorine. His introduction of the 'lime-manganese' process in the production of chlorine reduced the price of bleaching powder £6 a ton and, in the words of Dumas, cheapened "every sheet of paper and every yard of calico." The Weldon process has now been superseded by electrolytic methods.

March 2, 1617.—This is the date of the first British patent, but it was the Act of 1623 which for the first time secured "the sole working or making of any manner of new manufactures within this realm to the true and first inventor."

March 4, 1866.—On the memorial to Sir Norman Lockyer in the observatory on Salcombe Hill, Sidmouth, he is described as a "pioneer in the investigation and interpretation of the chemistry of the sun and stars and in the science of astronomical physics." It was on Mar. 4, 1866, that Lockyer first applied the spectroscope to the direct examination of the sun's surface, and in the same year he proposed a new method of observing the 'red flames' of the sun in daylight. A more powerful instrument came into his hands in October 1868, and on Oct. 20 he wrote to the Royal Society: "I have this morning perfectly succeeded in obtaining and observing part of the spectrum of a solar prominence." Janssen had achieved the same result in India, and the joint discovery was recognised by the striking of a medal by the French Government.

March 5, 1874.—Dr. (now Sir) David Ferrier brought before the Royal Society his experiments mapping the surface of the brain of the monkey into regions whence minute electrical stimulation was found by him to evoke precise movements of the face and limbs, characteristic for each region. The experiments were made to test "the theory of Hughlings Jackson that unilateral epilepsies are caused by irritation of the grey matter of the cerebral hemisphere." Ferrier's experiments laid the foundation of the knowledge which guides the physician and surgeon in locating to-day the seat of injury, tumour, etc., in the cerebrum. Moreover, the success of the surgical operations on the monkey's brain obtained in those experiments made clear that similar success might be attained on the brain of man; and in 1884 Rickman Godlee removed a tumour from the human brain. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 17.—G. C. Simpson: The mechanism of a thunderstorm. The theory that the separation of electricity is brought about by the breaking of raindrops is adopted. The orders of magnitude of the meteorological and electrical quantities involved are in accordance with observations. The observations made by Schonland and Craib in South Africa of changes of electrical field strength produced by lightning discharges are in complete accord with the theory.

G. U. Yule: Wolfer's sunspot numbers considered as a disturbed periodic series. The series of sunspot numbers is analogous to the data that would be given by the observed departures of a simple pendulum subjected to random (or largely random) impulses. The graph of such a series is very smooth, but amplitude and phase are continually changing, just as with the sunspot graph. The problem of determining period and 'disturbances' for such a series is attacked by two methods: (1) By forming the least-square equation of the form appropriate to a simple harmonic function

$$u_x = ku_{x-1} - u_{x-2},$$

between three consecutive terms. Trial of the corresponding extended equation appropriate to two periods gave no evidence of the existence of any period other than the fundamental. (2) By forming the general least-square linear equation

$$u_x = b_1u_{x-1} - b_2u_{x-2},$$

and solving as a finite difference equation: the solution is a heavily damped harmonic function. The correlations between u_x and the preceding terms up to u_{x-5} again fails to give evidence of any period other than the fundamental. The 'disturbances' (divergences of u_x from the value estimated by the two preceding terms) show two conspicuous characteristics: (*a*) a tendency to be mainly positive and highly variable, mainly negative and much less variable, over alternate intervals of 40 to 42 years; (*b*) a tendency to be mainly positive during the rise of the graph, mainly negative during the fall.

H. Horrocks: Meteorological perturbations of tides and currents in an unlimited channel rotating with the earth. As tidal predictions from analysis of observations still differ considerably from observations, this paper aims at throwing light on the type of disturbance to be expected when conditions of wind and atmospheric pressure vary at the ocean surface. The special basin considered is an unlimited rotating channel with atmospheric conditions varying across it, and turbulence in the water is taken into account.

G. M. B. Dobson, D. N. Harrison, and J. Lawrence: Measurements of ozone in the earth's atmosphere and its relation to other geophysical conditions (Part 2). As previously found, there is a marked connexion between the amount of ozone and the meteorological upper-air conditions. Possible reasons for this connexion are briefly discussed and connexions with terrestrial magnetism and possibly with sunspots are indicated.

M. Bentivoglio: An investigation of the rate of growth of crystals in different directions. The crystal is grown in a rotating vessel, and relative rates of face-growth are determined for crystals of isomorphous double sulphates of magnesium-ammonium, iron-ammonium, and magnesium-potassium, and potassium and ammonium tartrates. The measurements show that, under conditions of experiments, (i) similar faces of a *simple* form grow at same rate, even when of different sizes. Hence a misshapen crystal, if grown

under uniform conditions, *tends* towards the ideal form. (ii) On a combination, unlike faces grow at different rates, like faces grow at the same rate, except when adjacent to a large face of another fast-growing form. Except in this case there is a constant ratio between rates of growth of any two different forms. (iii) In crystals having no centre of symmetry, rates of growth of parallel faces may be widely different. (iv) In isomorphous series the order of increasing rates of growth is not the same in different members.

P. A. M. **Dirac**: The quantum theory of the emission and absorption of radiation. The problem is treated of an assembly of similar systems satisfying the Einstein-Bose statistical mechanics, which interact with another different system, a Hamiltonian function being obtained to describe the motion. The theory is applied to the interaction of an assembly of light-quanta with an ordinary atom, and gives Einstein's laws for the emission and absorption of radiation. The interaction of an atom with electromagnetic waves is then considered, and it is shown that if one takes the energies and phases of the waves to be q-numbers satisfying the proper quantum conditions instead of c-numbers, the Hamiltonian function takes the same form as in the light-quantum treatment. The theory leads to the correct expressions for Einstein's A's and B's.

Physical Society, Dec. 10.—A. O. **Rankine** and J. W. **Avery**: Electrical polarisation in selenium cells and the effects of desiccation. The secondary E.M.F.'s displayed by selenium cells and the apparently abnormal effect of illumination on the corresponding secondary currents were measured. Both are probably due to an invisible water film in parallel with the selenium. That this film is the principal seat of the polarisation seems to be proved by the fact that the polarisation disappears almost completely with prolonged drying. On this basis a satisfactory quantitative explanation of the various effects is given. An important practical consequence of the desiccation of the cell is the large increase obtained in its sensitivity to light.—T. G. **Hodgkinson**: Synchronous alternating-current motors and mechanical vibrating systems maintained by thermionic valves at the frequency of the vibrating systems. The design of a chronograph which will give a time trace subdivided into units and fractional units requires the association of a rotating system and a vibrating or time-keeping system. If a low-frequency vibrating system be employed, the rotating system, although keeping good average time, may show exaggerated errors in unit subdivisions due to acceleration and deceleration between periods of control. The paper discusses the association of a high-frequency synchronous alternating-current motor with a high-frequency valve-maintained tuning-fork.—K. R. **Rao**: (1) On the spectrum of ionised tin; (2) On the spectrum of doubly ionised gallium and indium.

LEEDS.

Philosophical and Literary Society, Jan. 25.—J. **Lamb**: A 15-ic resolvent of the sextic equation. If this resolvent—whose coefficients are all invariants—has a rational root, the sextic breaks up into three quadratic factors involving a cubic irrationality.—H. **Jones** and R. **Whiddington**: The passage of electrons through gases. Quantum energy losses appear to occur when low-speed electrons pass through gases at low pressure. These losses in some cases correspond with sufficient accuracy with previously known critical potentials, but in other cases do not so correspond.—W. R. **Atkin**: Development of the Sörensen equation for the isoelectric points of ampholytes. The isoelectric point of a simple ampholyte such as an amino acid is $h = \sqrt{k_w \cdot k_a/k_b}$, but this equation is not valid for proteins where the terminal $-NH_2$ and $-COOH$ groups are not necessarily equal in number. The isoelectric point of proteins is given by the equation $h^2 + k_a(1-n)h - n \cdot k_w \cdot k_a/k_b = 0$, where n is the ratio of $-COOH$ groups to $-NH_2$ groups, and k_a and k_b represent average values of the acidic and basic dissociation constants.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 12, No. 12, Dec.).—Arthur **Bramley**: Maxwell's equations and atomic dynamics. Electric and magnetic forces within a charge are stated as functions of the velocities of the moving body and its position. This satisfies the first of Maxwell's equations and gives the second set as equations of motion of the charge; from the latter, Bohr's frequency condition can be derived.—Lucien B. **Taylor**: The spectrum of krypton in the extreme ultra-violet.—C. H. **Kunsman**: Some thermionic experiments with a new source of positive ions. Fused mixtures of iron oxide with about 1 per cent. of an oxide of an alkali or alkaline earth metal form a satisfactory hot anode in a vacuum tube. The positive ions emitted are single atoms, mostly of the added metal, stripped of one electron. Positive ions are emitted when the equivalent voltage of the work function for vaporisation of the ion is greater than the potential holding the outer electron to the atom.—J. H. **Van Vleck**: The dielectric constant and diamagnetism of hydrogen and helium in the new quantum mechanics. Whenever the quantum numbers are small, the theory developed here gives values more in accord with experiment than those of the old quantum theory.—Richard C. **Tolman**: On the equilibrium between radiation and matter. From the first and second laws of thermodynamics, an equation connecting concentration and temperature can be obtained. It contains a constant b, requiring a knowledge of the absolute entropy of the system; Planck's procedure, $S = k \log P$, where S is the absolute entropy and P is the total number of stationary states the energy of which does not exceed the total energy available, may lead to the evaluation of the constant b.—R. C. **Gibbs** and H. E. **White**: Extension of doublet laws in the first long period to chromium and manganese.—Leonard B. **Loeb**: Ionic mobilities in ammonia-hydrogen mixtures and an anomalous effect of ammonia. Traces of ammonia in hydrogen and in air increase the mobility of the positive ions by as much as 30 per cent. without affecting the negative ion, and the formation of a stable NH_4^+ ion which prevents clustering is suggested. 0·1 per cent. and more of ammonia decreases both ionic mobilities by about the same amount. Experiments to find if ammonia would 'protect' the positive ion from ether suggest that the ether molecule attaches to the positive ion in preference to the ammonia molecule.—Carl **Eckart**: Note on the correspondence principle in the new quantum theory. If the co-ordinate matrix is expanded in terms of Planck's constant, the first term approaches the coefficient of the $(m-n)$th harmonic in the Fourier expansion of the motion in the old theory when n approaches infinity. For large quantum numbers, the Fourier coefficients thus constitute a first approximation to the matrix terms, in accordance with the correspondence principle.—M. **Demerec**: Miniature-*a*—a second frequently mutating character in *Drosophila virilis*. This wing character 'mutates' to wild type at any stage in the life-history; it is sex-linked.—Chas. W. **Metz**: Genetic evidence of a selective segregation of chromosomes in Sciara (Diptera). Maternal chromosomes separate from the

paternal ones, the maternal group always going to the pole to remain in the spermatocyte.—Roscoe G. Dickinson and Allan C. G. Mitchell: Decomposition of ammonia by optically excited mercury atoms. The photochemical decomposition is sensitised by mercury vapour illuminated by a cooled quartz mercury arc with radiations of less than 2340 Å.U. filtered off. Diffuse band fluorescence in the green and ultra-violet accompanies the action.—J. M. Cork, C. James, and H. C. Fogg: The concentration and identification of the element of atomic number 61. *L*-series lines of the new element were given by a neodymium concentrate obtained from a large quantity of Brazilian monazite sand.—Gregory Paul Baxter and Howard Warner Starkweather: (1) The density of oxygen and its compressibility below one atmosphere (ii). The average corrected normal density is 1·42897, the coefficient of deviation from Boyle's Law −0·00092 per atmosphere, and the molal volume 22·4144 litres. The atomic weight of helium (density 0·17846) is 4·0001, the last decimal place being without special significance. (2) The density, compressibility, and atomic weight of nitrogen. The average density at 1 atmosphere is 1·25036. The average of the coefficient of deviation from Boyle's Law between 0 and 1 atmosphere is −0·00045 and the average atomic weight 14·006(7).—William D. Harkins and Hugh A. Shadduck: The synthesis and disintegration of atoms as revealed by photography of Wilson cloud tracks (see NATURE, Dec. 18, 1926, p. 875).—Hugh Stott Taylor and John Reginald Bates: Photosensitised decompositions by excited mercury atoms. Various gases, with and without mercury vapour, were passed through a system including a cooled mercury arc; the difference in the rate of increase of pressure in each pair of experiments indicated the occurrence of decomposition. Water gives oxygen and hydrogen in excess, ethyl alcohol gives acetaldehyde and other decomposition products, benzene gives some diphenyl, and so on. Ammonia gives a big excess of hydrogen, suggesting decomposition by stages, probably through hydrazine.—Cecilia H. Payne: (1) Some applications of the ionisation formula. Graphical illustration of the principles of the comparison of the state of ionisation of the atmospheres of stars for which both temperature and pressure differ. Curves for pressure change at constant temperature give the ratio in partial electron pressure in the atmospheres of two stars of known temperature, if the intensity ratio of the corresponding spectrum line is known. (2) On the spectra of stars of class *cF*8.—Willard J. Fisher: The apparition dates of the Andromede (or Bielid) meteor swarms. The method used by H. A. Newton is applied to the known records of this shower. Apparitions may be expected yearly about Nov. 16-19. Three of the 'plots' converge at Nov. 16·7, 1935 U.T.—Maynard M. Metcalf: Larval stages in a protozoon. The Opalinidæ, which are commensals in the recta of frogs and toads, are arranged in an evolutionary table ranging from Protoopalina, an archaic genus of the Triassic, cylindrical in form and with two nuclei, through a flattened form, through another cylindrical form with four or more nuclei, to the flat Opalina, which may be broad or narrow. Opalinids from tadpoles showing all these varied stages in development have been found.—S. Lefschetz: Transformations of manifolds with a boundary.—Paul Slavenas: A possible way to discuss the fundamental principles of relativity. The method is applied to the motion of a rigid system relative to another in Euclidean space, and it is found that Euclidean space admits the law of uniform translation, and that the moving system undergoes contraction in the direction of motion.—R. L. Moore: Concerning paths that do not separate a given continuous curve. In space of two dimensions, every two points that do not belong to a given continuous curve may be joined by a simple continuous arc that does not disconnect that curve.—W. A. Manning: On simply transitive primitive groups.—L. E. Dickson: Quadratic forms which represent all integers.—Luther Pfahler Eisenhart: Congruences of parallelism of a field of vectors.—Gordon T. Whyburn: Concerning certain types of continuous curves.—H. S. Vandiver: Summary of results and proofs concerning Fernat's last theorem (second note).

Official Publications Received.

BRITISH.

The Journal of the Institute of Metals. Vol. 36. Edited by G. Shaw Scott. Pp. xi+785+58 plates. (London.) 31*s.* 6*d.* net.

The Journal of the Polynesian Society: containing the Transactions and Proceedings of the Society. Vol. 35, No. 4, December. Pp. 267-354. (New Plymouth, N.Z.) 10*s.* 6*d.*

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1925-26. Vol. 70. Pp. 151+xxxvi+iv. (Manchester.) 12*s.*

Aeronautical Research Committee: Reports and Memoranda. No. 1049 (Ae. 235): The Direct Measurement of the Angle of Flight Path of an Aeroplane as a means of eliminating the Effect of Air Currents on the Measurement of Lift and Drag. By E. T. Jones and H. L. Stevens. (C.I. Instruments, 91.—T. 2319.) Pp. 9+2 plates. 9*d.* net. No. 1051 (Ae. 236): Second Report on Full Scale Experience with the Slot and Aileron Control fitted to a Bristol Fighter. By H. L. Stevens. (A.2 b. Stability—Full Scale Experiments, 41.—T. 2320.) Pp. 3+2 plates. 4*d.* net. (London: H.M. Stationery Office.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1494: Tobacco Cutworms and their Control. By S. E. Crumb. Pp. ii+14. 5 cents. Department Bulletin No. 1428: The Cadelle. By E. A. Back and R. T. Cotton. Pp. 42. 10 cents. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 69, Art. 22: Descriptions of New and Little Known Diptera or Two-winged Flies. (No. 2648.) Pp. 26. (Washington, D.C.: Government Printing Office.)

Proceedings of the Imperial Academy. Vol. 2, No. 9, November. Pp. xxv-xxvi+459-519. (Ueno Park, Tokyo.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 25, for the Year 1925-26.) Pp. 185-235. (Washington, D.C.: Government Printing Office.)

Acta Societatis Scientiarum Fennicæ. Tom. 50, No. 7: Recherches sur les mouvements propres des étoiles dans la zone photographique de Helsingfors, II. Par Ragnar Furuhjelm. Pp. 162. (Helsingfors.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 533: Relations between Rotatory Power and Structure in the Sugar Group. Part i: Introductory Article and Articles 1 to 10. By C. S. Hudson. Pp. 241-384. 35 cents. Scientific Papers of the Bureau of Standards, No. 539: Radiometric Measurements on the Carbon Arc and other Light Sources used in Phototherapy. By W. W. Coblentz, M. J. Dorcas and C. W. Hughes. Pp. 535-562. 15 cents. (Washington, D.C.: Government Printing Office.)

Institut de France: Académie des Sciences. Annuaire pour 1927. Pp. 382. (Paris: Gauthier-Villars et Cie.)

Veröffentlichungen des Geophysikalischen Instituts der Universität Leipzig. Zweite Serie: Spezialarbeiten aus dem Geophysikalischen Institut. Band 3, Heft 3: Über Luftdruckwellen; synoptische Darstellung der 24 tägigen und der 8 tägigen Welle für die Zeit vom 10 Dezember 1923 bis zum 19 Febr. 1924. Von Paul Mildner. Pp. 173-239+9 Tafeln. (Leipzig.)

Cornell University: Agricultural Experiment Station. Bulletin 453: An Economic Study concerning the Operations of Fruit and Vegetable Shippers in Western New York. By Roger D. Corbett. Pp. 67. Bulletin 456: Sunflowers as compared with Corn as a Silage Crop for New York. By R. G. Wiggans. Pp. 29. Memoir 104: Pasture Studies. By R. G. Wiggans. Pp. 59+4 plates. (Ithaca, N.Y.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 11: Residence and Migration of University and College Students. By George F. Zook. Pp. vii+127. (Washington, D.C.: Government Printing Office.) 20 cents.

Diary of Societies.

SATURDAY, FEBRUARY 26.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Royal Anthropological Institute), at 11 A.M.—Dr. C. Delisle Burns: The Group Mind in Industry.

MERSEYSIDE AQUARIUM SOCIETY (at Liverpool University), at 3.—Prof. J. Johnstone: Address.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Leebetter: Winning Thin Seams of Great Britain.—Papers open for further discussion:—Screening and Washing Plant at Deaf Hill Colliery, by L. F. H. Booth; Steam and Electric Locomotives for Colliery Purposes, by P. F. Hope.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. B. McEwen: Beethoven (1).

MONDAY, FEBRUARY 28.

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of Fuel and Yorkshire Sections) (at Queen's Hotel, Leeds), at 2.30.—The Influence of Atmosphere and Temperature upon the Scaling of Steel:—Dr. C. B. Marson and Prof. J. W. Cobb: Part I. Scaling by Air, Water Vapour, and Carbon-Dioxide.—Dr. H. T. Angus and Prof. J. W. Cobb: Part II. Prevention of Scaling by Hydrogen and Carbon-Monoxide.—Dr. A. Parker: A Thermal Study of the Process of Manufacture of Water Gas.—At 5.—R. A. Mott: A Study of Coke Formation.—H. Hollings: Coke in Relation to some of its Industrial and Domestic Uses.—Margaret F. Bligh and H. J. Hodsman: The Behaviour of Cokes in the Open Grate.

ROYAL IRISH ACADEMY, at 4.15.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 4.30.—R. E. Holttum: Some Problems of Plant Biology in Malaya.—*Papers to be communicated by title only*:—Dr. A. S. Parkes: The Mammalian Sex-Ratio.—Dr. V. Nath: On the Present Position of the Mitochondria and the Golgi Apparatus.—H. E. Tunnicliffe: Glutathione.—G. C. Steward: On Herschel's Condition and the Optical Cosine Law.

INSTITUTE OF ACTUARIES, at 5.—E. W. Phillips: The Actuary in Commerce and Industry.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. V. Z. Cope: Shock and Collapse, with special reference to Acute Abdominal Disease.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Lt.-Col. K. Edgcumbe and F. E. J. Ockenden: Some Recent Advances in Alternating-Current Measuring Instruments.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. Corbett: Organisation and Cost of the Building Industry in America.

ROYAL SOCIETY OF ARTS, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (3).

CHEMICAL INDUSTRY CLUB, at 8.—C. Ainsworth Mitchell: Expert Evidence in Criminal Trials.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. H. W. Barber: The Relationship of Diseases of the Skin to Dental Infection.—E. C. Sprawson: Further Notes on Dentigerous Cysts.

HUNTERIAN SOCIETY OF LONDON (at Cutlers' Hall, E.C.), at 9.—W. G. Ball: The Value of Modern Methods of Investigation in the Diagnosis and Treatment of Hæmaturia.

UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY.—Prof. W. N. Haworth: Some Hetero-cyclic Compounds (Presidential Address).

TUESDAY, MARCH 1.

NORTH STAFFORDSHIRE INSTITUTE OF MINING ENGINEERS (in Central School of Science and Technology, Stoke-on-Trent), at 5.—T. C. Maynard: Notes on the Re-opening of a Working District after Spontaneous Combustion.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. W. F. Dearden: Health Hazards in the Cotton Industry (Milroy Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (5).

CHILD-STUDY SOCIETY (at Central Hall, Westminster), at 6.—St. John Ervine: The Drama and Education.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—Major E. E. Austen: Tse-tse Flies and their Significance to Tropical Africa (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at University College, Nottingham), at 6.45.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation.

ELECTRICAL POWER ENGINEERS' ASSOCIATION (Midland Division) (at Chamber of Commerce, Birmingham), at 7.—C. Vernier: Super-Tension Cables.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Terry: Northern Australia—An Account of my 1925 Expedition.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Annual General Meeting.

HULL CHEMICAL AND ENGINEERING SOCIETY, at 7.45.—Dr. W. H. Hatfield: Stainless Steel.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—H. R. Ricardo: Some Notes on Petrol-Engine Development.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.

INSTITUTE OF CHEMISTRY (Annual General Meeting).

WEDNESDAY, MARCH 2.

ELECTRICAL ASSOCIATION FOR WOMEN (at Hackney Electricity Showrooms, 18 Lower Clapton Road, E.5), at 3.—Discussion on Electric Cookers, from the Housewife's Point of View.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Researches carried out in the Museum.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—T. L. Eckersley: Short Wave Wireless Telegraphy.

LIVERPOOL ENGINEERING SOCIETY (at The Temple, Dale Street, Liverpool), at 6.—J. Wilding: The Mersey Crossings and Industrial Developments.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—L. G. B. Rock: The Construction of a Large Cleaning-shed for Electric Trains.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—Discussion on paper by Dr. Margaret Fishenden on The Effect of Weather Conditions upon the Heat Requirements of a House.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—A. W. Knapp, J. E. Moss, and A. Melley: Cacao Butter Substitutes and their Detection.—Dr. H. W. Bywaters, F. T. Maggs, and C. J. Pool: The Detection of Illipé Butter in Chocolate.—A. F. Lerrigo and A. L. Williams: A Study of the Determination of Saccharin, Colorimetrically and by the Ammonia Process.

ROYAL SOCIETY OF ARTS, at 8.—U. R. Evans: The Corrosion of Metals at Joints and Crevices.

EUGENICS SOCIETY, at 8.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—C. Max Page, Dr. Beddard, R. C. Elmslie, and others: Discussion on The Surgical Treatment of Chronic Non-tuberculous Arthritis.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, MARCH 3.

ROYAL SOCIETY, at 4.30.—Prof. W. L. Bragg: The Structure of Certain Silicates.—M. Bentivoglio: An Investigation of the Rate of Growth of Crystals in Different Directions.—M. C. Johnson: Doppler Effects and Intensities of Lines in the Molecular Spectrum of Hydrogen Positive Rays.—W. L. Webster: The Transverse Magneto-Resistance Effect in Single Crystals of Iron.—*Papers to be read in title only*:—E. Mallett: A Vector Loci Method of Treating Coupled Circuits.—H. Gregory and H. Marshall: The Thermal Conductivity of Carbon Dioxide.—Prof. H. S. Allen and I. Sandeman: Bands in the Secondary Spectrum of Hydrogen.—Prof. C. G. Darwin and F. H. Watson: The Constants of the Magnetic Dispersion of Light.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 4.30.—Dr. C. McClure, Dr. Wybauw, Dr. F. Fox, and others: Discussion on The Breakdowns of Middle Life.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. W. F. Dearden: Health Hazards in the Cotton Industry (Milroy Lectures) (2).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Garstang: The Progress of Hittite Studies (2).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—G. K. Jones: The Battersea Scheme of Children's Concerts and Cinema Shows.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. W. T. Walsh: Illuminating Engineering.—H. T. Harrison: The Problems of Public Lighting by Electricity.

INSTITUTE OF METALS (Birmingham Section) (jointly with Staffordshire Iron and Steel Institute and Birmingham Metallurgical Society) (at Engineers' Club, Birmingham), at 7.—Dr. E. W. Smith: Metal Melting Furnaces.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Annual Meeting) (at Bristol University), at 7.30.—G. Gray: Science and Industry (Chairman's Address).

CHEMICAL SOCIETY, at 8.—R. W. Lunt and R. Venkateswaran: The Decomposition of Carbon Monoxide in the Corona due to Alternating Electric Fields. Part II.—Prof. T. M. Lowry, L. P. McHatton, and G. G. Jones: The Properties of the Chlorides of Sulphur. Part I. Freezing-points.

FRIDAY, MARCH 4.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Researches carried out in the Museum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group Meeting.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—A. E. Tonge: Notes on the Eggs of Lepidoptera.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool and Manchester Sections) (at Manchester), at 7.30.—Dr. D. Clibbens: Chemical Control in the Cotton Bleaching Industry.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Informal Meeting: An Evening with the Old Brigade.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. R. L. Sherlock: A Correlation of the British Permo-Triassic Rocks. Part II. The Permo-Trias of England and Wales South of the Pennines.

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. D. Jones: Cardinal Vowels.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB, at 8.15.—Prof. R. A. Peters: Nutrition in the Light of Modern Research.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Herbert Jackson: Some Colouring Agents in Glasses and Glazes.

SATURDAY, MARCH 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. B. McEwen: Beethoven (2).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Daryll Forde: Ancient Ships and their Modern Descendants.

SUNDAY, FEBRUARY 27.

GUILDHALL (Eccleston Square), at 3.30.—Prof. J. A. Thomson: The Naturalist's Approach to Religion.

MONDAY, FEBRUARY 28.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Prof. H. J. Laski: The Political Philosophy of Spinoza.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.15.—J. Fletcher: Principles of Design in Furniture and Decoration.

TUESDAY, MARCH 1.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. H. H. Turner: Conceptions of the Cosmos in the Galilean and Newtonian Period.

WEDNESDAY, MARCH 2.

UNIVERSITY COLLEGE, at 5.30.—W. H. Patterson: Volta.

THURSDAY, MARCH 3.

KING'S COLLEGE, at 5.30.—R. G. Collingwood: The Mind: Æsthetics.

FRIDAY, MARCH 4.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Herodotus in Babylon.

SATURDAY, MARCH 5.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Some Poisonous Snakes of India.

SUNDAY, MARCH 6.

GUILDHOUSE (Eccleston Square), at 3.30.—Dr. C. Delisle Burns: Experimental Religion.