NATURE

SATURDAY, FEBRUARY 13, 1926.

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. 2937, VOL. 117]

Progressive Thought and Traditional Doctrine.

THE address entitled "The Scientific Method and Authority," delivered by Prof. Edwin Linton before Section F (Zoology) of the American Association for the Advancement of Science at the recent Kansas City meeting, is an interesting and unusual survey of old and new conflicts between progressive knowledge and traditional authority.

Five years ago, says Prof. Linton, no one would have thought of discussing a semi-theological topic before the Zoological Section of the Association, and the fact that the vice-president should think it necessary to devote his retiring address to a formal defence of the theory of evolution and the right to teach it, is eloquent testimony to the wave of religious intolerance—the "wave of anti-science," as Prof. Linton terms it—which has recently swept over certain States of the American Union, or at least over certain very vocal sections of the population.

Those of us who are old enough can recall the not unnatural excitement in theological circles in the sixties and seventies of last century on the first appearance of the "Origin of Species" and the "Descent of Man," the heated encounters between Huxley and the bishops, and the famous occasion when Disraeli declared himself "on the side of the angels." But the noise and fury died down almost as rapidly as it had arisen. In a surprisingly short time, if the magnitude of the change in outlook is considered, a truce between the combatants was called. Philosophical theologians found themselves able to regard evolution as a method of creating new species which was not inconsistent with a theistic view of the universe as a whole. Perhaps the ambiguity of the term evolution helped them in arriving at a concordat: Prof. J. Arthur Thomson tells us that it is used at present in at least five different ways. But at all events the general principle of development was accepted, and men of science were set free to work out the theory more completely and define more carefully the factors in operation. For the last thirty years and more this work has been proceeding in a purely scientific spirit, as in the case of any other scientific hypothesis, without any intrusion of the *odium theologicum* or *anti-theologicum*.

The scientific world, and indeed intelligent opinion everywhere, listens accordingly with a kind of incredulity to the wild outbursts of American religionists in Tennessee and other places. We naturally smile at the popular volume "God or Gorilla?" and the vituperative preacher who consigns "the consensus of scholarship" to the same place which, he assures us, is "old Darwin's" present abode. But the anti-

scientific legislation which has been carried in several States, and has been defeated in others only by a few votes, is a more ominous fact, as showing to how large a body of uneducated voters such fanatical outbursts appeal. As Prof. Linton says, quoting from an eye-witness: "Any one who has faced, as the President of the Science League has done, five thousand furious Fundamentalists, laughing aloud at the simplest scientific statement, and roaring and howling their rage at the slightest opposition to the ignorant and prejudiced statements of their spokesman, will realise the grave danger involved in such utterances as those just quoted. Every one of these Fundamentalists is a voter, and they will all vote against evolution. We shall be fortunate if they do not carry the lynching spirit incited by their speakers and writers to an even more extreme point than the passage of anti-evolution laws." He quotes elsewhere the advice of one of these speakers and writers: "Take the evolutionists, infidels, and no-hell teachers out somewhere and crucify them head downwards, and we shall have a better country to live in."

In the course of his address, Prof. Linton aptly reminds us of "the epidemic of witchcraft hysteria" which flared up in Massachusetts towards the close of the seventeenth century, just as that superstition was dying out in Europe. The comparison is apt on various grounds. In the first place, it may be said without offence that, now as then, the religious public in America is less instructed, and therefore more intolerant, than the corresponding public in Protestant Europe. Parallels might no doubt be found in Great Britain even to-day to the utterances of the American Fundamentalists, but they would be drawn from small and obscure sects which have entrenched themselves in the past. There will always be such survivals, but their influence is confined to an ever-narrowing circle. The gradual diffusion in the American religious public of more enlightened views about the Bible and the course of history may be trusted, therefore, to make the present attitude a passing one. The very concentration of attention upon the subject must have this effect. By staking their whole position on the verbal inspiration and inerrancy of the Biblical canon, the Fundamentalists will very soon be found to have engineered their own defeat.

We constantly forget the different educational levels of our population and the slowness with which new ideas and the results of scholarship spread among the general body of the people. This is especially the case in religion, where the influence of authority is so strong, and the accredited teachers and guides are themselves by instinct conservative. It is evident from the temporary success which has attended the Fundamentalist campaign in America that a large proportion of the religious public there has remained until now completely ignorant of the great movement of historical criticism which, within the last fifty years, has transformed our view of the sacred writings. Ignorant of the principles on which such criticism proceeds, they are unduly alarmed when presented even with its simplest and best accredited results, and they find relief for their feelings in denouncing the critics and all their works. But violent words are no remedy, and it is impossible to ventilate such a question at all without ensuring the gradual spread of saner principles of interpretation among the more intelligent and fair-minded members of the public, especially among the younger generation.

It is well, therefore, to bear in mind that the present attack on the teaching of evolution is, as Prof. Linton says, "but incidental to a larger conflict of ideas, namely, between the so-called Modernists and the self-styled Fundamentalists," and the hopeful feature of the present situation, as he rightly remarks, is the changed attitude of theologians themselves. It is no longer a struggle between men of science and theologians as such, for the foremost theological teachers of the day are as penetrated by the scientific and historic spirit as any man of science in the ordinary sense of that term. It is in reality a struggle in common against the miserably defective culture of great masses of our population.

The De Filippi Expedition to the Eastern Karakoram.

Spedizione italiana de Filippi nell' Himàlaia, Caracorùm e Turchestàn Cinese (1913–1914). Pubblicata sotto la direzione di Filippo De Filippi. Serie 1: Geodesia e geofisica. Vol. 1: Astronomia geodetica, geodesia e topografia. Per G. Abetti, A. Alessio, C. Antilli, J. A. Spranger, N. Venturi Ginori, H. Wood. Pp. xxxv+423+55 tavole. (Bologna: Nicola Zanichelli, n.d.)

THREE sumptuous volumes of scientific results (glaciology, anthropo-geography, ethnography) appeared in 1924, and also Dr. De Filippi's general report; the remaining nine volumes are now being published as soon as the necessary re-computations have been completed.

The present volume deals with the determination of the latitude, time, longitude and altitude of certain selected stations; the details of the triangulation and survey of an area of some 5000 sq. miles; and the photographic work, a very brief account, followed by fifty-five plates, most of which are admirable photographs of the various stations and important positions mentioned in the text.

The equipment of this remarkable expedition was superb. In the selection of each instrument, the test applied was that it should be the best for the purpose within the limits of weight and dimensions suitable for human transport. It included a zenith telescope of 615 mm. focal length for latitude observations; for time and azimuth determinations, a telescope with two stands, so as to serve either as a transit instrument or as a 12-in. theodolite; a pendulum apparatus for determining gravity; a chronograph and a number of chronometers, mercurial barometers and hypsometers, sextants with tripod stands and mercury troughs, tacheometers, a level, a base-measuring apparatus, instruments for determining the magnetic elements, besides gas cylinders, pilot balloons, a radio-telegraphic set, photographic apparatus, plates and films.

The accounts are written by the experts who were in charge of the several operations, namely: Capt. A. Alessio, who later became hydrographer of the Italian Navy; Prof. G. Abetti, of Florence; Mr. J. A. Spranger and Lieut. C. Antilli, of the Italian engineers.

The latitude observations (Chap. i.) are very clearly described by Prof. Abetti. Eleven principal latitudes were observed with probable errors varying from ±0″·11 to ±0″·34, the average being ±0″·17. This is a precision which is more commonly associated with major geodetic operations than with the exploration of little-known regions of great natural difficulty; indeed, a very striking feature of this expedition is the contrast between the difficulties of the region and the refinement of the methods employed.

The time determinations (Chap. ii.) were undertaken, first, for the determination of the difference of longitude between the stations of the expedition and Dehra Dun, the headquarters of the Trigonometrical Survey of India, and secondly, for finding the rate of the chronometer used in timing the pendulums in the gravity observations.

As there was no wireless station in India for the emission of controlled time signals, it had been arranged that at certain hours, on certain days during a considerable period, the wireless station at Lahore should emit a series of suitable signals. A comparison of the local time of the reception of these signals at Dehra Dun and at a station of the expedition gives the difference of longitude of the latter from Dehra Dun. In this way the longitudes of eight stations were determined, and at each of them the latitude was also observed. Of these stations, Skardu, Karghil, Lamayura, Leh and Depsang are connected with India by triangulation. At each of these five, therefore, it will be possible to determine the total local deflexion of the plumb line, and these observed values, together with the values calculated by Hayford's method on the isostatic hypothesis, will appear in Vol. 2 of this series and should yield results of the highest interest. The remaining three stations at which the latitude and longitude were determined are Sughet Karol, Yarkand and Kashgar, all in Turkestan. The positions of the last two were tolerably well known, but the fixation of Sughet Karol adds a useful point in a little-known region.

In Chap. iii., on the determination of positions by the methods of nautical astronomy, Capt. Alessio discusses the advantages for both latitude and time determinations of the prismatic astrolabe as compared with a zenith telescope and transit instrument. His decision was in favour of the latter. For use at secondary stations, where portability was of first importance, he declared a distinct preference for a sextant mounted on a tripod stand with mercurial horizon. It would be interesting to know whether he would come to the same decision to-day, fourteen years later, if the same choice lay before him. In such a matter, personal predilection must always be a factor of importance, yet with an observer so versatile and so practised as Capt. Alessio, it is unlikely that predilection was confined to narrow limits, and this fact gives special interest to the discussion and to his decision. This chapter also contains an account of the watch kept on the rate of the chronometers and of the determination of various differential longitudes by the transport of some of them. This method was only employed when wireless was not available; indeed, the strong battery of chronometers included in the equipment was intended as a *pis aller*, in case it had been found impossible to arrange for the emission of wireless signals.

Chap. iv. contains a very complete account of the determination of altitude by barometers and hypsometers, also by Capt. Alessio. Five mercurial barometers came with the expedition from Genoa, and an additional and particularly good instrument was brought by Prof. Alessandri, who carried it—*in senso assoluto*—all the way from Italy to Leh! Of the six, only the last came safely back to Italy; all the others succumbed sooner or later to the vicissitudes of the journey. The care expended on the treatment and on the comparison of these barometers, and the attention to detail in the deduction of altitude from the data obtained, are worthy of study by any one who contemplates making observations of the kind. Indeed, the whole chapter is more like an account of a careful experiment in physics than that of the operations of a party of explorers.

Results obtained with hypsometers are compared with those deduced from the barometers, and Capt. Alessio arrives at the following conclusions: (*a*) That in determinations of atmospheric pressure with a hypsometer, the accidental error of reading is negligible in

comparison with the analogous error in reading a barometer; (*b*) that the correction to a hypsometer is a function of the prevailing low pressure and temperature, and tends to increase positively as the prevailing pressure diminishes and as the prevailing temperature increases; (*c*) that if, but only if, it is possible to ascertain the effects of the above two causes (long-continued low pressure and temperature), then a determination of atmospheric pressure with a fully standardised hypsometer is of the same order of accuracy as a determination with a mercurial barometer of the best quality and observed under the most favourable conditions. Great stress is laid on the need for study of thermometers when subjected to such conditions, and it is suggested that the Monte Rosa Observatory might undertake such an investigation.

The triangulation which forms the framework for the map of the area surveyed is dealt with by Mr. J. A. Spranger in Chap. v. After the establishment of the base camp on the Depsang Plateau, the weather was at first so bad that it was found impossible to make a satisfactory connexion with known peaks, and it was determined to measure a base and start an independent triangulation resting on an astronomically observed latitude and azimuth. However, a week later the weather cleared, and it was then possible to observe peaks in all directions, including several fixed by the Indian triangulation; among these were K^2 and one of the Teram Kangri peaks. The chart of the triangulation shows that the system divides into two parts, the dividing line running east and west through the Karakoram Pass, and that the connexion between the two parts is weak. Fortunately, it was found possible to fix the ultimate station towards the north by means of rays to well-fixed points, namely, the Gasherbrum peaks and another (12/52E) which had already proved useful in the southern portion. This gives a valuable check, and we may feel confident that the positions of the numerous points on which the topography depends are correct enough for their purpose. The work was immensely difficult, and the success achieved reflects great credit on Mr. Spranger and Major Wood, R.E., who jointly carried it out; nor must we omit to mention the names of the two Indian surveyors, Jamna Pershad and Shib Lal, who did the plane-tabling, and of whom Dr. De Filippi speaks in very appreciative terms.

All the stations at which observations were made are fully described in a special chapter, together with the details of the connexion with the Indian triangulation. The descriptions are supplemented by photographs with arrows marking special peaks, and other arrows in the margins which by their intersection indicate the exact position of the astronomical instrument or the gravity apparatus as the case may be. The care bestowed on these details is much to be commended. Trouble has often been caused in the past by the difficulty of identifying points about which some important fact had been laboriously ascertained.

The introduction, which we deliberately mention last, is a masterly summary by Dr. De Filippi of the whole campaign. It is illustrated by a map of the whole region, on the scale of 1/2,500,000, showing the routes followed by members of the expedition. Large-scale maps of Rimu Glacier and of the new area surveyed have already been published in the general report.

It must be remembered that the Eastern Karakoram is one of the most barren and inhospitable regions of the world, cut off from civilisation by hundreds of miles of extremely high mountains where passes are few and liable to be closed by snow even in summer, and that there are no roads or bridges—only rough tracks along the valleys, where possible, or with astounding gradients up and down steep slopes where the water is bank high.

The scientific instruments, camp material and personal luggage of the Europeans alone weighed four tons and required sixty horses and twenty porters, quite apart from the necessary supplies (some six and a half tons) of European food. So carefully had the details been thought out, that all this mass of material was so subdivided that in no case was the work of individual groups hampered, though frequently they were separated by two hundred miles or more from the main party. The first seven months from the end of September 1913 had been spent in strenuous work in and around the Upper Indus valley. Meanwhile some fifty tons (about 2250 sacks) of food for the porters and fodder for the horses and yaks had to be assembled in the vicinity of Leh ready to be sent forward as early as the condition of the passes into and out of the Shyok valley made it possible. Everything was timed to a nicety; the whole party, with the scientific equipment and all necessary supplies, assembled early in June 1914 a few miles south of the celebrated Karakoram Pass, on the Depsang Plateau (17,590 ft.), which was to be the headquarters of the expedition for nearly three months.

In this introduction, as in the general report, we realise with pleasure how cordial were the relations between the expedition and the several departments of the Government of India with which it had contact, and also what friendly relations subsisted with the Kashmiri officials, with the caravan leaders and the natives generally. But the most striking feature of both accounts is the simplicity and directness of the narrative, together with the modesty and self-effacement of the writer. The funds so liberally subscribed in Italy were obviously used to the best advantage. Each member of the party was selected as being a specialist

in his own branch and devoted unremitting efforts to accomplish the utmost possible. It is not surprising that the investigations have yielded such important results, for it is a fine example of successful team work. Yet the reader's attention is so persistently directed to the activities of the various groups that he is apt to forget that the success is very largely due to Dr. De Filippi's master mind, and that his genius as organiser made it possible, not only to carry out all the main objects of the expedition, but also to branch out in other directions far beyond the area originally selected for scientific research.

B. B. D.
G. P. L.-C.

The Kinetic Theory of Heat.

Müller-Pouillets Lehrbuch der Physik. 11 Auflage. Dritter Band, Zweite Hälfte: *Kinetische Theorie der Wärme.* Von Karl F. Herzfeld. Pp. x+436. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1925.) 21 gold marks.

IT is stated in the preface to this treatise on the kinetic theory of heat that there exists, on one hand, a number of adequate works on the kinetic theory of gases, and on the other hand, a number of very complete treatises on statistical mechanics, but that there is no text-book which gives a comprehensive treatment of the various applications of the kinetic theory in a convenient form. This gap Prof. Herzfeld has set out to fill, and he has been so successful that we could wish that his work was available for English students in their own language.

The first chapter contains an elementary treatment of the kinetic theory of gases, and it is at once evident that the author clearly realises the great importance of stating the precise mathematical and physical interpretation of every assumption made and of every equation obtained, a fact which contributes in no small measure to the success of the book. The discussion of the Maxwell distribution of velocities is accompanied by clear descriptions of Bahr's work on carbon dioxide bands, Stern's investigations of molecular velocities, and the work of Cantor, Minnaert, and Wulf. The portion of the chapter devoted to the consideration of the viscosity of gases and allied phenomena contains short sections on the Gaede molecular pump, the Knudsen absolute manometer, and the diffusion pump.

The second chapter deals with general statistical mechanics; the author has again tried as much as possible to emphasise the physical meaning of each statistical formula, and the use of very advanced mathematics is avoided. The treatment of the behaviour of ordinary gases in the third chapter loses a good deal of its reference value by the omission of any account of the numerous attempts, other than that of Van der Waals, which have been made to obtain a satisfactory equation of state. The author considers them to be practically useless, but, whether that be so or not, they are at least of considerable interest, and, after all, much other scientific work has, in all probability, little further claim on our attention. The English reader must deem it remarkable that in this chapter of forty pages, containing nearly ninety references to original papers, only three of these references are to the work of English and American workers, namely, to the work of Dushman, Rideal, and "McLewis."

The succeeding chapters on solids, the theory of fluids, and the theory of solutions are very extensive, and the sections on sublimation and liquid crystals are of special interest. An excellent treatment of Brownian motion is given in the chapter on the theory of fluctuations, and the developments of the quantum theory, in so far as they affect the kinetic theory, are concisely introduced in Chap. viii. The final chapter deals with the determination of the Loschmidt number and of the absolute dimensions of molecules; it contains a brief account of Rankine's work on this subject, and concludes with a short history of the development of the atomic hypothesis.

The book forms a valuable work of reference, and can be more particularly recommended to those workers who, being conversant with recent English contributions to its subject matter, require ready access to the results of German investigators.

Indian Botany.

The Botany of Bihar and Orissa: an Account of all the known Indigenous Plants of the Province and of the most Important or most commonly Cultivated Exotic Ones. By H. H. Haines. (Published under the authority of the Government of Bihar and Orissa.) In 6 Parts. Part 1. Pp. x+199. 8 rupees. Part 2. Pp. 224. 10 rupees. Part 3: *Calyciflorœ.* Pp. 225-418. 9 rupees. Part 4: *Gamopetalæ.* Pp. 419-754. 13.8 rupees. Part 5. Pp. 755-1058. 11 rupees. Part 6, including Appendices and Index to Parts 2-6. Pp. 1059-1350. 10.8 rupees. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1921–25.)

WITH the issue recently of Part 1, Mr. H. H. Haines has brought to a conclusion his account of the botany of Bihar and Orissa, and removed thereby another large slice from the area of Peninsular India not yet provided with a flora of its own. The first part was published in 1921, so that the work has been completed in the short space of four years. It must not be thought, however, that it is the product of only

forty-eight months of labour, for Mr. Haines had been working on it before he left India, and indeed the contents themselves are full of evidence of the careful preparation of years of research in the field and in herbaria, and of personal acquaintance with the living plants in their natural habitat.

The system of classification adopted closely follows that of Bentham and Hooker with some modifications; *e.g.* the Euphorbiaceæ follow immediately after the Tiliaceæ. This arrangement is not because the author is convinced that it is inherently the best, as indeed will be realised from a study of his discussion on taxonomy and classification, but because, being that followed by most English herbaria, it is the most convenient for English field botanists.

Mr. Haines has taken great pains to give the correct botanical nomenclature according to the International Rules, and to adopt the later developments in raising some of the Bentham and Hooker tribes to the rank of families; *e.g.* with the Urticaceæ. Even when one does not entirely agree with him, his expositions are always illuminating. The keys to the families and genera are Mr. Haines's own and are generally clear and easily applied, and the descriptions are sufficiently detailed to enable any field botanist to make quite certain of his identification. That they are accurate needs no assertion; they are based on intimate and painstaking observation and the study of type specimens. Localities of occurrence and dates of flowering and fruiting are furnished for each species, and also notes on the uses of various parts of the plant.

Part 1 is the most interesting from the general aspect, as it includes, besides a fairly detailed and very interesting account of the area comprised and its topography, geology, and climate, an arresting and lucid dissertation on the general character of the flora, which denotes a most intimate acquaintance with the tract as well as a love for the study of its flora. The chapter on taxonomy and classification is thoughtful and stimulating, and concludes with a conspectus of orders and families in their interrelationship as conceived by the author. The part concludes with a glossary of the botanical terms used and an index for this part—there being a separate index at the end of Part 6 for the other five parts, which are devoted to the descriptive flora itself.

An outline map of the distribution of the rainfall is attached to the chapter on climate, and in a pocket at the end of Part 1 will be found a good topographic map of the Province. The type and paper are excellent, and there can be nothing but praise for this achievement of Mr. Haines, for which all botanists, and particularly those directly interested in the locality, will be grateful.

Our Bookshelf.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 1 (Teil VI. d, VII. a, XI. a). Teil VI. d: Echiuridæ, Sipunculidæ, Priapulidæ, von W. Fischer; Teil VII. a: Enteropneusta, von C. J. van der Horst; Teil XI. a: Pantopoda, von Johannes Meisenheimer. Pp. 55+12+12. (Leipzig: Akademische Verlagsgesellschaft m. b. H., 1925.) 4·80 gold marks.

THE series of which this forms the first section is planned to give an account—systematic, biological, ecological—of the fauna of the North Sea and the Baltic, and is expected to be completed in about 2000 pp. in three years. Each part deals with one group of animals, is separately paged, and bears a number in Roman figures and a letter, so that eventually all the parts with the same Roman figure can be placed together and bound in the sequence indicated by the letters; *e.g.* all the parts on Cœlenterata will be headed "III." followed by one of the letters a-f according to the class or order—the part on Ctenophora will be marked "III. f."

The accounts are intended to be of service to those teachers, students, and amateurs who wish rapidly to refer to the systematic characters and to ascertain the principal facts in the biology of the animals of the area. The descriptions of external and internal characters are necessarily brief, and some previous knowledge is necessary for a proper understanding of the text, but a good third-year student should find little difficulty in using the work.

In Dr. Fischer's part, the Echiuridæ, Sipunculidæ, and Priapulidæ are treated separately. A statement of the characters of the family is followed by a key to the genera. A short diagnosis of each genus and species is given, the localities in the North Sea and the Baltic from which the species has been recorded are mentioned and shown on a map, and the general distribution briefly indicated. In the space of about a couple of pages, a summary is given of the anatomical features which can be made out by the naked eye or with the help of a lens or a binocular dissecting microscope, with references here and there to microscopic structure. Locomotion, food, reproduction, and development are successively considered, and attention is directed to parasites and to those members of the family which commonly serve as food to fishes. Dr. Fischer's work is well up-to-date; it includes, for example, adequate notice of the investigations of Baltzer on Bonellia (1914 and 1924), and appended is a list of works of reference. The illustrations on the whole are good; a better one of the female Bonellia might have been given.

The account of the Enteropneusta follows similar lines. In the part on the Pantopoda a key is given to families only; this part would have been much more useful if keys had been added for the genera and for the fifteen species.

Judging from the portion before us, the series is likely to fulfil its functions very satisfactorily. We cordially wish success to the enterprise, which should result in placing in the hands of those whose work or pleasure leads them to examine the fauna of the North Sea the means for rapidly determining their captures, and for ascertaining the main facts of their biology.

The Radio Year-Book 1926 (Fourth Year): a Book of Reference for all Interested in Broadcast Receiving. Pp. xiv+182. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 1*s.* 6*d.* net.

THIS book will prove of value to all who listen to broadcasting. Photographs are given of many of the eminent men and of many of the popular artistes who have spoken or performed before the microphone during the past year. So far as British broadcasting is concerned, this year will be a momentous one, as the Government will have to come to a decision regarding the future of the British Broadcasting Company. The book is not a mere record of past achievements; many of the contributions look into the future and make conjectures as to new developments. Mr. Thorne Baker discusses the problem of the radio transmission of visual images. He shows that theoretically it is possible to have a screen in one's home on which, for example, the progress of the yachts at a regatta, possibly hundreds of miles away, could be watched. He points out the difficulties in the way, but says that they have nearly all been overcome by Mr. Baird.

The technical section of the book gives many useful hints on the management of receiving sets and aerials. A chapter has been included on "speaking" films by Mr. Elwell; the reason being that the three-electrode valve has proved of the greatest value in this connexion. Dr. Lee de Forest is rightly given the credit of being the pioneer of perfectly synchronised talking motion pictures, which are called "phonofilms" in America. We learn that the talking motion picture in a commercially perfect form will shortly be introduced into Great Britain. A chapter is also devoted to loud-speaker extensions, and a system of wiring the various rooms of a house so that each room can have its own loud speaker or head-phones if so desired is described. A drawback to the method, however, is that if one is speaking in a room with a loud speaker, a listener on the phones in another room hears most of what is said.

Intermediate Mathematics (Analysis). By T. S. Usherwood and C. J. A. Trimble. Pp. xii+457+xxiv. (London: Macmillan and Co., Ltd., 1925.) 7*s.* 6*d.*

THE authors of this text-book on mathematics to the intermediate degree standard have already established a reputation by their previous works which is fully maintained in the present. The book is well planned. It commences with simultaneous and quadratic equations and moves easily to the study of simple graphs and their applications to the determination of observational laws and to the approximate solution of equations. Following a chapter on algebra there come two on trigonometry and one on co-ordinate geometry. The three succeeding chapters return to algebra. Chaps. xi. and xii. deal respectively with vectors and trigonometry of the triangle, and the book is completed with two chapters on the calculus up to elementary differential equations.

The book is well supplied with an admirable collection of varied examples. The argument is well developed and evidently based on a critical teaching experience. If a suggestion may be offered, it is that the subject of vectors is too much segregated within its one chapter. There is no reason why it could not be reintroduced in examples of differentiation, integration and differential equations. Applications of the method of least squares might, moreover, with advantage be introduced into the sections treating of maxima and minima and the determination of observational laws.

In Praise of Birds: Pictures of Bird Life. Described and photographed by the Rev. Canon Charles E. Raven. Pp. xiv+148+48 plates. (London: Martin Hopkinson and Co., Ltd., 1925.) 14*s.* net.

DR. C. E. RAVEN, Canon of Liverpool, has produced an attractive volume in praise of birds and of bird-watching. The story of his quests shows him to be an ardent bird-lover who takes a proper pleasure in every aspect of bird-life and in every opportunity of studying it on intimate terms. His photographs are evidence of much patient zeal: they are of varying merit, but the best are very good indeed. The author takes us from Cambridge to Surrey, with occasional excursions elsewhere; and finally on a visit to the Dutch coast, to the ornithological wonders of which about half the book is devoted. Incidents both of bird-life itself and of experiences in watching and photography are pleasingly described, and a happy enthusiasm for the subject pervades the whole account.

Physik in graphischen Darstellungen. Von Felix Auerbach. Zweite Auflage. Pp. xii+257 Tafeln+29. (Leipzig und Berlin: B. G. Teubner, 1925.) 14 gold marks.

THE author of this work must be a real enthusiast for graphical representation. From every branch of mathematics—pure and applied—physics, chemistry, and metallurgy, he has collected together graphs and drawings to illustrate the principal features and the most critical phenomena of these subjects. In many cases the drawings are new, but more frequently they are reproductions of those that appeared in the original memoirs dealing with the particular phenomenon. In all there are 1557 figures in 257 pages, followed by 25 pages of short explanations of each figure, with references. The drawings are well reproduced and combine together to provide a most interesting "picture" book for the scientific worker.

The Configuration of the Saccharides. By Prof. Dr. J. Böeseken. Translated into English from the Dutch by Dr. Samuel Coffey. Part 1: The Configuration of the Monosaccharides. Pp. iii+71+iv. Part 2: The Configuration of the Polysaccharides. Pp. ii+58+iii. (Leyden: A. W. Sijthoff's Publishing Co., n.d.) n.p.

IN these two monographs, the professor of pure and applied organic chemistry in the Technical University of Delft, Holland, has presented a clear and succinct account of the investigations which have led to the most recent views on the molecular configurations of the members of the sugar group. The work is well done and will be valued as a handy and accurate résumé by the research worker, the lecturer, and the student. Although quite intelligible, the translation appears to be too literal, and we fear that much of the phraseology employed would not be passed by the Society for Pure English.

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.*]

On One-Eyed Vision.

I CALL "solid" or "three dimensional" vision the faculty of the brain to interpret the flat retinal images so as to give the impression of a three-dimensional space. A person with two healthy eyes views the same object from two slightly different angles, when the muscular effort required to bring the two images into coincidence serves as the guide for estimating the distance. This is the generally accepted explanation, but shortly after I had lost the sight of one eye, a friend expressed doubts of its sufficiency on the ground that if he alternately shut and opened one of his eyes, he noticed very little—if any—difference in the three-dimensional impression. I could understand his scepticism, because previous to my accident I had experimented in the same way with the same result. Since then experience has shown me that there is a very substantial distinction between the permanent and temporary closing of one eye.

Before explaining the inconclusive nature of the described experiment, we may consider what powers the one-eyed person retains to help him in estimating the distance of an object. So long as he is young, he may find sufficient assistance in the focussing effort of the eye, but in old age, when that power is gone, what is left?

Everybody who is in the habit of visiting picture galleries must have occasionally come across a painting which gives an almost compelling illusion of a three-dimensional space. Apart from the imitation of atmospheric effects, it is the correct perspective and the true appreciation of the relative sizes of the objects that give a feeling of solidity, which artists occasionally enhance by wilful exaggeration. A picture has the same appearance whether looked at with one eye or two, and it is the "perspective" vision—as it may be called—on which in old age a person who has lost one of his eyes has to depend.

One-eyed vision is not flat, but it is untrustworthy because the unconscious mental process involved, depending on a knowledge of the dimensions of objects and their relation to the apparent sizes, is liable to be seriously at fault. A few examples derived from experience may illustrate this.

If we are accustomed to a wine glass of a certain size we may fill it with fair safety, but if another glass of similar shape and different size is substituted the result may be disastrous; we have a wrong idea of size in our mind, and this leads to a wrong impression of distance. In our homes we are familiar with most of the objects that surround us, but there are some exceptions. I find flowers in a room difficult to locate when the receptacle in which they are placed happens to be hidden. The flowers then seem to cling to the object with which they are in apparent contact. They may appear in the hair or in the hat of a lady sitting in front; and within the last few days I have seen a man drinking his tea with two fine roses growing out of his bald skull. The same is true of moving objects. A fly passing quickly across my field of vision is almost indistinguishable from a bird flying across the window. If such errors occur when we are fully conscious, they are much more striking at the moment of awakening from sleep. Once, in a somnolent condition, I had the firm impression of seeing in a corner of my study what looked like a tin box perhaps 18 inches long and 6 inches high; but rousing myself I found I was looking at a small tin cigarette box standing on a table beside me.

Most people know how, even with full command of two eyes, their sight may be interpreted in different manners. A rotating cup-anemometer may, for example, look as if the direction of rotation were inverted. Similarly, if a transparent cube be drawn in perspective, all twelve edges showing, we may by an effort of mind get two entirely different impressions of the cube, in which it appears as seen either from above and the right, or from below and the left. Similarly, a cone drawn in outline may appear to be turned inside out by an effort of the will. This shows how much the mind is concerned in the process of solid vision.

If we now return to the experiment described in the opening paragraph, we realise that the two-eyed person looking round a room has a firm impression of the three-dimensional relations of the objects he sees. That impression remains when he shuts one eye, and he is not conscious of any difference. He would have to bandage one eye for some time and go into new surroundings before the test could have any value.

There is another set of interesting and puzzling impressions which lie outside the immediate objects of this communication. It concerns objects in motion. We know all motion to be relative, but nevertheless when a moving train passes a stationary one a passenger in either of them, disregarding relativity, forms a definite and often wrong impression as to whether he is moving or at rest. During the first few months after I had lost one eye, an unconscious swaying of my head always appeared to me as a motion of the surrounding objects, and when these objects were close to my face a most unpleasant sensation of their rapid approach resulted.

I may in conclusion refer to the well-known interpretation of the apparent size of the moon when near the horizon, as showing how much psychological processes affect the interpretation we give to what our eyes perceive.

ARTHUR SCHUSTER.
Yeldall, Twyford,
Berks.

The "Modified Scattered" X-Radiation.

MAY we now supplement what we have already told regarding the scattering of X-rays by stating that we now know quite definitely that even after the *J*-transformation has taken place in a scattered X-radiation and this has become a "modified scattered" radiation when its absorbability is measured in certain substances, it has, even after passing through those substances, precisely the same absorbability as the primary when measured in certain other substances.

This is in perfect agreement with the generalisation we have already made that there are various definite levels of activity of an X-radiation in any substance, the level depending upon the whole of a more or less complex beam, and that a change of the activity in one substance from level to level may take place without the least indication of any corresponding change in a second substance. What we have now found is, that the penetrating powers of secondary and primary radiations are equal in some substances *subsequent* to transmission through plates of material which exhibit or produce the difference.

What then of Compton's hypothesis, and more important still, the second line obtained in the spectrum of the scattered radiation? Can the wavelength of a radiation change without producing a corresponding change in absorption in *all* substances?

In answer, we must point out that we have already demonstrated that a change in the activity (photo-electric action, ionisation, absorption) of a radiation can take place without a change in the wave-length—that wave-length and material substance are not the only factors in X-ray phenomena. In order to reconcile our experimental results with Compton's hypothetical change of wave-length, we should be compelled to go further and state that a change of wave-length may take place without a corresponding change in activity—that is, we should be obliged to dissociate the properties of an X-radiation from wave-length altogether, or at any rate we should have to assume that within certain limits, absorption, electronic emission, etc., are independent of wave-length.

Consequently we are very sceptical as to whether a change in the diffraction angle in spectroscopic measurements really does correspond to a change of wave-length. A measurement of absorption is purely experimental, but a measurement of wave-length is dependent on the adequacy of the classical theory of diffraction, and assumes the absence of any unforeseen phenomenon.

It is an experimental fact that the critical condition which governs the change of activity which we have called the *J*-phenomenon is not wave-length, but something analogous to " temperature " of the whole beam of X-rays. Our critical condition for the excitation of the *J*-electronic emission, *J*-ionisation and *J*-absorption is not that the frequency of the primary beam should be higher than a certain critical value, but that this " temperature " shall be higher than a certain value. Thus in place of Stokes' Law which we found to hold for *K* and *L* radiations, we find that in the case of the *J*-phenomenon at least, we may write T_1 must be greater than T_2 where T_1 is the average penetrating power (" temperature ") of the beam and T_2 is a penetrating power characteristic of the substance traversed. We use the term " temperature " only tentatively because it is a familiar physical quality which represents most closely, or is analogous to, the state of a complex radiation as measured by penetrating power by ionisation-absorption methods. It seems just possible that Stokes' Law may need to be re-stated in some such way in order to make it more general, and to express what is most fundamental. This, however, is speculative: the experimental facts we have recorded are in a different category altogether; they are beyond dispute.

To summarise, we must accept one of the following possible alternatives:

(1) The second spectral line in Compton's experiments does not represent another wave-length in the secondary radiation incident on the crystal of the spectrometer, or

(2) Wave-length may change without a corresponding change in the activity of an X-radiation. This seems possible only on the assumption of the dual nature of radiation in some such way as is suggested by Sir J. J. Thomson, or

(3) The conditions essential to the production of the second spectral line in the spectrum of scattered X-radiation have not been realised in the hundreds of experiments we have made on the phenomenon. This is highly improbable both from the variety of our experiments and from the fact that we do under some conditions obtain what has the *superficial appearance* of a change of wave-length.

The alternative probabilities are thus reduced to (1) and (2).

C. G. BARKLA.
S. R. KHASTGIR.

The University, Edinburgh,
January 21.

The Energy Levels of the Carbon Monoxide Molecule.

IN a recent communication (NATURE, 116, 170, 1925) I gave formulæ for the two band systems (or " groups ") associated with ionised carbon monoxide. These formulæ were afterwards verified (NATURE, 116, 207, 1925) by the discovery of " combination " bands due to the third possible transition between the three known energy levels. These electronic levels may be called *X'*, *A'*, and *B'*, in order of increasing energy. *A'* is a double level of spacing 126 cm.$^{-1}$, while *X'* and *B'* are single. The *A'*-*X'* transition gives the comet-tail bands, the *B'*-*X'* transition the first negative group of carbon, and the *B'*-*A'* transition the new Baldet-Johnson combination bands.

In an investigation on the excitation potentials of nitrogen bands, Duncan (*Astrophysical Jour.*, 62, 145, 1925) has observed four systems of bands which he considers to be new nitrogen band systems. I find, however, that his second negative group is the first negative group of carbon, just mentioned above, his seventh positive group is the fourth positive group of carbon, commonly attributed to carbon monoxide, and his fifth positive group is probably the third positive group of carbon, commonly attributed to carbon dioxide. I have been unable to identify his sixth positive group. The second negative group is strong, and his value of the excitation potential is therefore doubtless reliable. Applying the correction of 1·3 volts which I found necessary in the case of the known nitrogen band systems (NATURE, January 16, p. 81), one obtains 19·8 volts for the energy of state *B'*. This gives 14·2 volts as the calculated energy of state *X'*, *i.e.* the ionisation potential of CO. The best direct experimental values are 14·3 and 14·1 volts (see p. 123, Report of National Research Council on " Critical Potentials ").

When writing my letter on the band spectra associated with carbon (NATURE, 116, 170, 1925), I was unable to obtain any satisfactory quantum relations for the fourth positive group. The vibration frequencies of 500 and 3000 quoted there were based on the series arrangement of a portion of the bands of this very extensive system, made by Deslandres and by Lyman. I now find on re-examination of this matter that in this one instance Deslandres arranged the bands in sequences (corresponding to a given *change* in vibrational quantum number) instead of following his usual custom of arrangement in progressions. It is, however, possible to arrange this system in progressions, showing the usual numerical relations, and the new tabulation includes not only all of the bands arranged in series by Deslandres and by Lyman, but also all of Lyman's " fifth positive group " (*Proc. Amer. Acad. Arts*, 45, 315, 1909), and all of the remaining unassigned bands, with the exception of about a dozen very faint members. Approximately 150 bands thus appear on the *n'n''* diagram, the most extensive band system known for molecules of this general type. The heads are given within the rather large limits of error (and with Deslandres' values raised 1 Å.U., to be consistent with those of subsequent investigators) by the formula

$$\nu = 64{,}721 + (1499{\cdot}28n' - 17{\cdot}24n'^2) - (2147{\cdot}74n'' - 12{\cdot}703n''^2),$$

where n' varies from 0 to 14, and n'' from 0 to 22. The distribution of intensity is similar to that in the familiar aluminium bands, which I have previously cited as typical (*Phys. Rev.*, 25, 240, 1925).

Investigators agree that this so-called fourth positive group of carbon, which seems always to

appear in a vacuum tube discharge when stop-cock grease is used, is due to CO (see Kayser and Konen, vol. 7, p. 141), and direct evidence on this point is now available. Leifson, in an investigation of the absorption of some gases and vapours in the extreme ultra-violet (*Astro. Jour.*, in press), photographed a strong series of narrow absorption bands in carbon monoxide which I find represent, for *absorption*, the o-o, o-1, o-2, etc. to o-11 transitions, in my arrangement of the fourth positive group of carbon. Since the cold gas was used, only this one progression should appear. This definitely establishes the final state of this system (in emission) as the stable state of the carbon monoxide molecule. Moreover, the *final* state of the Ångström CO bands is given by the same progression as the *initial* state of the fourth positive group. Thus the Ångström band heads can be represented by

$$\nu = 22{,}162 + (2158n' - 76n'^2) - (1499{\cdot}28n'' - 17{\cdot}24n''^2),$$

where n'' varies from o to 5 or more, and $n' = 0, 1$, and probably 2. This relationship places $\lambda 4511$ as unquestionably the o-o band, a point concerning which there has been some dispute. (See Hulthén, *Ann. d. Phys.*, **71**, 41, 1923, and Mecke, *Phys. Zeit.*, **26**, 217, 1925.)

The system of electronic energy levels for carbon monoxide thus evaluated consists of X, A, and B for the neutral, and X', A', and B' for the ionised molecule. The transition A-X gives the fourth positive group of carbon, and B-A the Ångström CO bands. From the known structure of these latter bands, B and A are both single levels. The transitions for CO^+ have been given. Taking X as the zero level, the energy values of the various levels, in wave-numbers, and in volts, are approximately as follows:

$A = 64{,}721$ cm.$^{-1} = 8{\cdot}0$ volts,
$B = 86{,}883 = 10{\cdot}7$ volts,
$X' = 115{,}082 = 14{\cdot}2$ volts,
$A' = 135{,}554$ and $135{,}428 = 16{\cdot}7$ volts,
$B' = 160{,}720 = 19{\cdot}8$ volts.

The o-o band of the various systems should thus be excited at the following voltages: fourth group ($\lambda 1545$) at 8·0 volts, Ångström bands ($\lambda 4511$) at 10·7 volts, comet-tail bands ($\lambda 4880$) at 16·7 volts, first negative group ($\lambda 2190$) and "combination bands" ($\lambda 3974$) at 19·8 volts.

Carbon monoxide is the only molecule, in addition to nitrogen, for which electronic energy levels of both the neutral and ionised state are known, and is the only molecule for which the spectroscopic data are complete. The new information now obtained leads to theoretical results of some significance. These are discussed in a letter on the "Structure of Molecules" to be published in another issue.

RAYMOND T. BIRGE.

University of California,
December 19, 1925.

The Dynamics of Surface Action in Closed Vessels.

THE theoretical treatment which has been advanced, and experimentally tested, describing the effect of diluent gases and vapours on the initial stages of catalytic action (see NATURE, vol. 116, pp. 278-279), has been successfully extended to the dynamics of catalytic decomposition in closed vessels. Let $l.A \longrightarrow m.B + n.C + \ldots$, etc., be the reaction, and let $a, b, c, \ldots$, etc., be the initial pressures of the molecular species $A, B, C, \ldots$, etc., and let x be the pressure of A transformed in time t. At time t the pressure of $A = (a - x)$, of $B = (b + m/l.x)$, of $C = (c + n/l.x)$, . . . etc., A gas stream of varying composition bombards the surface during the reaction, and the probability that a molecule A will hit a centre of activity immediately it becomes bare is given by the fraction of A molecules in the bombarding stream, *i.e.* by

$$\frac{\mu_A(a-x)}{\mu_A(a-x) + \mu_B(b + m/lx) + \mu_C(c + n/lx) + \ldots}, \quad (a)$$

where μ_A, μ_B, μ_C are constants depending on the nature of the gas.

If $\tau_A, \tau_B, \tau_C, \ldots$, etc., represent the mean lives of the molecules $A, B, C, \ldots$ on the centres of activity which are assumed in the present argument to be homogeneous, ξ be the fraction of a given time interval t during which the centre is free of adsorbed molecules, and n be the number of molecules adsorbed during this time t, which number is equal to the number of times the centre becomes vacant, then the number of molecules of A that are present among the adsorbed molecules during t seconds

$$= \frac{n\mu_A(a-x)}{\Sigma\mu_A(a-x)}$$

and the time they occupy the centre is

$$\frac{n\tau_A\mu_A(a-x)}{\Sigma\mu_A(a-x)}.$$

Thus the fraction of the interval of t seconds during which the "centre of activity" is occupied by A is

$$\frac{1}{t}\,\frac{n\tau_A\mu_A(a-x)}{\Sigma\mu_A(a-x)}.$$

But
$$t = \xi + \frac{n\Sigma\mu_A\tau_A(a-x)}{\Sigma\mu_A(a-x)}.$$

Hence the fractional time during which the centre is occupied by the reactant becomes

$$\frac{\mu_A\tau_A(a-x)}{(\Sigma\mu_A\tau_A(a-x) + \xi/n\Sigma\mu_A(a-x)}. \quad (b)$$

If k be a constant depending on the number and nature of the centres of activity present, then at constant temperature the rate of reaction may be calculated from the fractional times of occupation.

L-molecular Reaction.—The rate of reaction is proportional to the probability that l adjacent centres should be occupied simultaneously by the reactant. Thus

$$\frac{dx}{dt} = k \prod_{1 \to l}\left(\frac{\mu_A\tau_A(a-x)}{\Sigma\mu_A\tau_A(a-x) + \xi/n\Sigma\mu_A(a-x)}\right) \quad (1)$$

$$= k \prod_{1 \to l}\left(\frac{a(a-x)}{1+\beta x}\right) \quad (2)$$

or
$$kt = \int_0^x \prod_{1 \to l} \frac{1}{a}\left(\frac{1+\beta a}{a-x} - \beta\right).dx,$$

where

$$a = \frac{\mu_A\tau_A}{\Sigma\mu_A\tau_A a + \xi/n\Sigma\mu_A a}, \text{ and } \beta = \frac{\Sigma m/l\mu_B\tau_B - \mu_A\tau_A}{\Sigma\mu_A\tau_A a + \xi/n\Sigma\mu_A a}.$$

If $\xi/n\Sigma\mu_A a$ be independent of x, then the general solution is

$$k = \frac{A}{t}\log_e\frac{a}{a-x} + \frac{Bx}{t} + \frac{C}{t}\left\{\frac{1}{a-x} - \frac{1}{a}\right\} \ldots + \frac{L}{t}\left\{\frac{1}{(a-x)^{l-1}} - \frac{1}{(a)^{l-1}}\right\}, \quad (3)$$

where $A, B, C, \ldots$ are constants. The special case $\beta = 0$ becomes

$$k = \frac{1}{(l-1)\,t}\prod_{1 \to l}\frac{1}{a}\left\{\frac{1}{(a-x)^{l-1}} - \frac{1}{a^{l-1}}\right\} \quad (4)$$

and is of the form followed by homogeneous reactions.

Uni-molecular Reaction.—In the great majority of surface actions the effect of the catalyst is to simplify the reaction, lower the heat of activation, and make the change uni-molecular. The general relation becomes

$$\frac{dx}{dt} = \frac{K(a-x)}{1+\beta x}, \quad . \quad . \quad . \quad (5)$$

and, when K and β are independent of x, integrates to

$$K = \frac{1+a\beta}{t} \log_e \frac{a}{a-x} - \frac{\beta x}{t}, \quad . \quad . \quad (6)$$

where

$$k = \frac{\mu_A \tau_A k}{\Sigma \mu_A \tau_A a + \xi/n \Sigma \mu_A a}, \text{ and } \beta = \frac{\Sigma m/l \mu_B \tau_B - \mu_A \tau_A}{\Sigma \mu_A \tau_A a + \xi/n \Sigma \mu^4 a}.$$

The form of (6) varies markedly with the values of the constants, and the majority of the forms it can assume have been experimentally verified by Hinshelwood and co-workers in their experiments on the decomposition of gases on hot wires. I have repeated the experiments on the decomposition of nitrous oxide and ammonia by platinum, and find good agreement with (6). The dehydrogenation of ethyl alcohol by copper in closed vessels also follows this equation. It is to be observed that it is now unnecessary to assume that the surface is saturated to obtain relation (6).

F. H. CONSTABLE.

St. John's College, Cambridge,
January 15.

Discovery and Dialectics.

PROF. MASSON, in NATURE of January 2, courteously dissents from the conclusions expressed in my "Science and Scientists in the Nineteenth Century," and, thanks to the courtesy of the editor, I am allowed to reply.

My proof-sheets were revised by seven Cambridge fellows, who were kind enough to give me the benefit of their accurate knowledge in the different departments of science with which I deal. In addition to them, Sir A. E. Shipley, Sir J. J. Thomson, Sir Joseph Larmor, and Sir Oliver Lodge read through my proofs and made many helpful suggestions. The last, in his Introduction, expressly agrees with my conclusion that there are every whit as many prepossessions in science as there are in theology. The warfare between science and theology is, therefore, in no wise unique; for a similar warfare is characteristic of *every* form of human knowledge.

This is my main thesis, and Prof. Masson does not seriously attack it. He does, however, dissent from my conclusion that men of science do not receive new ideas with enthusiasm, suggesting that if they oppose them they are the rank and file of the scientific army. Let us take, therefore, two outstanding contributions to knowledge, the conservation of energy and the evolution of species. Joule performed not merely one experiment but many experiments, and a man of the standing of Kelvin points out that scientists like Graham or Miller objected to the results of these experiments, saying "simply he did not believe in Joule because he had nothing but hundredths of a degree to prove his case by." Mohr, Mayer, and Helmholtz shared the keen hostility Joule encountered. Gustav Magnus warned Helmholtz against undue partiality for mathematics, and the attempt to bring remote provinces of physics together by its means. Poggendorf thought that the paper of Helmholtz on the conservation of energy was not worth publishing in the *Annalen*. The older physicists, like Dove and Reuss, would not admit the principle of the conservation of energy. Distinguished mathematical colleagues like Eisenstein and Lejeune-Dirichlet seconded the opposition of Dove and Reuss.

Darwin succeeded in obtaining the qualified approval of Lyell, Hooker, and Huxley to his illuminating conception. With these three signal exceptions, it is true to say that the leading men of the world of science offered the stoutest opposition to his ideas. Sir Richard Owen was a naturalist who occupied such a foremost position in science that he has been called the British Cuvier, and he could not see his way to accept the new view. Among the opposition were W. H. Harvey, J. H. Balfour, H. Falconer, Sir E. Sabine, H. C. F. Jenkin, St. G. J. Mivart, A. Gray, L. J. R. Agassiz, J. L. A. de Quatrefages de Bréau, G. A. Brullé, F. J. Pictet, J. H. C. Fabre, Henri Milne-Edwards, O. Volger, R. A. von Kölliker, and K. E. von Baer. The bulk of the criticisms given in my book appeared almost immediately after the publication of the "Origin of Species," and I do not think that I have given any criticism of later date than the year 1864, within five years of its appearance. These critics leave on the mind of the candid reader the impression Huxley took the trouble to record in 1887: "There is not the slightest doubt that, if a General Council of the Church scientific had been held at that time (*c.* 1860), we should have been condemned by an overwhelming majority." In 1885 he wrote: "It is curious now to remember how largely at first, the (scientific) objectors predominated."

ROBERT H. MURRAY.

Broughton Rectory,
Huntingdon.

DR. MURRAY'S reply to my review makes me feel, like the Elephant's Child, "a little warm, but not at all astonished." For I have not been taken literally, and I wished to be. Nor, I think, has Sir Oliver Lodge; for, whatever opinion the words of his "Introduction" may cover, in them he most certainly does not "expressly agree" that science is as full of prepossessions as is theology; he presents Dr. Murray's conclusion and its consequence, but his personal verdict on the question of equality is withheld. So far am I from dissenting from Dr. Murray's statement that new ideas are not enthusiastically received in the scientific world, that I was at pains to emphasise this fact, and went further by asserting that this coldness plays an indispensable part in the method of science by counteracting hasty belief. That Dr. Murray neglects the fundamental value of decent scepticism is my main quarrel with him. Please, I did not suggest that only the rank and file pooh-pooh new ideas! I expressly included every one. In doing so, I propounded an idea, and Dr. Murray has unkindly blighted it by neglect; I said, "Moreover, no man of science, not even the greatest, has more than a short period in his life during which he is so free from human vanities that his discoveries are faultless and his opinions just." Dr. Murray implies that I called Joule's work "one experiment"; I said "one research."

I shall not, I hope, be thought guilty of impatience if, for the sake of saving space, I close by referring any one who wishes to concern themselves in these matters (*a*) to the literal sense of my article of January 2, (*b*) to Sir Oliver Lodge's Introduction to (*c*) Dr. Murray's well-founded facts about men of science, and (*d*) to Dr. Murray's natural, but—I am sorry!—fallacious inferences about science.

IRVINE MASSON.

Genes and Linkage Groups in Genetics.

I HAVE no intention of criticising in detail the elementary lecture on Mendelism which Prof. Huxley gives in NATURE of January 30, p. 154, as a supposed reply to my remarks in the issue of December 26, 1925. Our minds are so differently constituted that what he regards as facts I consider to be unproved assumptions, and what he calls proof I consider to be begging the question. Nothing of what he says is new; indeed much of it, it has been my painful duty to present to my students year after year whilst never concealing from them my utter scepticism as to the assumptions involved.

Prof. Huxley's statistics leave me entirely unmoved. Statistics in biology are a very dangerous weapon; their value entirely depends on the validity and definable character of the *unit* which is counted. It is because I do not regard Morgan's units as having any validity whatever that I consider his deductions as valueless. These units are avowedly assumed in order to make his observations fit a preconceived theory; if the fit is not exact, then further units will be assumed in order to make the fit better, and this procedure he calls proof.

I should like, however, a brief space to set forth to readers of NATURE the reasons why, in company with some of my most distinguished colleagues, I regard the whole of this "factorial analysis" as both formal and futile.

In the first place, the supposed "genes" or "unit factors," even if we concede their existence, throw no light whatever on the course of evolution or on the past history of existing species. This is the opinion of those whose opinions are most entitled to respect in the realms of systematic zoology, of palæontology, and of embryology, which are the three great sources of our knowledge of evolution. What is the use of telling us that the constitution of an animal is to be represented by the factors *a*, *b*, *c*, *d*, *e*, *f* and *g*, if it was not formerly represented by *a*, *b*, *c*, *d*, *e* and *f*, and has become what it is by the addition of "*g*"?—Yet when we examine in detail what the "factors" in Drosophila actually are, any competent entomologist would laugh to scorn the idea that they represent elements in the evolution of an actual insect. Secondly, what Morgan has proved in the case of Drosophila and what has been shown to occur in every case where plants are cultivated or animals bred in confinement in large numbers, is that sharp deviations from the type occur and that these aberrant individuals when crossed with the type exhibit Mendelian segregation in their inheritance. So universally is this the case that geneticists like Baur have been driven to assume that there must be "idiokinetic factors" in the environment to account for these mutations.

Now if the true object of science is *rerum causas scire*, once this fact has been well established, the next step should be to ascertain how the distinctive features of these mutations are acquired in the course of individual development and whether apparently unrelated mutations might not be due to varying intensities of the same disturbance of embryological processes. As I pointed out in the review which originally excited Prof. Huxley's criticism, we can show in the case of Vertebrata that "mutations" as apparently diverse in nature as mental defect and supernumerary fingers can be explained as due to varying degrees of abnormal amniotic pressure. Yet we look in vain in the work of the Morgan school for any trace of analysis of this sort.

Thirdly, when the course of individual development has been ascertained, the next step should be to try to find the environmental influences which have produced the disturbances of development. It is because Tornier has done this and has brought a great mass of direct and indirect evidence in support of his views that I regard his work as equal in value to that of all the other geneticists put together. Not only has he shown how mutations arise, but he has also thrown light on the still more interesting question of why these mutants when exposed to natural conditions tend to revert to type. This valuable work is of course only in its initial stages: like other pieces of important work, its course was interrupted by the War and has not been since resumed, but it is only along lines such as these and not by the assumption of imaginary factors that a ture explanation of the origin of mutations and of the physiological nature of Mendelian inheritance will ever be attained. E. W. MACBRIDE.

Greenland or Polar Front.

To Mr. L. C. W. Bonacina's communication entitled "Greenland or Polar Front," which appeared in NATURE of November 21, p. 748, I should like to make a brief reply. I must again insist upon the contrast which exists between the two polar regions of the earth,[1] and repeat that, despite much misconception, the Arctic basin is neither cold nor dry relative to Greenland or, during the cold season, even to Siberia and British America. Nansen's observations made during the drift of the *Fram* show that 66·5 days in the year were foggy. Mr. Bonacina's statement that fogs did not occur during the winter, does not refer to the long cold polar season, but to the short period of December to February inclusive. Fogs occurred in every other month, and one day in every four was foggy for this period. During Capt. Amundsen's flight toward the Pole, fogs were so thick that little could be seen for much of the way, and near 89° N. fogs were a serious handicap in taking off after the forced landing.

Mr. Bonacina urges in support of a supposed cold high-pressure "polar front" a pressure difference between the Arctic basin and the Icelandic low, but it is significant that within this very sector of the Arctic basin the dominant wind component along the meridian is not from the north, but from the south. Mohn's tables based upon Nansen's observations on the *Fram* for the year 1895 (when the vessel zigzagged throughout along the 85th parallel of latitude within the European sector) showed that for the entire year 59·4 per cent. of the wind force had a southerly component and only 40·6 per cent. a northerly. Reckoned for the periods November to April and May to October separately, the corresponding figures are for the southerly component 58·1 per cent. and 60·5 per cent. respectively. For the short winter season (December to February) when fogs were not observed and when, according to Mr. Bonacina, it might be supposed that cold air would move out southward from the Arctic basin, no less than 63·2 per cent. of the wind component reckoned along the meridian was from the south.[2] As pointed out in my earlier communication to NATURE, the most striking fact which emerges from all the *Fram* observations is their monotony of character with but slight seasonal changes—these are the well-known characteristics of an expanse of sea.

The course of the *Fram* as it drifted in the ice supplies an even more striking proof that the dominant

[1] William Herbert Hobbs, "L'asymétrie de la circulation atmosphérique," *Comptes rendus de l'Acad. des Sciences*, t. 181, 17 août 1925, pp. 289-290.

[2] H. Mohn, "The Norwegian North Polar Expedition 1893–1896, Scientific Results," London, vol. 6, 1905, p. 315.

winds over the Arctic basin do not move outward, but, on the contrary, inward. The wind components throughout have been computed by Mohn, and these appear strikingly set forth upon two of his charts.[3] Evidence has piled up along the same direction from stations on the Arctic coasts of Siberia and British America for the long winter season, during which winds from the north are accompanied by elevation of temperature and those from the south by a fall of temperature. Kindle, with much personal experience in Arctic America, has rendered a service through assembling the observations to prove this generalisation.[4]

A more complete answer to the objections raised by Mr. Bonacina will be found in a monograph now in press and soon to be obtained through the General Library of the University of Michigan.[5]

WILLIAM HERBERT HOBBS.

The Palæolithic Drawing of a Horse from Sherborne, Dorset.

IN entitling his account of this object "On an *apparently* Palæolithic Engraving on a Bone from Dorset" (my italics) Sir Arthur Smith Woodward displayed his habitual caution, and it is with great regret that I now find myself obliged to differ from one for whose judgment I have so great a respect. For I still believe the Sherborne drawing to be a forgery and a clumsy one at that. It was perpetrated as a practical joke, such as delight the heart of boys of fifteen. How far the finders of the bone were involved in the affair there is nothing to show, one or other of them may have been innocent of it. But that some of the boys in the school were not quite so ignorant as Mr. Araldo Cortesi professes himself to be is shown by the fact that they were familiar with "Early Man in Britain" and the illustration of the Creswell Crag horse given there by Sir W. Boyd Dawkins.

Mr. Bayzand, who was intimately acquainted with all the facts—which he communicated to me—acutely remarks that a tracing of the Sherborne drawing when superposed on that of Creswell reveals an identity in size and as well a remarkable correspondence in outline. The odds against such a correspondence arising as a mere coincidence are sufficiently great, but it is easy to understand how a tyro in the art of forgery would have found it difficult—unless he happened to be a skilled artist—to make a sufficiently plausible copy with a change of scale. Further, those parts of the Sherborne copy which differ from the Creswell original do so in just those details which are likely to betray the inexperienced observer.

I do not fully understand the term "semifossilised," but I imagine it is intended to mean less altered than the mammalian teeth found in the gravels of the neighbourhood, *i.e.* in just such a state as might be expected of a bone which had lain in a refuse heap exposed to the air.

W. J. SOLLAS.

University Museum,
Oxford, January 22.

PROF. W. J. SOLLAS has directed my attention to a letter in the issue of NATURE of January 16, by Sir Arthur Smith Woodward, on the supposed Palæolithic drawing of a horse from Sherborne.

At the time of the "discovery" of this drawing I was engaged at the Sherborne School in arranging the museum collections and then learnt something of the history of the find.

The whole affair, as I gathered, was a trick played solely for the benefit of the science master without any idea that it would go any further. Its success was a source of much merriment at the school, particularly amongst those boys who were under this master, and I was even invited by some to inspect the fake.

I may mention that a copy of "Early Man in Britain" was lying in the Museum while I was there, and I should add that I was informed that the bone was discovered near a rubbish heap on the Bristol road, where some of the refuse of the town had been deposited.

This, so far as I can remember, was in the year 1912 or 1913, and I dismissed the whole matter from my mind until I learnt, not without surprise, that Sir Arthur Smith Woodward had communicated the "discovery" to the Geological Society. When later I read his account I at once informed Prof. Sollas of all that I knew, and so am directly responsible for the statement made by him in the third edition of "Ancient Hunters."

C. J. BAYZAND.

Oxford, January 21.

Spermatogenesis in Spiders and the Chromosome Hypothesis of Heredity.

PROF. WARREN, in NATURE, January 16, writes a second letter in support of his previous contention that the spermatogenesis of spiders is different from that of all other animals, and that it is "a good corrective to the view of the all-sufficiency of chromosomes, and to the tendency to substitute cellular structure in the place of the directive vital activity of the organism."

It is difficult to understand what Prof. Warren means by this statement, because it is universally allowed that modern cytological observations have thrown a clear light on nearly every problem of genetics and heredity.

In the past ten years I have probably carried out more investigations than any one else on the cell cytoplasm and its organellæ, yet throughout I have been obliged to admit that the only cell organs which fulfil the necessary conditions which a study of genetics lays down, are the chromosomes.

At the same time, while I have been forced to believe the chromosome theory in general, I recognise clearly that there are still many facts which the chromosome theory does not explain. The spermatogenesis of spiders, as we know it in this laboratory, provides no stumbling-block to a belief in any part of the chromosome theory, any more than does the presence of atypic spermatozoa in molluscs, for example.

The amitosis question has long been a subject which the anti-chromosome theorist has toyed. Prof. Warren is not the first rebel; he will not be the last. When I was a student at Oxford I caused some concern to my teachers by developing a bad attack of amitosis-itis. It was brought on by reading Prof. Child's interesting paper on "Moniezia." However, that is "past history."

Now Prof. Warren is in the middle of a bad attack of the same disease. Like all the evidence for amitosis in germ cells, Prof. Warren's is going to be unconvincing. Even if this investigator does demonstrate division or fragmentation of nuclei, this does not necessarily mean that the cell is dividing amitotically. I can only refer Prof. Warren to Macklin's

[3] *Op. cit.*, vol. 3, pls. xviii. and xxviii.
[4] E. M. Kindle, "Observations on Ice-borne Sediments by the Canadian and other Arctic Expeditions," *Am. Journ. Sci.*, vol. 7, April 1924, pp. 253-257.
[5] William Herbert Hobbs, "The Glacial Anticyclones, the Poles of the Atmospheric Circulation," *University of Michigan Publication*, Ann Arbor, Mich., pp. 200, 3 pls., 53 text figures. 3 dollars.

paper in the Carnegie Institution of Washington, Series, Embryology.

If the chromosome theorist can demonstrate one normal mitosis in Prof. Warren's slides, the whole of this observer's claims must be in doubt. The onus lies with Prof. Warren, and not with the chromosome theorist. The atypic sperms of molluscs have been followed even into the egg; no cytologist could sustain an attack on the chromosome theory when we know that the typic sperms of these molluscs are the real agents in fertilisation.

As was reported in NATURE in October 17, 1925, Dr. S. D. King examined one species of spider, and found a normal chromosome cycle in certainly a vast majority of the cells. In fact, I have never seen a bigger X-chromosome. Now, we know from Dr. King's work that a normal chromosome cycle may occur in spiders, with normal spermatogonial divisions and normal spermatogonial spindle-bridges, so we must hesitate in accepting Prof. Warren's statements so far as they constitute an attack on the chromosome theory.

Prof. Warren seems to have been the first person to have shown that peculiar atypic spermatogenesis may occur in spiders, and for this he deserves much credit.

J. BRONTË GATENBY.

Zoological Laboratory,
Trinity College, Dublin,
January 19.

Polyploidy and Sex Chromosomes.

THE interesting announcement of Dr. J. W. Heslop Harrison (NATURE, January 9, p. 50) that he has found a single pair of sex chromosomes in certain polyploid species of Salix will, if confirmed, add to our knowledge of sex chromosomes in diœcious plants, but does not necessarily alter any of the current views regarding the origin of polyploidy. The fundamental fact that the chromosomes in many plant genera occur in arithmetical series, shows that the process of multiplication in number is one that affects all the chromosomes simultaneously. This is true however the change comes about, whether, for example, through a suspended mitosis or by the union, in hybridisation, of nuclei the chromosomes of which are sufficiently incompatible to be unable to pair in the following meiosis. Multiplication of the whole chromosome series through a condition involving a suspended mitosis is well known to occur naturally in various plant tissues and has been produced experimentally by a variety of methods.

There has been evidence for many years, for example, in the genetic behaviour of *Oenothera gigas*, that secondary changes took place in addition to the primary doubling of the chromosome number, such changes being either coincident with or subsequent to the original doubling. The hypothesis ("Polyploidy," 1924, *Brit. Journ. Exp. Biol.*, vol. 1, p. 175) that the hexaploid condition in wheat has arisen through the crossing of a diploid with a tetraploid species, producing a sterile F_1, in certain individuals of which a split in the chromosomes gave all the chromosomes mates and so produced a fertile hexaploid individual, has recently been fully confirmed experimentally (Clausen, R. E., and Goodspeed, T. H., "Interspecific Hybridisation in Nicotiana," *Genetics*, vol. 10, p. 278, 1925). In a cross between *Nicotiana tabacum* var. (diploid, $n=12$ chromosomes) and *N. glutinosa* (tetraploid, $n=24$ chromosomes) they obtained a sterile F_1 with $3n$ (36) chromosomes. A single capsule, however, produced from seeds two plants, one of which was fertile and when selfed produced an F_2 population like the F_1 but somewhat larger in size. These were shown to be hexaploid ($2n=72$), although the authors speak of it as a tetraploid form.

This removes any possible doubt about such processes actually taking place and affecting all the chromosomes simultaneously. If a single pair of sex chromosomes occurs in a hexaploid species of Salix, it would mean that an additional process of adjustment has taken place, the nature of which might be disclosed by further investigation. There is evidence that secondary changes have taken place in the chromosomes of certain polyploid species. The size relationships of chromosomes and nuclei in the Salices have already shown that some peculiar conditions are involved, and these may well be concerned in part with the readjustment of the sex chromosome mechanism.

Two further points must be briefly stated in this connexion. (1) Bridges (*Amer. Nat.*, vol. 59, p. 127) has recently obtained tetraploid females of Drosophila with 4 sex chromosomes, showing that the X-chromosomes have been duplicated at the same time and in the same way as the autosomes. (2) The situation which Dr. Harrison mentions has already been described (Santos in *Bot. Gaz.*, vol. 75, 1923) in Elodea. This is tetraploid in comparison with related forms, having 48 chromosomes including an unequal XY pair. Meurman (*Soc. Sci. Fennica, Comm. Biol.*, 2, 3) has also recently given reasons for suggesting that *Rumex acetosella* ($n=20$-21) is a ditriploid species. It has a single pair of sex chromosomes and another pair which are transitional in behaviour between sex chromosomes and autosomes. These are further reasons for believing that sex chromosomes duplicated in the process of tetraploidy can later be gradually transformed into autosomes.

R. RUGGLES GATES.

King's College, London, W.C.2,
January 12.

The Magnetic Storm of January 26-27, 1926.

THE great increase in solar activity since the middle of November last, as manifested by spots and faculæ, was not accompanied by any notable magnetic disturbances until January 26, when the greatest storm of the present solar cycle was recorded.

There is some ground for considering this storm as one of a sequence of disturbances at approximately 27-day intervals, extending with only three interruptions since March 5, 1925, but this is not yet definitely established.

There was a small "Sudden Commencement" at $17^h\ 30^m$ on January 25, but it is uncertain whether this should be associated—except as a premonitory symptom—with the storm proper, which may be considered as beginning on January 26, with pronounced movements in both D and H at $15^h\ 30^m$. The general character of the disturbance followed a normal course, with an extreme range in D of 74′, and in H of 660γ.

An interesting feature of the H record was a periodicity in the recurrence of maxima in the first phase of the storm. Four conspicuous maxima were found to be spaced at intervals of exactly 54 minutes, whilst midway between the last two was the highest maximum of the storm. Further examination of the curve suggested the superposition of two periodicities of about 18 and 27 minutes respectively. This was tested by measuring the times of all the more obvious maxima in this portion of the curve, when it was found that during a period of three hours there was a maximum corresponding to every integral multiple, from 0 to 10, of 18^m, whilst all the principal maxima

corresponded to integral multiples of 27^m, and all except the greatest, to the concurrence of integral multiples of both periods. This exception may seem to vitiate the whole conception of the double periodicity suggested, but the objection disappears when it is remembered that an impulse may be periodic without its amplitude factor being a constant, and it only requires a suitable adjustment of the values of these factors for the maximum of the 27 minute period to more than neutralise at this one point the minimum of the 18 minute period. There are also many other oscillations of short period present which must necessarily modify the absolute values of maxima.

This double periodicity may be accounted for, if we suppose the magnetic disturbances to be due to ionic emissions from the sun, propagated in rays with approximately equal spacing, whilst the density of the ions varies in a periodic manner, in shells along the rays, owing to a pulsating or rhythmic emission from the disturbed region on the sun. In this way the orbital motion of the earth, entering the successive rays, would account for one period, whilst the arrival of successive shells at the earth's position would account for the other, and variations in the degree of concentration in both rays and shells would account for any variations in amplitude, as well as for the presence of minor oscillations concurrently with those presenting the more conspicuous features of the record.

J. P. ROWLAND, S.J.

Stonyhurst College Observatory,
Blackburn.

Use of Interference Methods in the Determination of Stellar Diameters.

REFERRING to the article on the work of Prof. Michelson in NATURE of January 2, it is interesting to note that the first suggestion as to the application of interferential methods to the determination of the angular diameter of stars appears to have been made in 1868, being due to Fizeau, and that the method was actually put to the test in France—although with negative results—seventeen years before Prof. Michelson's paper of 1910 referred to by Sir Oliver Lodge. Pointing out a relation between the width of the interference bands and the dimensions of the source of light, Fizeau added this pregnant remark: "It is perhaps permitted to hope that by taking this principle as a basis, and in forming, for example, by means of slits wide apart, interference fringes at the faces of large instruments intended for stellar observations, it will become possible to obtain some new data on the angular diameter of the stars" (*Comptes rendus*, 5, 66, 1869, p. 934).

In the absence of any telescope of sufficient size, this suggestion was bound to remain barren for more than fifty years, but the method was nevertheless actually used in Marseilles in 1873, by Stephan, with a telescope of 0·80 metre aperture, for the purpose of measuring stellar diameter. The aperture was, however, too small, and Stephan had to be satisfied with ascertaining that the apparent diameter of stars of the first magnitude, including Sirius, is less than 0·158″ (*Comptes rendus*, 5, 76, 1873, and 5, 78, 1874, p. 1008).

The first successful application (to the measurement of the diameter of the satellites of Jupiter, of the order of about 1″) was made by Prof. Michelson in 1891, but, by an improvement of the method, Hamy in Paris measured in 1898 the apparent diameter of Vesta (0·54″).

As we all know, the prize fell finally to the hands of the American astronomers, thanks to the amazing self-confidence and tenacity of purpose, combined with almost superhuman skill, which rendered possible the adjustment of mirrors, some twenty feet apart, to an order of displacement comparable to the wave-length of light.

The fame of Prof. Michelson is so well established, and the results themselves are so striking and far-reaching, that the above acknowledgment of the efforts made elsewhere, sterile, it seems, only because of the modest equipment available, in no wise diminishes the glamour of the final achievement.

M. GHEURY DE BRAY.

The Free Path of Slow Protons in Helium.

IN the issue of NATURE for December 19, p. 900, Dr. A. J. Dempster states that he has found that slowly moving protons pass almost freely through helium atoms without being neutralised. In this connexion it may be of interest to state that I have found in the course of experiments on the scattering of protons (hydrogen positive rays) by helium and other gases, that the scattering in helium is a maximum for rays of the energy of about 10,000 volts. For slower rays the scattering is less, and for rays of 3500 volts, the slowest examined, is about 75 per cent. of the maximum. While these rays are considerably faster than those used by Dempster (300 to 900 volts), both results are probably part of the same effect. This may be analogous to the abnormal penetration of very slow electrons through certain gases found by Ramsauer. The *velocities* of these electrons were about the same as those of the protons used by Dr. Dempster. The effect was most marked in argon, but also occurred in helium and neon.

Results on the scattering of protons in hydrogen, now awaiting publication, do not show this abnormality, the scattering increasing with decreasing energy of the rays, though less rapidly than would be expected if the scattering were due to forces of the inverse square type. Experiments on argon are in progress.

G. P. THOMSON.

University of Aberdeen,
January 20.

Residual Ionisation in Closed Vessels.

EXPERIMENTS have frequently been carried out to determine the residual ionisation in closed vessels, and to reveal the conditions under which this is a minimum. One of the lowest values hitherto measured is that of McLennan and Murray, who made their measurements over Lake Ontario, using an ionisation chamber of ice. They obtained the value $q = 2{\cdot}6$ pairs of ions per c.c. per second.

It seems to have escaped notice that K. Bergwitz ("Elster-Geitel Festschrift," p. 585 (1915)) has made measurements in rock-salt workings in Germany, when he found the exceedingly small value of $q = 0{\cdot}8$.

The value of the residual ionisation has a significance in connexion with estimates of the contribution of the penetrating nebular γ-radiation to atmospheric ionisation, and I have not seen a reference to Bergwitz' result in recent publications on this subject. This is undoubtedly due to the fact that the above-mentioned publication is not so well known as it deserves to be. It commemorates the sixtieth anniversary of those two distinguished and inseparable German scientists, Elster and Geitel, and contains many valuable contributions to radioactive literature.

ROBERT W. LAWSON.

The University,
Sheffield.

Light Waves and Light Corpuscles.

By Prof. GILBERT N. LEWIS, University of California.

THE theory that light is a series of spherical waves progressing from the source with velocity c, and the theory that light is a group of corpuscles moving in straight lines from the source with velocity c, have seemed mutually incompatible. Yet we must inquire whether this apparent incompatibility may not be due to some error in our traditional modes of thought, for no prediction of either of these two theories has yet failed to be confirmed. Indeed, we have reached the point where it seems justifiable to summarise a part of our information regarding light in the following manner.

LAWS OF THE CORPUSCLE.

Recent experiments, especially those of A. H. Compton, have fully corroborated Einstein's brilliant surmise that the energy of radiation consists of quanta. Thus the energy lost by an emitting atom travels as a discrete particle along a single continuous path with the velocity c. This path is a straight line, except for

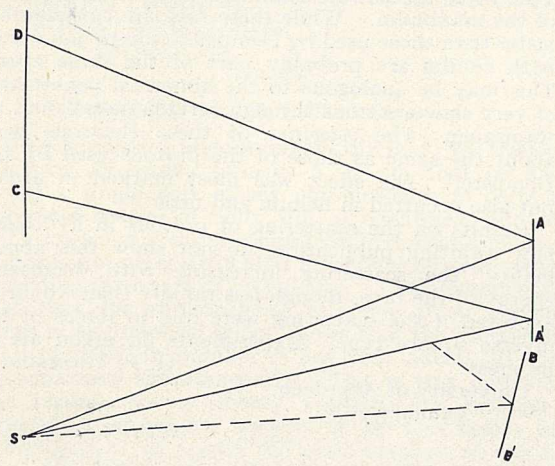

FIG. 1.

deflexions in the immediate neighbourhood of another mass. In the process of deflexion the particle of light and the other mass both obey in detail the laws of conservation of energy, mass, and momentum. If in Fig. 1 a corpuscle of light proceeds from S to a mirror at A and then to an absorbing screen at D, we are convinced that the time required for the corpuscle to pass from S to D is very nearly the length of the path SAD divided by c. But we are also convinced that the corpuscle never moves with a higher velocity than c, and therefore its path must be very nearly the two straight lines SA and AD. This law of the rectilinearity of the path will be very important in our further discussion.

LAWS OF INTERFERENCE.

The classical laws of interference maintain their full validity no matter how weak a source of light is employed. Thus if we should set up an optical apparatus to give light and dark interference bands upon a screen, even if the source of light were so extremely weak as to give only one atomic emission per hour, yet in course of time a photographic plate placed at the screen would show the typical bright and dark bands. The phenomenon of interference can, therefore, in no way depend upon any mutual interaction of a number of quanta, but each quantum by itself must obey, at least statistically, the laws of interference.

Let us suppose that the optical apparatus consists of a pair of Fresnel mirrors, as shown in Fig. 1. S is the source of light, and AA' and BB' are two mirrors producing interference bands on the screen CD. Now if the emitting source *only* sends out quanta, some of which reach the screen by way of one mirror and others by way of the other mirror, it would be impossible to understand how the presence of one of the mirrors could affect the paths of the quanta reflected by the other mirror. We are, therefore, led irresistibly to the conclusion that the phenomenon of light cannot be completely described as an emission of discrete quanta of energy. In addition to this, there must be something which may provisionally be called an interference field, perhaps existing even at times when the transfer of energy is not occurring, which determines where the emitted corpuscles will be absorbed.

This idea that radiation must be resolved into its two aspects, one relating to an interference field and the other to an actual transfer of energy, has been advanced by Slater,[1] and later by Swann,[2] both of whom assume that the emitting atom produces a sort of "virtual" Poynting vector, that the corpuscle of light can travel only along the path of a Poynting vector, and that the intensity of the Poynting vector determines the probability that a quantum will travel by a given path.

This explanation, however, encounters difficulties, of which the chief one is that in the region of interference the path of the Poynting vector is not a straight line but a wavy one, and a corpuscle forced to travel along this path would be quite appreciably retarded. Thus the law of the linear path excludes the possibility that quanta follow the Poynting vector.

Nevertheless, if we are to admit that the quanta travel from source to mirror and from mirror to screen in straight lines, the angle of incidence being equal to the angle of reflection, we are led to certain conclusions which at first sight seem absolutely indefensible. If the mirrors are so arranged that the point C lies in the centre of a dark band, then no quanta will start from the source in the direction SA'. But suppose that S is a distant source, and that the quanta are on their way before the mirrors are set up, how can the presence of the mirror BB' prevent the light corpuscles already on their way from S to A' from reaching the forbidden spot C? Do the emitting atoms know *in advance* how the mirrors are going to be arranged, and refuse to emit in the directions which would lead to the dark bands? Or, in other words, can we, by setting up such a simple interference system, alter a past event, such, for example, as a star's emission of a quantum in a certain direction some thousands of years ago? Such a

[1] Slater, NATURE, 113, 307 (1924).
[2] Swann, *Science*, 61, 425 (1925).

thought is repugnant to common sense, and yet, absurd as it may seem at first sight, it is essentially the theory which I now wish to propose. I shall attempt to show that such a theory requires only a slight extension of the idea of physical time introduced by Einstein, and that it leads to a far better agreement between physical concepts and the geometry which interprets so satisfactorily the kinematics of relativity. By way of introduction, let us consider briefly the meaning of time in the physical sciences.

The Idea of Time in Physics.

There is some discrepancy between the equations of mathematical physics and the less formal physical explanations with which we are accustomed to annotate them. The equations themselves recognise no distinction between positive and negative extension in time; they are symmetrical. But, in the language of physics, a great distinction is made between past and future. Yet the eclipses of a thousand years ago are calculated with just the same precision as those of a thousand years hence, and (except for slight tidal action) a moving picture of the solar system, if the film were run backward, would show a system equally in accord with the laws of Kepler, Newton, and Einstein.

In daily life we constantly recognise the uni-directional character of time, but here we deal with far greater complexity than is found in the simple systems of physics and chemistry. Is it necessary or useful in these sciences to assume any dissymmetry between past and future? [3] At first we should be inclined to say that there must be such dissymmetry in the so-called irreversible processes, but Gibbs and Boltzmann have taught us to regard these merely as an enormous number of elementary processes, each of which obeys simple mechanical laws.

However, the idea that elementary processes, involving only a few atoms or molecules, are in all respects reversible, has never been fully accepted; for while it is admitted that the motion of the atoms in their collisions with one another may be perfectly reversible, it has seemed that the process of *radiation*, even from a single atom, must be irreversible. Indeed, so long as it was supposed that a radiating atom sends out energy in all directions, there seemed to be no way of regarding such a process as reversible. But we now know that this is not the case, and in advancing the theorem of 'entire equilibrium,' I have recently shown [4] how we may consider all these elementary processes as completely reversible and symmetrical with respect to past and future. We thus arrive at the view that a corpuscle of light is shot out from an atom, as an electron may be ejected; that this corpuscle then travels about and later reaches another atom where it is absorbed, by a process which is the exact reverse of the process of emission. I desire now to go much further than this, and to point out an essential difference between the emission and later absorption of an electron and the emission and absorption of light. Here it will be necessary to recall some of the salient features of the geometry of relativity.

[3] This is a subject which I have discussed at some length in the recent Silliman Lectures, which will be published shortly by the Yale Press.

[4] *Proc. Nat. Acad. Sci.*, 11, 179 (1925); 11, 422 (1925).

The Geometry and the Physics of Relativity.

The new kinematics is so admirably represented by the geometry introduced by Minkowski [5] that we should spare no effort to secure harmony between the ideas of this geometry and the concepts of physics. Let me first point out how absurd it would be in any geometry to find a theorem true for a given figure, but false if the figure were turned upside down. In showing that all processes, including radiation, are perfectly symmetrical with respect to past and future, an important step has been taken toward reconciling our physical and geometrical ideas.

Next it may be noted that radiation occupies a unique position in kinematics. In the two-dimensional geometry of relativity, illustrated in Fig. 2, there are

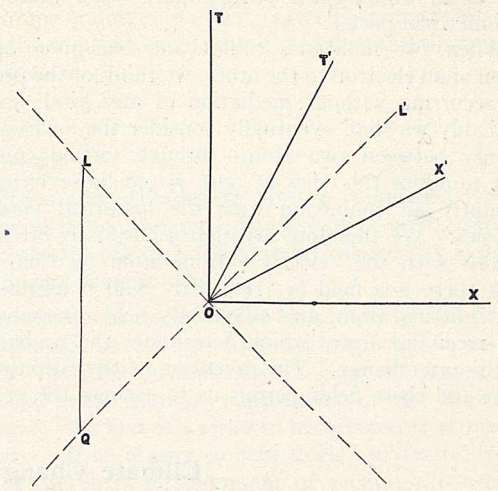

FIG. 2.

two singular lines through a point O, namely, OL and OL', which separate all of the space-like lines, such as OX and OX', from all time-like lines, such as OT and OT'. The singular lines occupy an intermediate position and belong no more to one class than to the other. Now a line such as OT or OT' may be regarded as a locus in space-time of a particle, but lines such as OX and OX' can have no such interpretation. When we associate the singular line OL with the time-like lines, and say that it represents the motion of a light particle, we are forsaking the symmetry of the geometry as a concession to certain habits of thought. If we continue to make this concession, it must be met with a realisation of the unique character of the radiation process.

It is characteristic of this geometry that any interval such as OL, along a singular line, is said to have zero length, and this is an idea of which much use has been made in the mathematics but none in the physics of relativity. Let us now say that if OT and QL represent the loci of two atoms, then any pair of points, such as O and L or O and Q, which are separated by zero distance are in *virtual contact*. In other words, I may say that my eye touches a star, not in the same sense as when I say that my hand touches a pen, but in an equally physical sense.

[5] This geometry has been worked out in some detail by Prof. E. B. Wilson and myself, *Proc. Amer. Acad.*, 48, 389 (1912).

A New Conception of Light.

It has been generally assumed that a radiating body emits light 'into space' regardless of whether there are near or distant objects which may ultimately absorb that light; but, so far as I am aware, the only evidence for this view is the qualitative observation that on a clear night objects radiate energy into what seems to be empty space. This, however, might merely indicate that there is a considerable amount of cold matter in the universe. It would be interesting to make some quantitative experiments in this direction.

I shall make the contrary assumption that an atom never emits light except to another atom, and that in this process, which may rather be called a transmission than an emission, the atom which loses energy and the atom which gains energy play co-ordinate and symmetrical parts.

When two molecules collide and one gives up an atom or an electron to the other, we think of the process as occurring without mediation of any kind, and so probably we shall eventually consider the exchange of energy between two atoms through virtual contact. But to adopt this view at once would be severing too abruptly all connexion with the historical views of physics. We therefore say that a corpuscle of energy travels with the velocity c from atom to atom, and that there is a field (a 'retarded' field if ascribed to the emitting atom, an 'advanced' field if ascribed to the receiving atom) which determines the probability of the interchange. The invention of the corpuscle of light and these fields permit us to express the process of radiation in conformity with our ordinary spatial ideas and with the laws of conservation.

However, if the theory that I propose is correct, it should later be possible to express the probability of an energy transfer merely as the degree of 'fit' between the emitting and absorbing atoms at their points of virtual contact. The great revolution in physical thought which resulted from Maxwell's electromagnetic theory of light made scarcely any change in the mathematical equations of optics; and it is also possible to derive the same equations in accordance with the new views which I am here advancing. How this may be done will be set forth in a series of papers in the *Proceedings of the National Academy of Sciences*, of which the first is now in press.

Before concluding, I may point out that there is a crucial experiment, apparently within the range of experimental feasibility, which should decide for or against the theory. In the apparatus described in Fig. 1, all previous theories of light would predict a practically constant radiation pressure over the mirror AA'. This is true of the theories of Slater and of Swann; for the Poynting vector is uniformly distributed over the mirror. But suppose that the mirror BB' is so adjusted that the point C is in the centre of a dark interference band, while the point D is at the centre of the next bright band. Then, according to the new theory, quanta are travelling by the path SAD but none by the path $SA'C$; therefore the pressure on the mirror will all be on the side A, and if the mirror is suspended at its centre it will experience a measurable torque.

Climate Changes in Western America.[1]

It is now more than ten years since Ellsworth Huntington first employed the growth rings of the Big Trees of California to demonstrate the existence of variations of rainfall during the past four thousand years. The chief difficulty has been the conversion of the curve of tree-growth into a curve of rainfall. Trees grow more rapidly when they are young than when they are middle-aged, while in old trees the growth becomes irregular, so that the equation connecting tree-growth and rainfall at the present day cannot be applied with safety to the early rings of the very oldest trees. Huntington, fresh from an investigation of climatic changes in western Asia, read into the tree-growth curve a close similarity to the fluctuations of level of the Caspian, and applied a "Caspian correction factor" to the curve of tree-growth. The early levels of the Caspian are themselves very problematical, however, and the extrapolation to Western America did not inspire confidence.

A more trustworthy control has now been supplied by the variations in the level of the salt lakes of the Great Basin in close proximity to the trees. It is well known that during the Pleistocene Ice Age the Great Basin was occupied by a number of lakes, of which the largest have been termed Lakes Bonneville and Lahontan. This was many thousand years ago, but some investigations carried out by J. Claude Jones into the salt content of Lakes Pyramid and Winnemucca, which occupy part of the old basin of Lake Lahontan, show that these lakes have been accumulating salt for a period probably between 2500 and 3000 years, so that at some date between 1000 and 500 B.C. they consisted of fresh water. A lake formerly salt may become fresh either by overflowing or by becoming dry for a period long enough for the salt deposit to be covered by a thick layer of detritus. There is no evidence that the lakes have ever overflowed, so that we must adopt the second alternative and suppose that a long dry period ended between 1000 and 500 B.C. If J. C. Jones had left the matter there he would have done much to assist the study of climatic changes, but unfortunately he has confused the deposits of the old Pleistocene lake Lahontan with those of the modern lakes, and has marred his work by some unwarranted statements as to the survival of the lion, horse, and camel in North America into historic times.

In the same publication, E. Antevs has made a thorough revision of Huntington's data of tree-growth, and has prepared a series of curves corrected for the various sources of error, from intrinsic evidence only. His various curves for damp and dry localities agree well among themselves and seem to establish the reality of the climatic fluctuations, though they still leave the absolute level of the early part of the record in some doubt. These curves point to a rapid increase of rainfall about 850 B.C. This evidently corresponds with the

[1] "Quaternary Climates: Geologic History of Lake Lahontan," by J. Claude Jones; "On the Pleistocene History of the Great Basin," by Ernst Antevs; "The Big Tree as a Climatic Measure," by Ernst Antevs; "Tree Growth and Climatic Interpretations," by Ellsworth Huntington. (Publication No. 352.) Pp. v+212+10 plates. (Washington: Carnegie Institution, 1925.)

formation of the modern Lakes Pyramid and Winnemucca; about that date the rainfall must have increased from less to more than its present value, and we can adjust the level of Antevs' curves accordingly. Various other points can be determined from a study of the terraces formed during different stages in the history of these and other lakes; for example, the salt content of Owens Lake shows that it became fresh rather more than 2000 years ago, in this case by rising to such a high level that it overflowed, indicating that a peak on the corrected tree-growth curve at 450 B.C. was the absolute maximum of the whole curve. The age of Lake Walker is estimated as 800 to 900 years, and it can be shown that this lake originated with some changes in the drainage during a period of increased rainfall. A peak on the tree-growth curve fixes this maximum, second only to that of 450 B.C., at A.D. 1000. The corresponding high-level beach can be recognised in the Lahontan basin, and we find that between these two maxima, sub-aerial deposits extended below the present level of Lakes Pyramid and Winnemucca, pointing to a rainfall below the present; the tree curve dates this as A.D. 650 to 850. Finally, a tree killed by the rising salt water of Lake Mono was 500 years old, showing that the rainfall has been slight since A.D. 1400.

This comparison of two different sets of data gives a rainfall curve which can apparently be accepted with a good deal of confidence. Huntington, however, adopts a different interpretation: he considers that the long dry period preceding the formation of Lakes Pyramid and Winnemucca is the American representative of his Caspian drought of A.D. 650, and to make the dates fit he arbitrarily reduces Jones's determination of the age of these lakes by one-half. He states that "that is the earliest time when there is any evidence of so dry a period within historic times"; but it happens that there is abundant evidence of a prolonged dry period in Europe ending in 850 B.C., agreeing remarkably well with the combined evidence of the lakes and the trees in America.

News and Views.

WE record with deep regret the death on February 8, at sixty-four years of age, of Dr. W. Bateson, F.R.S., Director of the John Innes Horticultural Institution and past president of the British Association; also of Dr. W. E. Hoyle, formerly Director of the National Museum of Wales, on February 7, at seventy-one years of age.

UNDOUBTEDLY the best-planned museum in the British Isles, and one of the best in the world, is the National Museum of Wales. It is therefore regrettable that the completion of the Museum should so long have been delayed by unforeseen financial difficulties. The Council in its eighteenth annual report announces that further grants from H.M. Treasury for building purposes are contingent on the collection of considerable sums from other sources, and it therefore again appeals for the sum of 55,000*l*., so that, with proportionate aid from the Treasury, at least the existing portion of the building may be completed and thrown open to the public. The donations to this end during the past year have been singularly few, but include 1500*l*. from Sir Wm. Reardon Smith and Lady Smith, as an instalment of their latest promised contribution of 5000*l*. Are there not among zoologists and museum men, several who would gladly give a trifle in recognition of the splendid work accomplished for this Museum by their old friend and colleague, the late Dr. W. Evans Hoyle? Now, under a Director energetic in another branch, archæology, especially in the field, bulks largely in this report. The excavation of the suburb of the Roman fort Y Gaer, near Brecon, also the investigation of Offa's Dyke and Watt's Dyke, are of particular interest. Among important additions is the botanical collection made by the late J. A. Wheldon of Liverpool, particularly rich in mosses, liver-worts, and lichens. But perhaps the most interesting paragraph of this report is that which tells how a summer school for museum curators was held at the National Museum last June and attended by sixteen representatives of twelve Welsh museums. The two days' course proved so successful that it is likely to be followed by another during the present year.

THE economic organisation and conditions of primitive peoples have been somewhat neglected by economists. Articles on the subject, however, have been included in the January supplement of the *Economic Journal*—the first of a series to be devoted to economic history. Prof. Muntz, of New York University, treating of the early development of economic concepts, selects Africa for his examples. There, he says, the vast majority of the native tribes were well acquainted with trade in some manner or another before contact with Caucasian peoples. Some tribes specialised in the manufacture of cotton goods, others in iron work; some were primarily agricultural, others pastoral, while in the forest many groups were in the hunting stage. The Bushmen and Hottentots had little or no notion of commercial exchange, though the latter had flocks and herds, could forge iron, and manufacture pottery. The most primitive form of peaceful exchange was that by means of reciprocal gifts, which were customary among the Bihénos and other tribes. Dumb barter or silent trade was carried on in many parts, as, for example, by the pigmy race of the Batuas or Akkas. Certain tribes, however, seem to have passed beyond the crude stage of barter. Salt formed a medium of exchange among the Latoukas, on the west coast and even in the interior. Indeed, throughout Africa the expression "a salt-eater" designated a rich man. Cowrie shells were employed for smaller transactions.

IN another article in the *Economic Journal* for January, Mr. Raymond Firth describes the primitive industries of the Maori. The unit was the village group, consisting usually of persons united by ties of kinship. Only the tattooer, the carver, or the tohunga (priestly adept) would be specialists, though some of the men

might devote particular though not exclusive attention to one task. Barter with other tribes was always a matter of ceremonial exchange of gifts; haggling or bargaining was not tika (*i.e.* etiquette). An adequate return for a gift, however, was expected, and if it was not given would be a subject of comment. So, after all, it would appear that "homo œconomicus" was latent if not active. Industry was largely organised on a communal basis, and the products of fishing or the chase were added to the communal larder. Likewise agriculture, house building, or the felling of trees, was communal, though the right to private property was recognised where things such as fish-hooks, tools, pigeon troughs, etc., were made by an individual.

DURING November and December, Mr. E. H. Embree, Director of the Division of Studies of the Rockefeller Foundation, and Dr. Clark Wissler, head of the Department of Anthropology in the American Museum of Natural History, visited the eastern universities of Australia inquiring into plans for the energetic prosecution of anthropological work on the mainland and in the Pacific islands under Commonwealth administration. Last year the Foundation expressed itself as warmly interested in this work and appreciative of its urgency, and, although the visitors have not been in a position to make specific promises of financial support, their visit has greatly increased the probability of immediate and hearty co-operation between Australia and the United States in developing a campaign of work. It is understood that Mr. Embree and Dr. Wissler incline to the view, which is also fairly general in Australia, that anthropological work on the mainland should remain in the hands of individual workers or groups in the several States, but that the work in the islands should be organised from the new School of Anthropology in the University of Sydney, under the advice of a representative Australian board or council. It is expected that Prof. A. Radcliffe-Brown, who will be the first occupant of the new chair, will visit Washington on his way to Australia to confer with the officers of the Foundation.

PROF. A. RADCLIFFE-BROWN, who has now relinquished his appointment of professor of anthropology in the University of Cape Town on his appointment to the newly instituted chair of anthropology in the University of Sydney, will arrive in England in the course of February. Before proceeding to Australia he will deliver a course of three public lectures at the London School of Economics, Houghton Street, Aldwych, W.C.2, on March 10, 12, and 15, at 3 P.M. The subject of the lectures will be "The Study of Backward Peoples: its Method and Practical Value." The series promises to be of considerable interest, as the subject is one on which Prof. Radcliffe-Brown is known to hold strong and original views. Admission to the lectures is free and without ticket.

AT a meeting of the Linnean Society on January 7, Prof. F. Wood-Jones gave a brief account of the fauna and flora reserve on Kangaroo Island, South Australia. This reserve—known as Flinders Chase—comprises some 200 square miles at the western end of the island. It was set aside as a sanctuary by the Government of South Australia by Act of Parliament in 1919. The administration of the reserve is carried out by a small Board which has to raise funds for the Chase, the Government granting a pound for pound subsidy. It is intended that the reserve shall function not only as a sanctuary, but also as a depot for the legitimate supply of scientific material to workers in Australia and other lands, and for the furnishing of living animals to zoological gardens, specimens to museums, and pelts to the fur market. In this way the Board is confident that ample revenue can be raised for much needed work upon the Chase, and, granted a continuance of public goodwill and proper political support, it may be safely predicted that Flinders Chase will rank among the important sanctuaries of the world, and be a cherished possession of South Australia. Considerable progress has already been made in the direction of introducing on the Chase those species which are in most immediate danger of extermination in continental Australia, and this policy will be steadily continued so far as opportunity and funds permit. At the conclusion of the meeting, a resolution was unanimously adopted expressing appreciation of the work which is being done for the preservation of this portion of the South Australian fauna and flora.

DR. F. DIXEY gives an account of the preliminary results of his survey of the country to the north-west of Lake Nyasa in the *Nyasaland Times* of December 15, 1925. Attention was directed to this area by the discovery of fossil Dinosaur bones by Mr. Holt in a sterile wilderness which has remained little known as it is practically uninhabited. This country consists of ridges of the old crystalline rocks, which form the foundation of all this region, with sedimentary beds in the intervening valleys. Dr. Dixey has obtained from these beds a large collection of fossil Dinosaurs from a tract of country 80 miles in length. The beds extend across the Songwe River into Tanganyika Territory. They rest unconformably on the coal-bearing Karroo Beds of Mt. Waller, in which Dr. Dixey has discovered remains of large reptiles, which he describes as millions of years older than the Dinosaur beds. The Dinosaur beds pass eastward under the deposits of Lake Nyasa, which contain fossil shells similar to those still living in the lake. The lake beds occur in successive terraces, some of them hundreds of feet above the level of the lake. Their deposition was followed by volcanic eruptions, of which the line of hot springs that runs throughout Nyasaland represents the final stage. Dr. Dixey reports that this part of the floor of the Rift Valley has been lowered by faults in several stages, each accompanied by an increased tilt toward the north-east. Lake Nyasa originally occupied a small area near Florence Bay, and has increased to its present size by the continued subsidence of the floor of the Rift Valley. The discovery of these fossils represents a valuable contribution to the geology of Africa, for

when determined they will give two well-established Mesozoic horizons in Nyasaland.

MR. T. A. JOYCE, Deputy-Keeper of the Department of Ceramics and Ethnography of the British Museum, sailed on February 6 for British Honduras, where he proposes to spend a period of four months in investigating the relics of ancient Maya civilisation. Mr. Joyce's work will be in continuation of the pioneer investigations of Lady Richmond Brown, Mr. F. A. Mitchell-Hedges and Dr. T. W. Gann, who have already spent two seasons on these sites. As the ruins are covered with forest growth, the work of these expeditions has been confined mainly to clearing away the jungle. Evidence was, however, obtained of the existence of some remarkable buildings and of at least one structure of a type not known elsewhere in Central America. The masonry of the earlier work was of a higher character than the later. This is fully in accord with what is known of the development of Maya culture in other parts of Central America. Nothing is at present known of the origin of these buildings, but the absence of defences would suggest that they were used for ceremonial purposes. Mr. Joyce's special knowledge of American archæology should enable him to throw fresh light on the problems of Maya culture as a result of this expedition.

EXCAVATIONS in Mesopotamia during the present season are proving highly successful, and the results of the expeditions now in the field, especially the Weld-Blundell Expedition, are likely to produce some remarkable results. At Kish, where the Weld-Blundell Expedition is at work, a number of complete early Sumerian skeletons have been obtained. These will provide valuable material for the elucidation of the physical characters of the early Sumerians and the obscure problem of their ethnological affinities, especially if this material should prove really comparable with the dozen or more skeletons of the Indo-Sumerian period, of which the discovery at Mohenjo-Daro in Sind is announced by the Indian Archæological Department. Equally important is the announcement of the discovery of a complete series of perfect specimens of the early painted polychrome and monochrome Sumerian pottery with geometrical design. This is the first discovery of perfect specimens of this ware in any quantity, and places beyond dispute its connexion with the thin pottery of the first Susan period. The pictographic script discovered with the painted ware is the earliest yet known, dating from a period anterior to 3500 B.C. as a minimum.

THE Frankfurt correspondent of the *Times* describes, in the issue for February 3, the position and prospects of the German chemical industry, and some of the efforts it is making to regain the supremacy it enjoyed before the War. Since the conclusion of peace, that industry has encountered a sea of troubles. Foreign countries have developed powerful industries of their own, and strong protective tariffs have been erected against German chemical products both in Europe and the United States. Compared with the year 1913, external sales of German dyestuffs have decreased by 50 per cent. and of German fertilisers by more than 95 per cent. The United States now produces 90 per cent. of its requirements in dyestuffs, and Italy, which had practically no dye-making industry in 1913, about 60 per cent. Manufacturing profits in Germany have practically disappeared; loss of territory and raw materials, inflation and scarcity of capital, have combined to retard progress and expansion.

IN spite of all this, however, Germany still leads, and is making stupendous efforts to recover her former position of undisputed supremacy in the chemical industry. Belief in the value of scientific research is as potent as ever. The *Interessengemeinschaft* (I.G.), which formerly dominated the production of dyestuffs in most countries, has nearly doubled its capital, and extended its influence in many ways. It has taken over control of the big nitrogen factories and is energetically developing foreign sales (German farmers now pay less for their fertilisers than in 1913); its technical efficiency, economic cohesion, and other factors make it the most powerful chemical organisation in the world. As in the past, this combination is pursuing an intensely nationalistic and aggressive chemical policy: to secure the most effective working of foreign markets, its work is subdivided among groups, each of which is allotted a definite geographical sphere of influence. The South American markets have been recaptured, whilst those in Russia and south-eastern Europe have been nearly secured. Recent attempts to win over the Norwegian manufacturers have so far been unsuccessful, and the overtures to dyestuff producers in Great Britain and Japan are still proceeding.

THE eleventh annual report of the Committee for the Investigation of Atmospheric Pollution, for the year ending March 31, 1925, has recently been issued by the Meteorological Office, Air Ministry (M.O. 280: H.M. Stationery Office, 5*s.* 6*d.* net). The results obtained for the year show that there are large areas of Great Britain which are not represented, but the Midland area, which suffers most from smoke pollution, is taking a very active interest in the investigation. The deposit of impurity is registered at forty-eight stations, the results are given for each month, also the summer total, winter total, and total for the year. A comparison is made between the general average and the average at the same stations for the previous five years. The amount of rainfall is also given; the total was generally more than the average, while the deposit of tar was lower. A series of maps shows the position of the gauges at the different stations, which in many cases offers considerable explanation of the results. The automatic recorder for suspended impurity shows some very interesting results. For Blackburn, Stoke-on-Trent, and Westminster, curves are given showing the impurities for week days, Saturdays, and Sundays; the industrial and domestic smoke each has its say. The smoke from chimneys is largely affected by the wind velocity and direction. Some results are also

given of the observations made with the dust counter. During the period of widespread fog in London between December 9 and 12, 1924, interesting observations were made in comparison with Cheam, 11 miles south-west of London; there was roughly fifty times as much impurity by weight in the London fog, while there was a much larger amount of water at Cheam. Often at Cheam the limit of visibility was less than in London.

AMONG the anniversaries of scientific interest which occur this year is that of the bicentenary of the birth of John Anderson, for forty years professor of natural philosophy at Glasgow. The contemporary of Watt and Black, Anderson was the first university professor in Great Britain to step aside from the beaten track to give regular courses of scientific lectures to men engaged in practical pursuits. Four days a week he lectured on physics illustrated by the aid of mathematics, but on Tuesdays and Thursdays the facts that were taken for granted in the other lectures were ascertained "by a direct appeal to the senses, or by stating the testimony of unexceptional authors, whilst the knowledge of these facts was shown to be of great advantage for the improvement of human nature and the progress of the useful and elegant arts." These ideas are set forth in his "Institutes of Physics," published in 1786. Ten years after the publication of this work, Anderson died leaving about 1000*l.* to be applied to the foundation of a university to bear his name. Though the sum was certainly too small to put his whole scheme into practice, a start was made; success was achieved from the first, and from the institution so founded sprang the mechanics institutions of the past and the technical colleges of to-day. Anderson's Institution, Anderson's University, or Anderson's College as it was known in the old days, is now the Royal Technical College of Glasgow, one of the most flourishing institutions of its kind. Anderson was born in 1726, but the exact day does not appear to be known.

AMONG the pioneers of Italian geology a prominent place must be given to Scipione Breislak, the centenary of whose death at Milan occurs on February 15. Born in Rome of Swedish parents, Breislak distinguished himself as a professor of physics and mathematics at Ragusa, and at a time when geology was in its infancy studied the rocks of the Papal States. He was also employed by the King of Naples as an inspector of mines. During the political upheaval due to the Napoleonic wars, he spent some years in Paris, but afterwards had an official appointment at a powder factory near Milan. His text-book "Introduction to Geology," which was published in 1811, contained an able criticism of the Neptunian dogmas, and did much to eradicate their teaching from the universities and colleges. Breislak was one of those who adopted Desmarest's views on the volcanic origin of basalt.

THE *Lancashire* (later *Lancashire and Cheshire*) *Naturalist* was founded by Mr. W. H. Western, of Darwen, in 1907, and he printed and published it for the common good until 1919. It was then taken over by a committee, and when three years later the committee found itself unable to continue, Mr. Western resumed responsibility. At the end of last year he found that he did not get the necessary support and was compelled to give it up—a decision which every one interested in the progress of natural knowledge will regret, for the paper has done splendid work in encouraging the examination of the local fauna. Fortunately, however, Mr. A. A. Dallman (17 Mount Road, Higher Tranmere, Birkenhead) has come forward with a scheme for re-establishing the journal as the *North-Western Naturalist*. We hope he will receive the support he deserves. The active botanists and zoologists of the district will provide plenty of good material, and Mr. Dallman is anxious to hear from any one who is interested in the scheme, and especially from prospective subscribers and those who would be willing to help the paper over its first year or two by means of a guarantee.

THE arrangements for the Optical Convention, the meetings and exhibition of which will take place in the Imperial College of Science and Technology, South Kensington, during the week April 12-17, are now well advanced. An important part of the work of the Convention will be the exhibition, which is being arranged to be fully representative of British optical manufacture in all its branches. Apart, however, from the commercial section of the exhibition, it is intended to have an Experimental and Research Section, to which it is hoped private individuals and research and teaching institutions will contribute. Those who have exhibits suitable for inclusion in this section are invited to communicate, not later than February 27, with the Secretary of the Optical Convention, 1926, 1 Lowther Gardens, Exhibition Road, London, S.W.7. A brief description of any exhibit accepted will be required, for inclusion in the catalogue. Those who wish to offer exhibits of historic interest should communicate with Mr. D. Baxandall, at the Science Museum, South Kensington, S.W.7, who is arranging the historical section.

THE Minister of Health, in conjunction with the Medical Research Council, has appointed a Committee to inquire and report from time to time, (1) on matters relating to the preparation, testing, and standardisation of vaccine lymph; (2) on practical methods of diminishing risks which may result from vaccination; (3) on the methods of vaccination which are most appropriate to give protection against risk of smallpox infection in epidemic and non-epidemic periods; and to co-ordinate the work on these questions in Great Britain and abroad. The Committee consists of: Sir Humphry Rolleston, Bart. (chairman), Dr. F. R. Blaxall, Dr. G. F. Buchan, Dr. A. E. Cope, Dr. Mervyn H. Gordon, Prof. J. C. G. Ledingham, and Mr. J. R. Perdrau. The secretary of the Committee is Dr. J. R. Hutchinson, a medical officer of the Ministry of Health, Whitehall, S.W.1, to whom all communications should be addressed.

IN recent years the activities of the Optical Society have expanded in many directions in the field of

optics, and the report of the Council of the Society presented at the annual general meeting of members on February 11 gives evidence of further development. During the past year the Council undertook the preliminary arrangements which resulted in the appointment of a representative committee to organise an optical convention in 1926. The formation of an Ophthalmological Section of the Society is now contemplated, and preliminary meetings devoted to the consideration of papers of an ophthalmological character have been arranged and have provided evidence of the increasing amount of scientific work that is being done in connexion with ophthalmological optics. In order to facilitate and extend the use of the decimal bibliographical classification of the Institut International de Bibliographie, a manual dealing with the application of that classification to optics, light and cognate subjects has been prepared and will shortly be published by the Society. The revenue accruing from the increased sales of the Society's Transactions has placed the finances of the Society in such a satisfactory position that the subscription payable by members has been substantially reduced and the entrance fee suspended.

THE *Quarterly Review* for January (No. 487) contains an instructive article by Prof. J. Arthur Thomson entitled "Biology and Social Hygiene," the general moral of which is "that social organisation is not necessarily a good thing in itself. It requires to be scrutinised not only in terms of wealth and health, both so conspicuous in the bee-hive, but in terms of the higher values—the good, the beautiful, and the true, with their outcome in the evolution of man's personality." Prof. Thomson would recommend to the Ministry of Health the discovery and utilisation of outstandingly healthy men and women as missionaries of health, the revival in every town and village of a Beautifying Society, a more conscientious criticism of what we buy, more selection for health, and lastly, an order of merit for outstanding health! He pleads for more biology in education, so that pupils leaving school would be interested in the world without, both animate and inanimate. Lastly, on eugenics, child-breeding and rearing, some very sane opinions and conclusions are expressed on the controversial subject of birth control.

RECENT winter storms which have wrought so much destruction in the North Atlantic, including the loss of the *Antinoe*, the crew being rescued by the *President Roosevelt* on January 27 after four days struggle with the elements, and the *Laristan*, which sank on the same day after the rescue of six of her crew by the *Bremen*, are the subject of an article in the *Times* of February 6 by Sir Napier Shaw. The stormy period is likened to the winter of 1898–9, which was made the subject of a special inquiry by the Meteorological Office. Just twenty-seven years ago, considerable anxiety was caused by the delayed arrival of vessels overdue, including the Cunard Liner *Pavonia* and the Hamburg-Amerika ship *Bulgaria*. For this special inquiry, information had to be extracted from the logs of ships. To-day, observations transmitted by wireless are sufficient to give necessary details. The conditions are similar; the main feature is the belt of vigorous air current across the Atlantic nearly along the shipping lanes from west to east and on to the Scandinavian coast. The westerly winds are fed by a current from the cold north-west over Labrador and eastern Canada, and a feeder from Bermuda or from the Gulf of Mexico. One feeder is cold and dry, the other warm and moist; these throw the air of the North Atlantic into convulsions. A feature in both stormy periods referred to is the intense cold experienced in America on one side of the Atlantic, while on the other side, in Great Britain, the weather was unseasonably mild. Sir Napier Shaw hints at certain calculations common to the two stormy periods, and concludes that we must expect still to find the Atlantic the scene of wrecks, unless we can develop still further our capacity to build invulnerable ships.

IN 1922 the Council of the British Psychological Society, at the request of the Educational Section of the Society, established a Committee for Research in Education. This Committee has now published a brief summary of its work in the past three and a half years. It has attempted to secure better understanding and closer co-operation between educationists and the research workers in the departments of psychology and education in our universities, and possibly its most important activities have been putting investigators into touch with those competent to give advice on particular research problems and advising and assisting heads of schools with regard to the use of mental tests. Periodic inquiries have been made as to researches bearing on education that are in progress, and summaries of the information so obtained are given in the *British Journal of Psychology*, Vol. 14, Part 4, and Vol. 15, Part 4. The place of psychology in the curriculum of training colleges formed the subject of another inquiry, and a summary of the detailed information received from sixty-three colleges was published in Vol. 2, No. 2, of the *Forum of Education*. Another side of the work of the Society, likely to grow both in amount and in importance, is international. In co-operation with the University of Toronto it is compiling a bibliography of mental tests published in England and, to assist the University of Iowa in an investigation of "arithmetical norms," it has secured "completed tests" from a number of schools in England.

THE French Association for the Advancement of Science will celebrate its jubilee this year at the annual meeting to be held at Lyons. An international Exhibition for the Advancement of Science, to include all branches of science and its applications, is being organised for July 24-August 1. M. Pilon, 23 rue Casimir Perier, Paris, has been appointed Commissaire Général of the Exhibition.

IT is announced that the first Federal Conference of Turcoman Educators will be held at Baku on February 20. The subjects will be the language, history, ethnography, and literature of the Tartar and Turcoman peoples, as well as Tartar and Turcoman education

Among those who have signified their intention to be present are Profs. Oldenburg, Barthold, Marr and Pavlovitch. In this connexion it is interesting to note that a proposal has been mooted and favourably received at a meeting held on December 14 last, for the substitution of Latin characters in place of Arabic as the basis of a new Turcoman alphabet. A committee of the Scientific Orientalists' Association has been formed to take steps to introduce the new alphabet.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A whole-time analytical chemist under the County Council of Dumfriesshire, as public analyst under the Sale of Food and Drugs Acts—The County Clerk, County Buildings, Dumfries (February 19). A Live Stock Officer under the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (February 22). A laboratory assistant at the Building Research Station of the Department of Scientific and Industrial Research—The Director of Building Research, Building Research Station, Garston, near Watford (February 22). An assistant in the Technical Records Section of the Admiralty—The Secretary (C.E.), Admiralty, Whitehall, S.W.1 (February 22). An assistant curator in the Department of Antiquities and Anthropology of the Bristol Museum and Art Gallery—The Director (March 6). A lecturer in applied chemistry in the Manchester Municipal College of Technology—The Registrar (March 12). A professor of mathematics in the University College of North Wales, Bangor—The Registrar (March 20). An assistant (museums) at the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (March 31). A calculator for the Royal Airship Works, Cardington, Bedford—The Director of Airship Development, Royal Airship Works, Cardington, Bedford. A junior assistant under the directorate of explosives research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

COMETS.—Dr. Baade detected Tuttle's periodic comet on January 12, 19^h U.T. in R.A. 22^h 27^m 52^s, N. Decl. 40° 18′; the magnitude being 15·5. The daily motion is $+3\frac{1}{4}^m$, south 10′. The time of perihelion passage is deduced to be April 28·73 U.T., which is 1·08 days later than the ephemeris of Idelson and Musselius, 3·33 days earlier than that of Stobbe. The period is 13·54 years, the last passage having been on October 28·543, 1912. The comet was seen at the returns of 1790, 1858, 1871, 1885, 1899, 1912. Its detection at the 1912 apparition was accidental, as no one had calculated the perturbations by Jupiter, which were large, so that it came two months before it was expected.

It will probably be visible with moderate instruments on March 4-15, when the moon will be out of the way. In April it is too near the sun for convenient observation.

Mr. H. E. Wood has sent a series of observations of Ensor's comet made by him at Johannesburg between December 14 and 21; from these Mr. G. Merton and Dr. A. C. D. Crommelin have revised the orbit as follows:

T	1926 Feb. 11·974 U.T.
ω	354° 55′ 43″
Ω	282 26 56
i	123 1 5
log q	9·50852

EPHEMERIS FOR 6^h U.T.

	R.A.	Decl.
Feb. 16.	20^h 56·0	10° 57′ S
,, 24.	20 52·0	3 47 N
Mar. 4.	21 2·8	21 4 N

The comet should be looked for in the east about dawn.

SOLAR RESEARCH AT MOUNT WILSON.—Since the publication in this journal (Supp., January 19, 1924) of a summary of the results obtained by Dr. Hale and his colleagues from their comprehensive investigations in solar physics during the last seventeen years, a more detailed account of their observations and conclusions has been awaited with great interest. This is presented in the *Astrophysical Journal* for November 1925 (vol. 62, p. 270), and bears witness to the untiring skill of the Mount Wilson observers in their examination of 2200 spot groups for polarity and field-strength. It would be out of place to attempt to give a summary of this paper, when it has been already more ably and completely given by Dr. Hale himself in the supplement mentioned, to which reference should be made for further information. It may be mentioned, however, that more details are given, both of the observations and of the results obtained, than in the previous account, while a revised scheme of classification into unipolar, bipolar, and complex groups, is fully described with various subdivisions.

The nature of the hydrogen vortices, as shown by direction of whirl, is discussed in another paper by Dr. Hale (*Proc. Nat. Acad. of Science*, November 1925). According to the electromagnetic theory of Störmer, these vortices are composed of charged particles constrained to move along the lines of force of the magnetic fields due to the spots beneath. The observations at Mount Wilson, however, show that the sign of the charge producing sunspot fields is invariable, a change of polarity being due to reversal of the direction of whirl. Change of polarity in the sunspot should produce a reversal of the direction of motion in the hydrogen vortices, according to the electromagnetic theory; but the observations do not confirm this, and Dr. Hale is led to the conclusion that the hydrogen vortices are purely hydrodynamical phenomena corresponding to terrestrial cyclones.

ANOTHER ALGOL VARIABLE.—In 1922, Miss Woods of Harvard College Observatory found that the star BD − 7° 5271 was faint on 6 plates out of 85 examined, and concluded that it was a variable, probably of the Algol type. Nothing more was published concerning the star for three years; Mr. J. Witkowski of Cracow Observatory now publishes a series of observations ranging from July 30 to Oct. 30, 1925 (*Acta Astronomica*, Dec. 30, 1925). He confirms the type as being that of Algol. The period is 2·1387 days, the light-range from 9·8 to 11·1 mag., and the duration of eclipse 6 hours. The minimum is fairly sharp, and the light-curve symmetrical about it.

The position for 1925·0 is R.A. 20^h 18^m 12^s, S. Decl. 7° 35′·4, spectral type A 2.

The observations were made with a comet-seeker of $5\frac{1}{3}$ in. aperture. The star is thus within reach of observers with moderate equipment.

Research Items.

A WOOD-CARVING FROM EASTER ISLAND.—In the *Museum Journal* (Philadelphia) for June last, which has recently been issued, Mr. H. U. Hall figures an example of that rare type of the so-called household gods of Easter Island which shows a combination of features of both human and animal forms. Five figures only of this type are mentioned in Dr. Brigham's survey of Polynesian material in museums, and three additional are known to have been at one time in the hands of private owners. The one here described by Mr. Hall is in the University Museum, Philadelphia. It represents a lizard-man, but it differs in detail from a similar lizard man formerly in the possession of Mr. J. Edge-Partington with which it is compared. The lower portion of the image ends in a rounded handle. The arms are brought together in the position of a suppliant. Other examples of these images are pierced with a hole to enable them to be carried strung on the person in procession, but this example, being some two feet long, was obviously carried by the handle, which shows signs of much use. Mr. Hall doubts whether it really represents a man-lizard. It may be an unconsciously anthropomorphised lizard. The lizard in Polynesia has a considerable prominence in magic and religion. Its appearance in Easter Island may be a memory of this prominence, or as an egg-producing animal it may have been regarded as a peculiarly effective mediator with the gods. This conception may have been helped by the prominent part played by the first egg of the season of a certain type of sea-fowl in the bird-man cult.

THE PREHISTORIC CULTURAL PROVINCES OF THE IBERIAN PENINSULA.—MM. Bosch-Gimpera and L. Pericot publish in *L'Anthropologie*, t. 35, Pts. 5-6, an important classification of the archæological remains of Spain and Portugal in the neolithic and æneolithic periods, by which they show that the Iberian Peninsula at these times can be divided up into a number of cultural provinces which persist into the Bronze Age, when they disappear, and do not appear again until the Iron Age. After briefly surveying the cultures of the palæolithic, epipalæolithic, and protoneolithic periods, which are derivative from the Franco-Cantabrian and the Capsian of the palæolithic, with an indigenous, but fully differentiated, culture on the Atlantic coast to be attributed to the influence of environmental changes, and an intrusive culture at Almeria, they distinguish four cultural provinces in the neolithic period: a western or Portuguese culture; a Central culture—this being a culture of special importance, of which the main characteristic is the highly decorated bell-beaker; the Almerian culture; and the Pyrenean culture. Each of these shows a continuous development with, however, certain advances and interactions except in the case of the Pyrenean culture, which apparently disappears for a time, possibly owing to failure to develop, but reappears in the æneolithic stage. At this period, indeed, it becomes sufficiently strong to force the retreat of the northernmost extension of the Almerian culture which had spread along the east coast of Spain at the beginning of the æneolithic period. The western culture is characterised in particular by the megalithic type of burial, and while in the earlier phases it was confined to Portugal, and in particular the north and centre, at a later stage, in the æneolithic period, it extended eastward and especially into Estramadura, Salamanca, and Huelva.

THE FISHERY OF THE GREENLANDERS.—In No. 7, *Meddelelser fra Kommissionen for Havundersøgelser Ser. Fiskeri*, Bind 7, Prof. Ad. S. Jensen gives a most interesting and well-illustrated account of the fisheries of Greenland. Dr. J. Schmidt in the preface points out that the author was leader of the fishery investigation expedition sent out by the Danish Government with the brig *Tjalfe* in 1908-9, and that many of the important observations regarding the Greenland Halibut made during those expeditions have been turned to practical use, proving a source of real profit to the Greenlanders. Several of those species which play a great part in the international fishery carried on in adjacent waters are almost, or entirely lacking in Greenland, the haddock for example, and the plaice and other flatfishes, with the exception of the halibut and Greenland Halibut. Prof. Jensen is inclined to believe that the stock of cod in Greenland is mainly recruited from elsewhere by immigration. He thus directs attention to an important problem which is also of interest in connexion with the Iceland investigations.

HYDROGRAPHY OF THE ENGLISH CHANNEL.—In *Rapport Atlantique* 1924 (Conseil Permanent International pour l'Exploration de la Mer) Mr. H. W. Harvey, Hydrographer at the Marine Biological Laboratory, Plymouth, gives a useful summary of the results, and interpretations based upon them, which have been obtained by various workers who have studied the hydrography of the English Channel. An account of the extent of our present knowledge of the features of the water movements, and the variation of temperature and chemical composition of the sea water, is followed by a discussion of their biological significance. Two observations regarding the herring are of interest. A result of water movement in the English Channel is that herring spawned in the eastern end of the Channel are likely to be carried into the North Sea. A comparison between the mean weight of herring per landing by steam-drifters at Plymouth during the herring season—December and January—since 1921, and the temperature at a depth of 5 metres, shows that for four consecutive seasons the mean weight per landing has reached its seasonal maximum when the temperature has been between 10° C. and 11° C.

CORALS AND ZOOXANTHELLÆ.—Dr. H. Boschma, working on living material collected at the Bermuda Biological Station, records observations on the part played by unicellular algæ (zooxanthellæ) in the nutrition of corals (*Proc. Amer. Academy Arts and Sci.*, vol. 60, No. 9, Nov. 1925). Most of his experiments were carried out with Isophyllia, which has large polyps. The statements in the literature that the cœlenteron seldom contains food are based chiefly on the examination of preserved material, the polyps of which have discharged the contents of the cœlenteron owing to the strong contraction which takes place on preservation. Under normal conditions, the food of the polyps consists chiefly of the algæ which are living in its endoderm cells—and in freshly collected specimens algæ are always present in the mesenterial filaments; small planktonic organisms are also captured and digested, but under normal conditions these are too scanty to serve as the sole nutriment of the polyps. When the digestive organs (the mesenterial filaments) can obtain sufficient food from other sources—as in examples fed in the laboratory with mussel—they do not ingest zooxanthellæ. The algæ which were present in the filaments are completely digested, so that after abundant feeding on mussel, the mesenterial filaments may become totally devoid of zooxanthellæ. The symbiotic algæ are ingested only when other food is

scarce, and to this extent the polyps are parasitic on the algæ. In other Bermudian Anthozoa the zooxanthellæ form a large part of the food supply of the polyps. In a further paper (*Biol. Bull.*, Dec. 1925) the author states that in Astrangia also the zooxanthellæ furnish part of the normal food of the polyps, and that polyps which have no zooxanthellæ can be easily infected by feeding them with crab meat mixed with parts of the tissues of strongly infected polyps.

THE FLORA OF JUAN FERNANDEZ AND HAWAII.—Prof. Carl Skottsberg, Director of the Botanical Garden at Gothenburg, Sweden, was Bishop Museum Fellow in Yale University for 1922–23; and as a result there is published as *Bulletin 16 of the Bishop Museum*, Honolulu, a very interesting phytogeographical discussion of the flora of the islands of Juan Fernandez and Hawaii. Both are groups of volcanic islands, very remote from each other, but with common features in their flora. Prof. Skottsberg considers that they are young islands of which the flora contains many isolated types, the result of isolation of considerable age, and of geographic changes. The high endemism, he concludes, is scarcely likely to be due to the extermination in all other countries of identical or closely allied species. There is evidence in favour of a continental origin of the Juan Fernandez flora; that it existed before the present islands were formed, and took possession of them during the submergence of its old home. Part of this flora he derives from the Antarctic continent, but by way of South America rather than by a direct land bridge. Hawaii also contains old Pacific and Antarctic types, but the road from Polynesia to Hawaii is more difficult to trace. However, the author is confident that the history of the Hawaiian flora is in main outline similar to that of Juan Fernandez. Another general conclusion is that the disappearance of the Tertiary Antarctic flora during the Ice Age is of fundamental importance and has been greatly underrated by plant-geographers. "No catastrophe of such dimensions and of such consequences has ever befallen the Tertiary flora of the Northern Hemisphere." The Bishop Museum Yale Fellow for 1921–22, Prof. F. L. Stevens, of Illinois, gives a full list of the fungi known to exist in the Hawaiian islands as *Bulletin No. 19 of the Bishop Museum*. Most of these are from collections made by himself in 1921, but all other available collections and lists are included; rusts, smuts and parasitic fungi have been more thoroughly collected, higher fungi and fleshy Agarics only taken incidentally.

TCHEVKINITE AND AFFINITIES OF TRILOBITES.—A series of eight papers in Russian, French, German or English, and an appendix containing abstracts of recent non-Russian scientific literature appears in the *Bulletin of the Russian Academy of Sciences*, Series 6, Nos. 12-18, 1924. Three papers, in Russian, by Boldyrev, Kaufman and Kryzanovskii describe the rare mineral tchevkinite, which is a titanosilicate of cerium, lanthanum and other metals, from the Ilmen Mountains. The mineral was originally regarded as an amorphous alteration product; some Russian crystals have now been thoroughly investigated and are found to be monoclinic, confirming the doubtful suggestion by Prof. Lacroix from Madagascan specimens. In a discussion, in English, of the relations of the trilobites by Fedotov, many of Walcot's genera are rejected as based on inadequate material, and the author concludes that the trilobites, though closely akin to the Crustacea, are an independent group ancestral to the arachnids. Nasonov describes the general distribution of the *Turbellaria rhabdocoelida* in European Russia.

POST-EOCENE MOLLUSCA OF NORTH-WESTERN INDIA.—The late Dr. Vredenburg, to whose four excellent memoirs on the Indian Tertiary gastropoda we directed attention in these pages (NATURE, May 6, 1922, p. 594, and August 25, 1923, p. 294), had at the time of his lamented death in March 1923 just completed the proofs of the memoir now before us. This "Description of Mollusca from the Post-Eocene Tertiary Formations of North-Western India" has now been issued by the Geological Survey of India (*Memoirs*, vol. 50, pt. 1). The forms dealt with were obtained from the stratigraphical division distinguished by Blanford as the Nari, Gáj and Mekran. The detailed study of these fossils has revealed the existence of many species already known either from Europe or from the East-Indian archipelago. A widespread temporary oceanic connexion established by the great marine oceanic transgression of the Oligocene, undoubtedly accounts for the mingling of eastern and western forms at this horizon. Some 150 species, a large proportion of which are new, are fully and carefully described in this ample memoir, and many of these are illustrated on 13 plates from photographs taken by the author himself, whose demise is assuredly a great loss to palæontology.

ISOSTASY IN THE SOUTHERN PACIFIC.—In the *Journ. Wash. Acad. Sci.* for December 4, William Bowie gives the results of an isostatic reduction of gravity determinations at five island stations in the Southern Pacific. Assuming a depth of compensation of 96 km., the isostatic anomalies that remain vary from +0·003 dyne to +0·061 dyne; the average being 0·033 dyne against an average free-air anomaly of 0·130 dyne. The theory of isostasy thus reduces the difference between observed and calculated values by 75 per cent. In explanation of the rather high anomalies that still remain, Bowie considers that in part they may be due to errors in the observations, the possible inaccuracy being so high as 0·010 dyne, but that a more important cause of divergence is a probable excess of density in the rocks underlying the islands. In the calculations the rock density is taken as 2·7, which, according to Washington's figures, is undoubtedly too low. By taking the density as 3·0 the average anomaly is reduced by about a half. The evidence is thus in close accord with that of land-data and supports the assumption that the earth's crust under the oceans is in an isostatic condition.

TIDAL FORCES AND CONTINENTAL DRIFT.—At the annual meeting of the Geological Society of America held during last December, F. B. Taylor, who anticipated Wegener in an hypothesis of continental drift, read a paper in which he advocates a remarkable theory of the origin of the moon. He considers that the Tertiary mountain ranges were raised as a result of the horizontal sliding of continental blocks towards the equator; that the evidence strongly points to an external cause for the movement; and that tidal forces are therefore the only causes to which adequate appeal can reasonably be made. Solar tidal forces alone are held responsible for the older mountain ranges. Near the close of the Cretaceous, however, a sudden and strongly-marked increase of crustal movements began, and has continued with diminishing energy down to the present day. There is no way of explaining this world-wide increase, according to Taylor, without assuming a corresponding increase in tidal force, and this assumption involves the acquisition by the earth of a body like our present moon and its permanent retention as a satellite. The implied capture theory of the moon is stated to be sound from the astronomical point of view. With regard to

mountain building, Taylor's views are not likely to meet with acceptance. The moon's tidal force is approximately 215 times more powerful than the present solar tidal force, and there is certainly no geological evidence to suggest that the Alpine-Himalyan mountains are the result of forces 216 times as great as those which produced the Armorican, Caledonian, and older mountain systems. The recent work of Joly and Holmes, to which Taylor makes no reference, shows that no theory of crustal movements can possibly be complete which ignores the almost incredible forces set up as a result of the liberation of energy from radioactive elements. Here we have an indubitable cause of mobility permitting conditions in which tidal forces can become effective, and involving no such gratuitous assumption as the capture of the moon in Cretaceous times.

SUPERFICIAL SOLUTIONS, OR TWO DIMENSIONAL FLUIDS.—M. A. Marcelin, in the *Annales de Physique* for November-December, deals with the thin films formed by certain oils on the surface of water from a new point of view. It has been supposed that the extension of the surface of the oil could go on until a layer of molecules was formed which were in contact with one another at their sides, and that if the amount of oil for a given surface was too small to cover it with such a layer, no change took place in the surface tension. Using, however, two-dimensional floating apparatus, cut out of paraffined mica, and representing pumps with valves and pistons, the author has been able to show that the surface tension is lowered for very much smaller amounts of oil than the above. If the amount of lowering is regarded as the "surface pressure," p, a law holds similar to that of Boyle and Mariotte for gases, pS = constant, where S is the surface. This is true up to about twenty-eight times the surface occupied by the oil in a monomolecular layer, with all its molecules in contact with one another, a state which corresponds to that of a saturated vapour. M. Delaplace has found that Gay Lussac's law applies to these superficial solutions between 15° and 27° C., so that $pS = KT$, where K is a constant characteristic of the floating molecule, and probably also depending on the liquid on which it floats.

INTERFERENCE BANDS.—In the October and November issues of the *Journal de Physique*, M. F. Wolfers describes a new system of interference bands he has discovered in the penumbra cast by the edge of an opaque screen when illuminated by a source of considerable dimensions. The best arrangement for observing them is a narrow horizontal slit illuminating a steel ball about 1 cm. in diameter, and behind the ball a fine grained photographic plate. Along a horizontal diameter the light, instead of falling off gradually from the edge of the penumbra to that of the umbra according to the ordinary theory of diffraction, is found to show three or four bands the intensity of which is greatest near the edge of umbra. Their positions are independent of the nature, dimensions, and form of the source and screen and of the nature of the surface of the latter, nor does the light from them show any signs of polarisation. Their positions in terms of the wave-length of the light used, and the distances of the screen from the source and photographic plate, lead the author to conclude that they are due to interference of light coming from that part of the source which determines the edge of the umbra with light coming from the edge of the screen where it has been absorbed and emitted in quanta.

PHOTOGRAPHING THE INNER SURFACE OF A RIFLE BARREL.—The difficulties of inspecting and photographing the inner surface of a rifle barrel with a length of about 700 mm. and an internal diameter of about 6 mm. have been ingeniously overcome by Mr. Seiji Nakamura, of the Physical Laboratory of the Tokyo Imperial University, by the construction of an instrument called a "solenoscope" (*British Journal of Photography*, 1926, p. 19). The final form of this instrument is a steel tube about 750 mm. long and 6 mm. external diameter, which has at one end a larger brass tube in which the eyepiece slides, and carries at the other end a microscope objective formed of two simple lenses, achromatism being found unnecessary. The eyepiece is an orthoscopic magnifier of Zeiss of 18 mm. focal length, and at the other end, beyond the objective, is a small 3-volt electric lamp. In order to get the image through so long and narrow a tube, five achromatic cemented doublets of about 68 mm. focal length are placed at a distance apart equal to twice the focal length of each. Thus the image formed by the first is reproduced by the third (inverted) and again by the fifth (erect), and so viewed or photographed through the eyepiece. The second and fourth lenses act as condensers to avoid loss of light and are fixed where the two middle images are formed, but slightly removed from these positions to avoid the image of dust, etc., on their surfaces appearing in the final image. The resulting image is an evenly illuminated annulus which represents a short length (or ring) of the barrel. The paper is illustrated and has a photograph of a new barrel and one of a much-used barrel, which clearly demonstrate the efficacy of the instrument.

TRINITRIDE AND CYANATE IONS.—Experiments on the X-ray spectra of trinitrides (hydrazoates) and potassium cyanate made by S. B. Hendricks and L. Pauling show that the trinitride and cyanate ions have closely similar configurations. An interesting result of the work, which is described in the issue for December 1925 of the *Journal of the American Chemical Society*, is that the trinitride ion is shown not to have a ring structure but to contain three nitrogen atoms in line (as in Thiele's formula).

RESISTANCE THERMOMETERS AT LOW TEMPERATURES.—Some experiments by A. G. Loomis and J. E. Walters are described in the issue for December 1925 of the *Journal of the American Chemical Society* which were intended to test the applicability of platinum resistance thermometry to −193°. Four platinum thermometers of the flat-coil type showed close agreement between observed and calculated resistances at the carbon dioxide point, and the flat coil types could, when properly constructed, be used at low temperatures and calibrated in the same manner as the strain-free types investigated by the Reichsanstalt and the Bureau of Standards.

PARTIAL PRESSURES OF WATER VAPOUR AND SULPHURIC ACID.—The December issue of the *Journal of the Chemical Society* contains an account of the investigation of the partial pressures of water vapour and sulphuric acid vapour over concentrated solutions of sulphuric acid at high temperatures, by J. S. Thomas and W. F. Barker. Air was passed through the acid and the saturated air passed to absorbing vessels. The results apply to sulphuric acid of concentrations between 89·25 and 99·23 per cent., and temperatures from 180° to 295°. It was not possible to take account of dissociation: figures are given on the assumption that the acid is not dissociated and another set on the assumption that it is completely dissociated. The results should be useful in connexion with large scale concentration apparatus.

The Control of Insect Pests in Agriculture.

THE completion of the Ministry of Agriculture scheme for the appointment of advisory entomologists in each of the fourteen agricultural provinces of England and Wales has recently been fulfilled. By means of this organisation, the Phytopathological Branch of the Ministry is now enabled to keep in touch from year to year with most parts of the country with regard to the incidence of insect pests. Each advisory entomologist has his headquarters in a collegiate or university centre in his province, and his field of work lies in the diagnosis of injury due to insect pests on behalf of the farmers and growers of that area; he is further concerned with the dissemination of useful information on such subjects, and in the carrying out of experiments on the practical control of pests of local importance. At present the advisors' duties are therefore of a somewhat comprehensive character. As time goes on, it is reasonable to hope that as the county councils' staffs develop and extend their spheres of utility, they will be able to take on much of the purely advisory duties. In this way it should eventually be possible to free the advisor in order that he may be able to devote his inquiries more especially to the investigation of particular local problems.

The work of the advisors renders them in a position to forward to the Ministry annotated lists, or in some cases more detailed information, respecting the pests that come under their notice. There is also a considerable number of voluntary observers located in different parts of England and Wales who assist in a similar manner. The information thus garnered is collated and sifted in the Ministry's Pathological Laboratory at Harpenden. The present report [1] is to a large extent a summary of the data collected by some sixty-two observers during the years 1922–1924. It is the fifth of its series, but differs from its predecessors in that tabular lists of every recorded species of injurious insect are, very wisely, no longer included. Certain innovations in regard to pest control during the years under review are mentioned. Perhaps the most notable of these is the application of certain proprietary compounds, collectively known as "carbolineum," as washes for fruit trees. These compounds consist of various products obtained in the distillation of coal and are of variable composition. There appears to be no question as to the efficiency of certain of the "brands" bearing the name of carbolineum in the destruction of the resting eggs of aphids and apple sucker. It is important to know, however, whether such treatment can be carried out over successive years without injury to the trees; also, whether the manufacturing firms are able to give guarantees to the effect that materials which gave good results one year will remain purchasable with their original composition unaltered.

Among individual pests the raspberry beetle has always been troublesome to raspberry growers and has also become a menace to loganberry culture. Experiments carried out at the Long Ashton station show that it can be largely controlled by spraying the plants with lead arsenate when they are one-third, two-thirds, and fully in bloom. Apart from the possibility of poisoning trees, the market price of the fruit in relation to the costs of spraying will be the deciding factor for, or against, this method of treatment. The apple blossom weevil is another insect difficult to control, and this fact has attracted attention at the East Malling Research Station, where the respective values of different methods of repression have been tested over the period 1921–1924. The only method that proved of value was the trapping of the weevils by means of bands of sacking tied around the trunks of the trees. The hibernating weevils lay up in such material, which led to their capture in large numbers. Among other noteworthy measures, the application of lime-sulphur against the "big-bud" disease of black currants has given promise when applied at winter strength in March.

The control of vegetable root flies, which is occupying the attention of Mr. K. M. Smith at Manchester, appears to be best achieved by the use of odorous substances acting as deterrents, which protect the crop by keeping the insects away. One of the best of these preventives is stated to be anthracene oil absorbed in some powder carrier, such as powdered chalk. As the result of Lloyd's work at the Lea Valley Experiment Station at Cheshunt, on fumigation with tetrachlorethane, fumigants of this type have come into prominence in the case of White Fly attacks on plants under glass. The application of tetrachlorethane is more expensive than that of hydrocyanic acid gas, but it is a less poisonous remedy for operatives to handle and, in the case of tomatoes, it is no longer necessary to dry off the house prior to treatment in order to avoid injury.

The British Isles have up to the present suffered very little from the attacks of imported agricultural pests. The factors contributing to this situation are not easy to discover, but the absence of extensive areas of country devoted to single-crop cultivation, together with the practice of crop rotation, afford conditions on the whole unfavourable to the establishment of immigrant forms. Furthermore, a variable and, on the whole, inclement climate is probably an important barrier to most species which are denizens of warmer regions. Legislation also serves to keep down the number of alien species which reach this country. On the other hand, sundry foreign insects do succeed in gaining entry and, unless track is kept of them, it is possible that one or other kind may succeed in gaining a permanent foothold. During the period covered by the present report several of such species are specially mentioned. The most important of these is the Potato Moth (*Phthorimaea operculella* Zell.), which has been detected by the Ministry's inspectors in consignments of potatoes imported from Malta and the Canary Isles. Since it is an insect with considerable power of adaptation to climatic conditions, the destruction, or re-exportation, of such consignments is a very necessary measure. Among other interceptions, larvæ of a beetle of the genus Brachycerus have occurred in consignments of snowdrop bulbs from Smyrna; beans affected by the American Bean Beetle (*Bruchus obtectus* Say.) from Minnesota; and peaches from S. Africa infested with larvæ of the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.).

The outstanding features during the period under review were: (1) the damage occasioned by Fruit Fly and to a lesser degree by Gout Fly in 1922, (2) severe outbreaks of aphids and caterpillars in orchards in 1923, (3) a remarkable absence of most epidemic pests in 1924. In each case the phenomenon observed appears to be largely fostered by the prevailing weather conditions during the seasons concerned, but, until we are in a position to correlate a larger number of years' observations between weather and fluctuations of pest epidemics, such conclusions are necessarily somewhat speculative.

Several indigenous species of insects are, for the first

[1] "Report on the Occurrence of Insect Pests on Crops in England and Wales, for the Years 1922, 1923, and 1924." Miscellaneous Publications, No. 49, Ministry of Agriculture and Fisheries, 1925. 1s. 6d. net.

time, recorded as injuring crops in England and Wales. These include the fly *Chortophila sepia* Mg. which did considerable damage to wheat in Cambridgeshire; barley and other cereals in Kent were attacked by the small acalypterate fly, *Diplotoxa limbata* Meig.; old potato sets in N. Wales were infested by a little-known Coccid, *Pseudococcus gahani* Green; in widely separated localities beans suffered from the attacks of several species of root flies of the genus Chortophila and, in Norfolk, the Dock Saw Fly (*Taxonus glabratus*) occasioned considerable injury to apples.

Mr. J. C. F. Fryer, the Director of the Ministry's Pathological Laboratory, has produced a report which summarises the activities of his charge in a concise and readable form. The value of documents of this character is usually not immediate, but it is rather that they place on permanent record information for the use of posterity. A. D. IMMS.

Recent Star Catalogues.

A VERY interesting star catalogue has lately been published in the joint names of Prof. Frank Schlesinger and Ida Barney. It contains 8359 stars between N. Decl. 50° and 55°, observed by photography at Allegheny Observatory between August 31, 1915, and July 14, 1916. The number of plates is ninety, their centres all being at Decl. 52½°, and the Right Ascensions increasing by 16 min., or 2·4° of great circle. The measured portion of each plate is a square 5° × 5°: each star appears on two plates; on one to the east of the centre, on the other to the west. The two plates are measured in reversed positions in the micrometer, so that all systematic "magnitude-equation" in R.A. should be eliminated. The object glass is a symmetrical doublet of four lenses, of aperture 103 mm., and equivalent focal length 1·635 metre, giving a scale of 126·2″ = 1 mm. A circular stop ensures full illumination over the plate, but reduces the effective aperture to 75·5 mm. Exposure of 25 minutes is found to give strong images to well below the ninth magnitude, except in the case of some red stars.

The places given are referred to those of 1070 stars in the zone, which were observed (each star twice) on the meridian by Prof. R. H. Tucker at Lick Observatory from February 1917 to March 1918. Their places for 1917·0 are given as a supplement to this catalogue. Their average magnitude is 8·5, the same as that of the main catalogue. The latter is referred to the equinox of 1875·0, to facilitate comparison with the Harvard A.G. Catalogue of the same zone. This comparison gives determinations of proper motion of all the stars. They are printed to the third decimal of 1″, the probable error of each being about 0·015″.

On plotting the "crude" proper motions in R.A. for the separate magnitudes and the separate hours of R.A., they form sine-curves the amplitudes of which steadily diminish for the fainter stars owing to greater distance, and the median lines of which get steadily lower. The latter result is due to "magnitude-equation" in the Harvard A.G. Catalogue. The values found for the latter increase from 0·039 s. for magnitude 6·4 to 0·232 s. for magnitude 9·7; these are applied in forming the printed proper motions.

It is welcome news that the zone from Decl. 2° south to 2° north, photographed about 1916, will shortly be published, and that Prof. Schlesinger contemplates the production of similar catalogues for all the A.G. zones.

Volumes 1 and 2 of the Sydney Astrographic Catalogue have lately come to hand. They cover Decl. 51° to 53° south, and R.A. 0^h to 6^h and 6^h to 12^h respectively. Vol. 3 appeared earlier. It will need fifty-two volumes to cover the entire Sydney zone, which extends from 51° to 65° south. The X, Y co-ordinates are printed to the third decimal of a reseau interval; the magnitudes are indicated by letters or numbers on two arbitrary scales; further information is needed to reduce these to the ordinary system. There are 280 stars on a fully printed page (but there are many gaps). Vol. 1 has 25 pages; vol. 2 (the galactic latitude of which is lower) 85 pages.

Explorations in Borneo.

THE fourteenth and fifteenth reports on the Sarawak Museum deal with the years 1915 to 1924. For most of this time it had no curator. Major J. C. Moulton left to join his regiment in February 1915, and his successor, Dr. E. Mjöberg, did not take office until May 1922. He in turn left in December 1924, and was succeeded in February 1925 by Mr. E. Banks. During his curatorship Dr. Mjöberg devoted his energies mainly to collecting, and these two reports give the chief results of his expeditions, of which the chief were those to Mt. Murud and Mt. Poi.

Mt. Murud had never been visited by a white man, and its precise position was in fact uncertain. It forms the most northern and highest point of the Pamabo Range, which here falls down into a deep valley, bounded by the east-west mountain range Batu Litan. Its height, estimated at 10,000 feet, proves to be 7200 feet, with another peak of 7160 feet. The mountain is built of sandstone, and its slopes are exceedingly rough, full of caves, holes, and crevices, and covered with enormous boulders. The natural difficulties of travel were not lessened by the difficulty of obtaining carriers, owing to the prevalence of an epidemic, and by the inability of the Dyaks to stand the climate of the heights. Dr. Mjöberg slept for six nights alone on the top ridge, making a proper biological survey. He describes it as "a strange-looking alpine region, with scanty low bushes of leathery appearance, covered with the yellow blossoms of a little epiphytic orchid. Here and there patches of smaller pine trees were seen. Bright scarlet or white flowers of the rhododendron and similar plant types were met with everywhere. Gigantic pitcher-plants (Nepenthes) of strange shape and countless varieties of beautiful, flowering orchids, formed the more striking types of plant life. Only a single little yellow-breasted bird broke the silence of this unknown landscape, never before seen by human eye."

The pitcher-plants just mentioned were responsible for the abundance of a very small frog. In the absence of pools, these frogs lay their eggs in the pitchers, and being thus dependent on a minimum of water for passing through their larval stages, they cannot grow larger than one's thumb-nail.

Strong lanterns of 250 candle-power were kept alight all night on the summit and attracted many curious moths and other insects. On the highest peak fresh tracks of the wild pig, *Sus barbatus*, were observed.

Descending to the plains of the Kalabit country, and along the Baram River, which was found to have

its source on Mt. Murud, Dr. Mjöberg found that the natives of the main plateau had snared for him no less than ten complete specimens of the long-sought Bornean badger.

Of the other expeditions undertaken by Dr. Mjöberg, we need mention only that to Mt. Poi, where he thoroughly surveyed the region above 3500 feet, the highest peak reaching 5600 feet. Here, at heights between 3000 and 3500 feet, were found specimens of the primitive arthropod Peripatus, previously unknown from Borneo. They are comparatively flat and large, and may represent a new species or one of the forms previously known from the Malay Peninsula.

The large collections made by Dr. Mjöberg were distributed by him to such specialists as he could find to undertake the work of determination, but specialists are still required for very many groups, especially among Arachnida, Hymenoptera, Neuroptera, and Pseudoneuroptera.

University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made: Dr. William H. Wynn, Physician to the General Hospital, Birmingham, to be joint professor of medicine in succession to the late Prof. J. W. Russell; Mr. L. G. A. Sims to be lecturer in electrical engineering in succession to Dr. Randall, who has been appointed to a chair at Johannesburg.

The title of emeritus professor is to be conferred on Sir John Cadman, lately professor of mining, on his resigning his appointment as honorary professor and adviser to the Mining Department.

The following gifts have been received: A legacy of 100*l.* from the late Prof. J. W. Russell; a scholarship of 60*l.* per annum from the British Burmah Petroleum Co. for students in the Oil Engineering and Refining Department; valuable models from the Mining Association of Great Britain; and a special weighing machine for the Fuel Treatment Laboratory of the Mining Department from Messrs. W. and T. Avery.

CAMBRIDGE.—The council of the senate has brought forward amendments to the general regulations for prizes and medals; it is proposed that in future, students shall not be permitted to use the same research work for obtaining a research degree and a university prize or medal. As matters stand, the student who has graduated at Cambridge is at a disadvantage when competing with a research student coming from another university; the former has to do three or four years' work before he begins his research, whilst the latter begins on arrival. The regulations for most prizes ordain that candidates must not be of more than a certain number of terms' standing.

OXFORD.—On February 2, Convocation confirmed a decree authorising a special allowance of 200*l.* a year, in addition to his ordinary stipend, to each professor being the head of a scientific department.

Active preparations are going on for the forthcoming visit of the British Association to Oxford on August 4-11.

There will be an election at Keble College, on March 15, to natural science scholarships, one on the Gibbs Foundation and one on the Field-Marshal Gomm Foundation, of the value of 80*l.* per annum. This sum is augmented by the College in the case of the former to 100*l.* per annum. Candidates will be eligible for these scholarships who have not exceeded the age of twenty years on March 15. Inquiries should be addressed to Mr. G. D. Parkes, Keble College. Intending candidates are requested to communicate their names and subjects on or before Saturday, February 24.

THE Committee of Award of the Commonwealth Fund Fellowships announces that applications must reach the Secretary, 50 Russell Square, on or before February 20. The fellowships will normally be tenable at an approved American university for two years. They are open to persons of British birth domiciled in England, Scotland, Wales, and Ireland who are graduates of recognised universities, are unmarried, and not more than thirty years of age. Women as well as men may apply. Provision amounting approximately to 600*l.* per annum will be made for the total expenditure involved during the tenure of a fellowship.

IN our issue of January 30, p. 178, reference was made to the lack of support which is hampering the development of the Imperial College of Tropical Agriculture, Trinidad. It is gratifying to learn from the reply given to a question asked in the House of Commons on February 8 that it has been decided to make a capital contribution of 15,000*l.* towards the cost of the erection of a hostel, a contribution of 3000*l.* towards the general expenses of the College in 1926–27, and, if absolutely necessary, certain further contributions in the three following years.

A THERESA Seessel Research Fellowship, for the promotion of original research in biological studies, is offered by Yale University. The value is 1500 dollars, and preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications should be made to the Dean of the Graduate School, New Haven, Conn., U.S.A., before April 1 next, and should be accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate.

FROM Manchester we have received a pamphlet by Mr. Spurley Hey, the Director of Education, entitled "Value for Money in Education." The gist of this answer to a call for economy in public expenditure on education is that whilst outlay can be stated in cash, the returns which the country is getting for the money spent on education cannot, that the expenditure is bound to increase still further, and that tax- and rate-payers had better pay up and look cheerful instead of criticising what they do not understand and cannot check. Manchester "business men" appear to have made unreasonable demands of the elementary schools: a "special type of arithmetical calculation" or "intimate knowledge of the geography of parts of the world with which their business is connected," or knowledge of foreign languages or shorthand or typewriting. Criticism based on such demands deserves the censure which Mr. Hey administers, but the pamphlet throws little light on such questions as: What, precisely, are the returns, admittedly not estimable in cash, which the administrators of education in Manchester aim at? Is the adjustment of means to ends demonstrably appropriate? And what evidence is there that the returns aimed at are, in fact, being produced?

Contemporary Birthdays.

February 11, 1847. Dr. Thomas Alva Edison.
February 11, 1868. Prof. R. J. Durley, M.Inst.C.E.
February 12, 1872. Prof. A. J. Ewart, F.R.S.
February 13, 1843. Sir Thomas H. Holdich, K.C.M.G.
February 15, 1861. Prof. A. N. Whitehead, F.R.S.
February 16, 1848. Prof. Hugo De Vries, For. Mem. R.S.

Dr. THOMAS A. EDISON was born at Milan, Erie Co., Ohio. He began life with scant educational advantages, and these, such as they were, came mainly from his mother's lessons (she was of Scotch descent) and his own omnivorous reading. Early in life he learnt telegraphy, and commenced experimenting in that department and in chemistry and electrical science. He invented the quadruplex and sextuplex telegraphic systems of transmission, the incandescent electric lamp, the phonograph, and a host of devices and appliances which have uses in the daily life of the peoples of all countries. He is a Commander of the Legion of Honour. During the whole of the War period he was engaged in work for the United States Government.

Prof. R. J. DURLEY occupied the chair of mechanical engineering, McGill University, Montreal, 1901–12. He is now a consulting engineer in that city, and secretary of the Engineering Institute of Canada, Montreal. Educated at Bedford Modern School, he studied at University College, Bristol, and afterwards at University College, London. Apprenticed to Earle's Shipbuilding and Engineering Co., Hull, he afterwards became lecturer in mechanical engineering at the Municipal Technical School, Hull. He is the author of "Kinematics of Machines" (1908) and of many technical papers.

Prof. A. J. EWART, of the University of Melbourne, who occupies there the chair of botany and plant physiology, is a Liverpool man, and was sometime a demonstrator of botany in the university of that city before he graduated at Oxford. Formerly he was well known in various centres in Birmingham as a lecturer and research worker in botanical subjects.

Sir THOMAS H. HOLDICH, traveller and mountaineer, was born at Dingley, Hampshire. He was educated at Godolphin Grammar School and Woolwich Academy, joining the Royal Engineers in 1862. An epitome of much of his career was reflected in 1887 by the award of the Royal Geographical Society's Founders Medal, allotted in consideration of services rendered in carrying out surveys in Afghanistan, also (1884–86) with the Russo-Afghan Boundary Commission, when he conducted operations over an area of 100,000 square miles. He was the first Englishman to ascend the Paghmán Range, which lies between Kabul and the passes of the Hindu-Kush. Sir Thomas has consistently upheld the great traditions of the corps of Royal Engineers.

Prof. A. N. WHITEHEAD was educated at Sherborne School and Trinity College, Cambridge. Formerly professor of applied mathematics at the Imperial College of Science, South Kensington, he took up in 1924 the post of professor of philosophy at Harvard University, U.S.A. He was joint author, with the Hon. Bertrand Russell, of that work of fundamental issues, "Principia Mathematica."

Prof. HUGO DE VRIES, emeritus professor of botany in the University of Amsterdam, was born at Haarlem. He is a foreign member of the Royal Society and the Linnean Society, and Darwin medallist of the former.

Societies and Academies.

LONDON.

Royal Society, February 4.—W. A. **Bone** and R. **Quarendon**: Researches on the chemistry of coal. Pt. iv. The "residues" obtained after the extraction of coals with benzene under high pressure can be easily oxidised by alkaline solutions of potassium permanganate, yielding a complex mixture of benzenoid carboxylic acids amounting to between 25 and 40 per cent. of the weight of the "coal-residue" treated. These acids include 1, 2, 3, 4 *benzene tetracarboxylic* acid and mellitic (*benzene hexacarboxylic*) acid.—G. M. B. **Dobson** and D. N. **Harrison**: Measurements of the amount of ozone in the earth's atmosphere and its relation to other geophysical conditions. Measurements of the amount of ozone in the atmosphere were made almost daily throughout 1925, and a few measurements were also taken during the autumn of 1924. The average amount is about 0·3 cm., which agrees with former measurements. A marked connexion is found between the atmospheric pressure and amount of ozone, the latter being large in cyclonic and small in anti-cyclonic conditions. There is a well-marked annual period with a maximum in spring and minimum in late autumn. The probable error of observation is about 0·005 cm. of ozone.—C. **Chree**: Atmospheric ozone and terrestrial magnetism. Using the results of the paper above, there appears to be a decided association of magnetic disturbance and higher values of ozone. Owing to the tendency to sequences of high ozone figures and of days of magnetic disturbance, it is difficult to say exactly how synchronous the phenomena are. The figures suggest that the high ozone figure precedes the crest of magnetic disturbance.—J. S. **Owens**: Condensation of water from the air upon hygroscopic crystals. Deliquescence of crystals of pure salts depends upon the vapour pressure of their saturated solutions, while mixed salts, as found in air, behave in a different manner from pure salts. It is usually assumed that before fog can be formed the air must be saturated, or nearly so; but it is demonstrated that all the examples of crystals obtained from the air would become liquid in air very much under-saturated. Thus the crystals from Algarve (Portugal) collected water at 69 per cent. relative humidity at 56° F.; crystals from the neighbourhood of the mouth of the St. Lawrence deliquesced at about 77 per cent. relative humidity at 56° F. Crystals obtained in Bournemouth deliquesced at about 67 per cent. relative humidity at 62° F., indicating that it is not necessary for air charged with such crystals even to be near saturation for a fog of liquid drops to form.—T. H. **Havelock**: Wave resistance: some cases of unsymmetrical forms. The type of asymmetry is suggested by the general effect of fluid friction in reducing the wave-generating properties of the rear portion of the model. Pairs of models are examined in which one model is symmetrical fore and aft, while in the other the rear portion is curved off into more of a streamline form. This produces a marked decrease in the magnitude of the interference phenomena.—H. **Jeffreys**: On the formation of water waves by wind. On the hypothesis that, in a first approximation, water waves may be considered irrotational, viscosity and other factors tending to change the amplitude being small, the conditions of growth of waves under the action of wind, even when the depth is finite and surface tension is allowed for, have been investigated. The rate of decay of waves, in the absence of wind, is independent of the

depth and the surface tension. The easiest waves for a wind to raise are always two-dimensional, and are gravity waves, not ripples. The wind velocity needed to produce waves is greater in shallow water than in deep water. The longer waves on shallow water (less than about 1 cm. deep) are, however, so much affected by viscosity that the hypothesis is invalid for them; it seems they can in no case be formed by wind. The waves produced on shallow water must therefore be very short, about 2-3 cm. say, which agrees with observation.—G. T. **Morgan**, W. J. **Hickinbottom**, and T. V. **Barker**: Stereoisomeric diaryl-β-γ-diamino-*n*-butanes. The secondary diamines of the general type $Ar.NH.CH(CH_3).CH(CH_3).NH.Ar$ contain two asymmetric carbon atoms, either mirror images of each other or absolutely identical. Like tartaric acids these bases should exist in an internally compensated *meso*-form, as well as an externally compensated mixture, potentially resolvable into optically active modifications. The most fully investigated series of compounds are those containing the *p*-tolyl residue:

$$CH_3.C_6H_4.NH.CH(CH_3).CH(CH_3).NH.C_6H_4.CH_3,$$

and the study of these bases affords a highly satisfactory confirmation of the requirements of stereochemical theory.—G. T. **Morgan** and G. R. **Davies**: Antimonial analogues of the cacodyl series. Methyl arsenicals were first discovered by Louis Claude Cadet de Gassicourt in 1760 (*Paris, Acad., Sci. Mém. Div. Sav.* t. 3, p. 623). Similar experiments on organic compounds of antimony led to the preparation of tertiary stibine and other derivatives by Löwig and Schweizer and by Landolt, but the antimonial analogues of the cacodyl series have so far eluded isolation. The thermal decomposition of trimethylstibine dihalides has now been investigated, the following reaction having been generalised when X is chlorine, bromine, or iodine:

$$(CH_3)_3SbX_2 = (CH_3)_2SbX + CH_3X.$$

This process affords the means of proceeding from the tertiary to the secondary series of organic antimonials.—G. T. **Morgan** and V. E. **Yarsley**: Dimethylstibine cyanide, an analogue of cacodyl cyanide. When anhydrous reagents are used, cyanogen bromide combines readily with trimethylstibine dissolved in light petroleum to form trimethylstibine cyanobromide, a white crystalline compound. This is relatively stable, and is only decomposed *in vacuo* at high temperatures, when dimethylstibine cyanide is obtained as a colourless crystalline compound, m.p. 113°-114°. This cyanide, the analogue of Bunsen's cacodyl cyanide, fumes on exposure to air, with the formation of white infusible trimethylstibine oxycyanide.

Faraday Society, January 18.—B. B. **Banerji**: The electrode capacity and resistance of electrolytes for a wide range of frequencies. The laws of variation suggested by Haworth and by Warburg are satisfied only through small ranges of frequency; a law is given which holds throughout the range investigated. The hypothesis of double leaky capacities at the electrodes has been put forward to explain this law. The existence of the capacities is ascribed, one to the double layer and another to the concentration changes brought about by the transport phenomena. The thickness of the double layer calculated from the value of the double-layer capacity is of the proper order and consistent with the value found by other methods.—J. A. V. **Butler**, W. E. **Hugh**, and D. H. **Hey**: A note on the effect of the electrode material on oxidation potentials. The independence of oxidation potentials of the electrode material, when this takes no appreciable part in the cell reaction, is confirmed.—R. E. W. **Maddison**: The electromotive behaviour of cupric oxide. (1) The behaviour of the electrode Pt/Cu_2O, CuO, N-NaOH has been re-examined. Initially, it gives a relatively positive P.D., which gradually becomes more negative. The initial and final P.D.'s depend on the temperature of preparation of the oxide, and on the duration and method of heating.—A. **Highfield**: The colloidal properties of nitrocellulose sols in mixed solvents. Nitrocellulose and its solvents contain both strongly and weakly polar groups. Mixed liquids are solvents if they contain these two classes of groups balanced in suitable proportions, and this conclusion holds whether the ingredients of the mixtures are solvents or not. The relation between the composition of solvent or solute and the viscosity of nitrocellulose sols has been investigated, and the results are in line with the conclusions reached from solubility considerations.—E. P. **Perman** and T. **Lovett**: (1) Vapour pressure of concentrated aqueous solutions of urea. These are given at the temperatures 40·02°, 60·28°, 70·39°, and 80·1° C., and the densities up to a concentration corresponding very nearly with saturation are given at the same temperatures. Van Babo's law does not hold for aqueous solutions of urea. The results indicate a normal molecular weight and no hydration for urea in aqueous solution. (2) The heats of dilution of concentrated solutions of urea at various temperatures. An original method is described by which these can be measured. From the results obtained it is possible to obtain the heat of dilution as defined by Kirchhoff's equation, the total heat of dilution between any two concentrations, and the relation between the heat of dilution and the concentration. A new method of determining solubilities is suggested.—W. **Taylor**: A note on kinetic activation as a factor in gas reactions.

CAMBRIDGE.

Philosophical Society, January 18.—H. F. **Baker**: On chains of two-two relations, and the theory of elliptic functions.—G. C. **Stewart**: The aberrations of a symmetrical optical system. The geometrical aberrations are considered in detail for the first three orders—both for the paraxial image plane and also for out-of-focus planes. Aberrations of all orders fall severally into one or other of two general types.—W. **Burnside**: On a group of 1440 birational transformations of four variables that arises in considering the projective equivalence of double sixes.—P. L. **Kapitza**: Over-tensions in a condenser battery during a sudden discharge. If a large condenser battery made of Leyden jars is discharged through a small self-induction, the tension across the jars reaches sometimes very large values, which may break the insulation across the Leyden jars. A photograph of the spark in this case shows that the current from the jars goes through the main circuit only for a few half periods. Due to the self-induction of the connecting wires, oscillations are produced in the battery between the Leyden jars, which account for the over-tension.—H. S. **Hirst**: Photocatalysis at mercury surfaces. A mercury surface, irradiated by ultra-violet light strong in the line $\lambda = 2536{\cdot}7$ Å.U., exerts a catalytic influence on the photochemical union of hydrogen with gases such as oxygen, ethylene, and carbon monoxide. The velocity of reaction is to the first order proportional to the area of surface exposed. A film of mercuric oxide on the mercury forms only in the presence of both hydrogen and oxygen. In the combination of nitrogen and hydrogen, hydrazine and ammonia have been identified, and in the case of oxygen and hydrogen, hydrogen peroxide and water. It is suggested the

reactions proceed by steps. The catalytic efficiency of the surface depends on its cleanness and is cut down by poisons.—P. **Bracelin**: The period of decay of RaB and RaC. Measurements of the saturation currents produced between two parallel plates by a source of radium C give a transformation constant of $(3{\cdot}514 \pm 0{\cdot}007) \times 10^{-2}$ min.$^{-1}$ for radium C, corresponding to a half value period of $19{\cdot}72 \pm 0{\cdot}04$ minutes. Similar measurements have been made on sources of radium active deposit and the decay compared with the values calculated by assuming the above period for radium C and trying various values for that of radium B. The experimental results indicate a value between 26·7 to 26·8 minutes.

EDINBURGH.

Royal Society, January 25.—T. J. **Jehu** and R. M. **Craig**: Geology of the Hebrides. Pt. iii. North Uist and Benbecula. The outstanding feature is the belt of crushed and sheared rocks traceable along the eastern side of Benbecula and North Uist, and separated by a thrust-plane from the relatively undisturbed gneisses forming the western and greater part of the area. This forms a continuation of that along the eastern side of South Uist. It is made up of crushed gneisses, mylonites, and flinty crush material intermixed, in contrast to the definite zones traceable in the case of South Uist. The dominant gneisses of the western area are acid biotite-gneiss, hornblende-biotite-gneiss, hornblende-gneiss, and garnetiferous hornblende-gneiss. Pyroxene and hornblende granulites often rich in garnets are intrusive into the dominant gneisses. Bands of pegmatite are frequent, sometimes yielding good graphic granite. Ultrabasic rocks in bands converted into actinolite schists occur especially in the isles of Berneray and Pabbay. All these types are altered igneous rocks of the Archæan complex. Minor intrusions of Tertiary age are much less frequent than in the more southern isles. The three Maddys, rocky islets at the entrance to Loch Maddy, are portions of an olivine-dolerite sill. Evidences of recent subsistence are afforded by submarine peat off the coast and by the drowning of fresh-water lochs.—T. M. **Finlay**: The Old Red Sandstone of Shetland. A new fossil zone occurred a short distance below the conglomerate in the south-eastern area of the Old Red Sandstone. This has yielded three species of fish, *Dipterus valenciennesi*, Microbrachius sp. nov., and a new genus *Stegotrachelus finlayi*, a palæoniscid of extreme interest as being the earliest of the family known in complete specimens from the Devonian, and the first to be recorded from the Old Red Sandstone of Europe. The genus has been described and figured by Smith Woodward and White.—J. Kaye **Charlesworth**: (1) The glacial geology of the southern uplands of Scotland, west of Annandale and Upper Clydesdale. The lines of ice-flow over the region by striæ, drumlins, and erratics has been traced and the position of the ice-edge ascertained at five successive periods of the retreat by the correlation of the moraines associated with the major glaciers. There is evidence of re-advances in connexion with two of these stages. (2) The great re-advance kame-moraines of the south of Scotland and some later stages of retreat. There is an important line of re-advance of the ice around the coastal areas of north-east Ireland from the mouth of Lough Foyle to the head of Belfast Lough, by the Bride Hills of the Isle of Man and the Cumberland coast. A later position of the ice-margin is from St. Abb's Head along the northern slopes of the Lammermuir and Moorfoot Hills, by Muirkirk and to the east of New Cumnock, and again at Stranraer and in the Rhinns of Galloway. At this stage, corrie glaciers lingered in the Lammermuir Hills, the Tweed below Broughton was ice-free, and the highland ice was confluent over south Ayrshire with the southern upland glaciers of (1). The North Ireland moraine is correlated with the Baltic moraine of N. Germany, the later moraines with the Ra moraines of Scandinavia and the "post-glacial stages" of the Alps.—A. E. M. **Geddes**: Distribution of electric force in high-voltage discharges. An investigation by F. W. Aston proved that for electric discharges in vacuum tubes, the potential across the dark space is equal to that across the tube, with voltages less than 1000 volts. It is now shown that, with voltages more than 13,750 volts, only a part of the total voltage is confined to the dark space, about 0·25 of the excess of the total voltage, more than 13,750 being found in the negative glow.

PARIS.

Academy of Sciences, December 28.—Charles **Richet, Gardner**, and **Goodbody**: The effects of salts of zirconium, titanium, and manganese on nutrition. These metals were administered to dogs as citrates mixed with the food. Neither zirconium, titanium, nor manganese had any toxic effect. Titanium and zirconium, especially the latter, appeared to have a slightly favourable effect on nutrition. The results with manganese were irregular.—Léon **Guillet**: The tempering of light aluminium-copper alloys containing more than 5 per cent. of copper.—Ch. **Depéret** and J. **Savornin**: The discovery of a fauna of Albian vertebrates at Timimoun (Western Sahara).—E. **Mathias**: Contribution to the study of fulminating materials. The colour. Chemical heterogeneities. The theory of ball lightning.—G. A. **Boulenger**: Remarks on the importance attached to the mode of insertion of the carpels for the classification of the species of the genus Rosa.—L. **Cuénot**: The signification of homochromy in some marine animals.—Gaston **Julia**: The series of rational repeated functions.—A. **Zygmund**: The summation of trigonometrical series and those of powers by typical means.—A. **Bloch**: Some theorems on integral and meromorph functions of a variable.—R. **Gosse**: The equation of the deformation of surfaces.—J. **Cayrel**: The properties of lead dioxide as a detector. Lead dioxide, in combination with points of various metals (magnesium, zinc, tin, aluminium), can be used as a detector in wireless telephony.—E. **Fromy**: The relation between the Wiedemann effect and the Joule effect.—A. **Dauvillier**: The biological action of X-rays of various wave-lengths. A discussion of the correct interpretation of some recent measurements of A. Dognon. It is concluded that the large difference found by Dognon in the biological action was not justified by the experiments and that in reality the radiations $\lambda = 0{\cdot}22$ and $\lambda = 0{\cdot}7$, for equal energy absorbed, have the same biological action.—Jean **Rey**: The brilliance and luminous flux of carbons of high light intensity, for projection of electric light. The electric light carbons contain a central core of rare earths (salts of cerium or titanium). The illuminating power per square millimetre is very high, but falls far short of the figures claimed by the manufacturers.—Mme. J. S. **Lattès** and Georges **Fournier**: The absorption of the β-rays by matter.—E. **Darmois**: A case of mutarotation. Application to the study of the saponification of ethyl oxalate by water or dilute acids.—R. de **Mallemann**: The calculation of Verdet's constant in the molecular theory.—René **Dubrisay**: Some phenomena of capillary chemistry. Benzene solutions of fatty acids (palmitic, oleic, stearic) were allowed to run from a burette into water or weak soda solutions at different temperatures. The variations in the surface tension were deduced from the size of

the drop.—Charles **Grard**: The influence of the thermal zone of work on the selection of steels for the valves of aviation motors. A study of the properties of chrome-silicon steels. A steel of the type carbon 0·4 per cent., silicon 2·5 per cent., chromium 12 per cent. gave the best results on these tests, and a trial of this alloy on a 450 H.P. engine gave very satisfactory results.—Raymond **Delaby** and Maurice Marie **Janot**: Cyclohexylglycerol.—G. **Georgalas** and N. **Liatsikas**: The new eruption of the Santorin volcano (1925). A detailed account of the phenomena observed between August 23 and October 13.—P. **Lasareff**: The results of geophysical work in the domain of the magnetic anomaly of Koursk. The magnetic anomaly is shown to be due to large deposits of iron ores. The quantity of iron, calculated as metal in this region, is of the order of 2×10^{10} tons.—Rafael de **Buen**: The genesis of the Rias.—Henry **Hubert**: The evolution of very extended masses of cumulo-nimbus in Western Africa.—P. **Allorge**: The variations of the hydrogen ion concentration in some Sphagnum peats in the centre and west of France. For the peats examined the *p*H values were found to be between 3·9 and 6·8.—A. **Maige**: The unilocular or plurilocular amylogen reaction of the plasts.—André **Dauphiné**: Experimental demonstration of the vascular ratio between the leaf and the root. It was shown by G. Chauveaud in 1921 that the appearance of new leaves is accompanied by the differentiation of new conducting elements in the stem and root. This is confirmed by experiments described by the author in which lesions resulting in the suppression of certain leaves correspond in the root to the absence of vascular groups.—R. **Morquer**: The biology of *Mucidula mucida*.—Raymond **Hamet**: A type of medullary cribo-vascular formations new for the family of the Crassulaceæ.—M. **Mascré**: The staminal periplasmodium of the Commelinaceæ.—M. **Bridel** and C. **Charaux**: The biological method of research, in plants, on glucosides hydrolysable by rhamnodiastase. The ferment rhamnodiastase, extracted from various species of Rhamnus, causes a partial hydrolysis of glucosides, some of the molecules of glucose remaining combined together in the form of complex glucides (primeverose, rutinose, rhamninose, etc.). Results are given of the application of this ferment to various plants.—H. **Colin** and A. **Grandsire**: The chemical characters of green leaves, yellow leaves, and red leaves. Compared with normal green leaves, red autumn leaves are richer in sugars and in free organic acids, are less mineralised, and are partially decalcified. The yellow leaves are poor in sugar, but rich in water and mineral salts.—Michel **Durand**: The influence of light on the formation of tannins.—Léon **Bertin** and Fernand **Angel**: The plankton and planktonic food of the fishes of the Lake of Geneva.—Ch. **Hollande**: The urate cells of acridian Orthoptera and the genesis of these urates.—Emile F. **Terroine** and Mlle. Anne Marie **Mendler**: The influence of the addition of ternary food substances to milk on the magnitude of the nitrogen retention in the course of growth. The results of experiments on the growth of sucking pigs fed with skimmed milk, whole milk, the latter alone or mixed with additional fatty or starchy material. The addition of fat or of carbohydrates to the milk caused a marked improvement in the proportion of proteid retained and utilised by the animal. Whole milk did not prove to be the ideal food.—Mme. L. **Randoin** and Mlle. A. **Michaux**: Glycogen reserves and arterial glycæmia (effective and proteidic) in the course of experimental scurvy.—Marcel **Francois**, I. **Meyerson**, and Henri **Pieron**: The latent time of reactions of equilibration to sudden longitudinal accelerations.—H. **Barthélémy**: The action of saline and aqueous extracts of eggs of the same species on the spermatozoids of *Rana fusca*.—P. H. **Fischer**: The influence of light and of the renewal of air on the awakening of snails (after hibernation). The humidity of the air is not a necessary condition of the awakening of snails. This is accelerated by light and by renewal of air.—F. **Vlès** and A. de **Coulon**: The physico-chemical properties of certain constituents of serum.—Jivoin **Georgévitch**: The structure of the spore of *Pleistophora periplanetæ*.—Raoul **Bayeux**: Hæmatolysis and hæmatopoiasis at very high altitudes and in air experimentally rarefied. Breathing rarefied air determines a toxic hæmolysis the clinical result of which is mountain sickness. It is possible that at medium heights (3000 feet) the blood may be purified by the destruction of fragile or unhealthy red corpuscles, replacing them by fresh healthy corpuscles.—Stefan **Jellinek**: Electrical accidents and artificial respiration. The author insists on the importance of immediate and prolonged artificial respiration in cases of the victims of electric shock.— — **d'Arsonval**: Remarks on the preceding communication. The views of M. Jellinek are in complete agreement with those published by the author so far back as 1885. A victim of electric shock should be treated like a person apparently drowned. As regards the method of artificial respiration, the best is that of Schaefer, possibly combined with oxygen inhalation.

January 4.—H. **Deslandres**: Obituary notice of Hildebrand Hildebrandsson.—A. **Cotton** and R. **Descamps**: A photographic spectro-polarimeter for the ultra-violet. The instrument described is based on the principle that the movement of rotation of the analyser produces a displacement of the image recorded on the sensitised plate.—Julien **Costantin** and Joseph **Magrou**: Contribution to the study of the roots of alpine plants and their mycorhiza.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: The determination of velocities in liquids and the paradox of Du Buat. A method of applying the Pitot tube in which, instead of measuring the difference of pressure, a compensating pressure is set up by means of a rotatory pump. Velocities of the order of 5 cm. per second can be measured.—E. **Mathias**: Contribution to the study of fulminating material. The black and white globes without light of their own. A development of a theory of globular lightning.—Maurice **Gevrey**: The resolution of the problems at the limits without Green's functions.— — **Mandelbrojt**: Some generalisations of theorems on series which admit of interruptions.—E. F. **Collingwood**: A theorem of M. Valiron.—Julius **Wolff**: The iteration of holomorph functions in a region, the values of which belong to that region.—R. **Chambaud**: The internal potential in thick circular arches and the idea of average slipping deduced from it.—E. G. **Barrillon**: Concerning the part of the resistance to towing of a float due to the formation of a field of waves.—V. **Bjerknes**: The temperature of sunspots.—Th. **Vautier**: The propagation of short sound waves and of low pressure.—F. **Holweck**: The critical potential K of neon. This was found to be 862 volts.—Jean **Thibaud**: The determination in absolute measure of the wave-lengths of X-rays by means of a reflection grating traced on glass. The spectroscopy of the X-rays is based on the diffraction of these radiations in crystallised media which act as gratings, of which the constant, the reticular distance d, can be calculated from certain hypotheses due to Bragg. The author describes experiments with a glass diffraction grating ruled with 200 lines to the millimetre and gives a reproduction of one of the spectra obtained. The wave-length for the copper

line $K\alpha$ was thus found to be 1·540 Å.U., in good agreement with the 1·538 Å.U. given by the crystal method.—Pierre **Sève**: A spectrograph with a non-inclined plate.—P. Mondain **Monval**: The thermal properties of viscous sulphur. The experimental results are summarised in a diagram in which the quantities of heat given out on cooling are plotted against the temperatures to which the sulphur has been heated. The curve is discontinuous, with four branches corresponding to orthorhombic, monoclinic, liquid, and viscous sulphur. The transformation of liquid sulphur into viscous sulphur at 160° C. is accompanied by an absorption of 2·8 calories per gram.—F. **Taradoire**: The rapid oxidation of drying oils and antioxygens.—L. **Bert** and P. Ch. **Dorier**: A complete synthesis of thymol starting from isopropyl alcohol. A diagram is given of the fifteen steps in this synthesis, together with the yield of each successive operation.—G. **Hugel**: Heterocyclic combinations containing pentavalent iodine or bromine.—**Orekhoff** and **Tiffeneau**: The transposition of trisubstituted aldehydes into disubstituted ketones. Details of transpositions of the type RRR′.C.CHO→RR.CH.CO.R′.—Joseph **Péneau**: The presence of Clymenia and the extension of the upper Devonian in the south-east of the Armorican massif.—E. A. **Martel**: The Bertarelli abyss (Istria), 430 metres deep.—Const. A. **Kténas**: The enclosures and ashes of Fouqué Kameni.—R. **Bureau**: The prediction of the weather and the daily variation of atmospherics.—P. **Lavialle**: The development of the anther and pollen in *Knautia arvensis*.—Pierre **Dangeard**: The flora of the peridineans of the western Channel.—G. **Nicolas**: A new and certain example of parasitism in Hepatica (*Marchantia polymorpha*).—Louis **Daniel**: Heredity of the property of second flowering in grafted plants.—Jacques **Pellegrin**: The biology of the omble trout of the Middle Atlas (*Salmo Pallaryi*).—André **Migot** and Adolf **Portmann**: *Chondranthus denudatum*, a new species from the Mediterranean.—Auguste **Lumière** and Henri **Couturier**: The toxicity of serum put in contact with starch. Serum from the guinea-pig, digested with rice starch at 37° C. and centrifuged, causes death by anaphylactic shock when injected into an animal of the same species. It was found, however, that the symptoms were attenuated when the centrifugation was prolonged for half-an-hour, and if the serum is centrifuged (tangential velocity 96 metres per second) for 50 minutes, the serum becomes completely innocuous. The author points out the bearing of these experiments on his theory of anaphylaxis, according to which the toxic agent is in all cases a flocculate more or less visible, which is insoluble and acts by its physical properties.—Jean **Roche**: The action of temperature on respiration *in vitro* of the tissues of homeotherms and pœcilotherms.—Mme. L. **Randoin**, Mlles. **Asselin** and **Charles**: Reproduction, growth, and food equilibrium.—Marcel **Duval** and Marcel **Prenant**: The molecular concentration of the internal medium of *Ascidia mentula*. Contrary to what has been observed with other marine invertebrates, the blood of this Ascidian is not isotonic with sea water, but is sensibly hypertonic, the difference between the freezing points of the two media being 0°·10. The proportion of chlorine in the blood is higher than that in the surrounding sea water.—J. E. **Abelous** and L. C. **Soula**: The cholesterogenic function of the spleen; the influence of the internal secretion of the spleen on cholesterogenesis in the muscles.—Edouard **Chatton** and André **Lwoff**: The structure and the evolutive cycle of the Infusoria of the cast skins of Crustacea and their place amongst the Fœttingeriideæ.—Jivoin **Georgĕvitch**: The evolutive cycle of *Pleistophora periplaneteæ*.

Official Publications Received.

Aeronautical Research Committee. Reports and Memoranda, No. 977 (Ae. 191): An Experimental Investigation into the Properties of certain Framed Structures having Redundant Bracing Members. Report No. 3. By Prof. A. J. Sutton Pippard. (B.2.g. Strength and Design, general, 67—T. 2114.) Pp. 12+1 plate. 6*d*. net. Reports and Memoranda. No. 979 (E. 15): Closed Vessel Explosions of Mixtures of Air and Liquid Fuel (Petrol, Hexane and Benzene) over a wide Range of Mixture Strength, Initial Temperature and Initial Pressure. By R. W. Fenning. (I.C.E. 369, I.C.E. 396, I.C.E. 440, I.C.E. 440A.) Pp. 28+16 plates. 2*s*. 6*d*. net. (London: H.M. Stationery Office.)

Dirección general del Instituto Geográfico. Anuario del Observatorio de Madrid para 1926. Pp. 520. (Madrid.)

Torquay Natural History Society. Transactions and Proceedings for the Year 1924–5. Vol. 4, Part 3. Pp. 199-285. (Torquay.)

Ministry of Finance, Egypt: Survey of Egypt, Geological Survey. The Geography and Geology of Makalla (South Arabia). By O. H. Little. With two Appendices: (i) Description of Fossils from South Arabia and British Somaliland, by Prof. G. Stefanini; (ii) Note on some Terrestrial Mollusca from the Hinterland of Makalla, by P. Pallary. Pp. xi+250+36 plates. (Cairo: Government Publications Office.) 50 P.T.

The Journal of the Institute of Metals. Vol. 34. Edited by G. Shaw Scott. Pp. xi+799+33 plates. (London.) 31*s*. 6*d*. net.

Society for the Preservation of the Fauna of the Empire Journal. New Series, Part 5. Pp. 73. (London: H. F. and G. Witherby.) 2*s*. 6*d*. net.

Proceedings of the Society for Psychical Research. Part 97, Vol. 36, January. Pp. 77. (London: Francis Edwards.) 5*s*. net.

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 297: A Statistical Study of Conditions affecting the Distance Range of Radio Telephone Broadcasting Stations. By C. M. Jansky, Jr. Pp. 639-650. 5 cents. Circular of the Bureau of Standards, No. 280: Standard Time Throughout the World. Pp. 9. 5 cents. Scientific Papers of the Bureau of Standards, No. 515: Thermal Expansion of Tungsten. By Peter Hidnert and W. T. Sweeney. Pp. 481-487. 5 cents. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 31: Medical Education, 1922–1924. By Dr. N. P. Colwell. Pp. 14. (Washington: Government Printing Office.) 5 cents.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 64: Notes on Egyptian Coccidæ, with Descriptions of new Species. By W. J. Hall. Pp. v+31+6 plates. (Cairo: Government Publications Office.) 5 P.T.

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 5, and Vol. 21, No. 6: The Uhle Pottery Collections from Moche, and The Uhle Pottery Collections from Supe. By A. L. Kroeber. Pp. 191-234+plates 50-69+235-264+plates 70-79. (Berkeley, Calif.: University of California Press.) 1.25 dollars.

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. The Pycnosonde: an Apparatus for Hydrographic Soundings. By D. la Cour. Pp. 13. (København: G. E. C. Gad.)

Diary of Societies.

SATURDAY, FEBRUARY 13.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.—P. S. Lea: Haulage Accidents.—S. Burns: Winding Costs: A Plea to the Purchaser of Electric Winding Plant for Withdrawal of Stipulations which are not Conducive to Economical Working.—Papers Open for Further Discussion:—J. S. Carson: A System of Mechanical Coal-mining combined with the Adoption of Systematic Timbering, using Composite Steel Props.—Prof. H. Briggs and Dr. J. N. Williamson: Experiments on Fan Casings and Fan Inlets.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth (2): Their Uses from Hucbald to the Present Day.

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College for Women), at 3.—Dr. E. H. Magson: Judgments of Intelligence based upon Interviews.—R. J. Bartlett: Indications of a Logarithmic Law in Learning.

INSTITUTE OF TRANSPORT (North-Eastern Local Section) (at Newcastle-upon-Tyne), at 3.—D. S. Burn: Notes on Railway Organisation.

MINING INSTITUTE OF SCOTLAND (at Heriot-Watt College, Edinburgh), at 3.—Dr. J. Parker: The Adjustment of Ropes on Bi-Cylindro-Conical Drums.—D. C. Gemmell: The Problem of In-bye Transport.—Papers open for discussion:—The Report of the Institution Committee on Ventilation of Mines; Notes on Cleat in the Scottish Coalfields, by Prof. R. W. Dron; Coal Cutting by Machinery and Conveyers in Scottish Mines, by G. L. Kerr.

SCOTTISH JUNIOR GAS ASSOCIATION (at Royal Technical College, Glasgow), at 7.—A. Philip: Municipal Gas Undertakings: Finance and Accounting.

MONDAY, FEBRUARY 15.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. G. R. Murray, H. Tilley, F. W. Broderick, and others: Discussion on Focal Sepsis as a Factor in Disease.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—S. Cade: Cholecystography.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Bedford College for Women), at 5.30.—Prof. J. Johnstone: Heredity and Development: Theory of the Germ-plasm.

ELECTRICAL ASSOCIATION FOR WOMEN (at 15 Savoy Street), at 7.—W. E. Bush and Miss Hodge: Electric Light in the Home.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—P. Dunshcath: Dielectric Problems in High-Voltage Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—C. W. Blacklock: Paper.
INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—T. D. Carpenter: Motor Coach-building Problems.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—R. G. Collingwood: Some Perplexities about Time.
ROYAL SOCIETY OF ARTS, at 8.—Dr. G. W. C. Kaye: The Production and Measurement of High Vacua (Cantor Lectures) (1).
MEDICAL SOCIETY OF LONDON, at 9.—Dr. E. Farquhar Buzzard: The Principles of Treatment in Relation to Diseases of the Nervous System (Lettsomian Lectures) (1).
CHEMICAL INDUSTRY CLUB.

TUESDAY, FEBRUARY 16.

ROYAL MEDICO-PSYCHOLOGICAL ASSOCIATION (at 19B Tavistock Square), at 2.30.—Dr. Isabel Robertson: Blood and Vascular Conditions in Psychoses.
ROYAL ANTHROPOLOGICAL INSTITUTE (Edinburgh and the Lothians Branch) (at Synod Hall, Edinburgh), at 5.—Rev. E. M. K. Raff: Life and Legend in the New Hebrides.
ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Sections) (Laboratory Meeting) (at Guy's Hospital), at 5.—Prof. C. S. Gibson: A New Series of Arsenical Compounds.—Prof. C. S. Gibson and Prof. A. L. Gibson: Demonstration of New Cryoscopic Apparatus.—Dr. E. P. Poulton: A Method of administering Oxygen without Waste.—Dr. N. Mutch: Differential Adsorption of Dyes by Kaolin and Aluminium Hydroxide.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Egg (1): Introductory.
ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—H. C. Scott: The Rignano Scheme in its Administrative Aspects.
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Bedford College for Women), at 5.30.—Prof. L. J. Russell: Matter, Life and Mind.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. Day and others: Discussion on Claims to Motion Picture Invention.
STAFFORDSHIRE IRON AND STEEL INSTITUTE (at Dudley), at 7.—Discussion on Iron *v.* Steel.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (jointly with Institution of Post Office Electrical Engineers) (at Milton Hall, Deansgate, Manchester), at 7.30.—E. H. Shaughnessy: Wireless (Lecture).
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—A. M. Hocart: The Power of Miracles.
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Sir Frederick Lugard, Hon. H. A. Wyndham, and Dr. M. Ginsberg: Discussion on The Problem of Colour in relation to the Idea of Equality.

WEDNESDAY, FEBRUARY 17.

INSTITUTE OF HYGIENE, at 3.30.—Dr. Risien Russell: The Prevention of Nervous Affections in the Young.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. A. Pincy: The Importance of Hæmatology in Surgery.
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at University of London Club), at 5.30.—Hon. Bertrand Russell: Physics and Psychology.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—D. S. Matheson: Subaqueous Tunnelling in Compressed Air, with Reference to Barking Power-Station Cable Tunnel under the River Thames.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—H. Parodi: The Electrification of the Paris-Orleans Railway.
ASSOCIATION OF MINING ELECTRICAL ENGINEERS (at Royal Technical College, Glasgow), at 7.—A. Dixon: Electrification of the Hodbarrow Iron Ore Mines.
ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. T. H. Somervell: On Temperature at High Altitudes. Meteorological Observations of the Mount Everest Expedition, 1924.—Dr. Vaughan Cornish: Observations of Wind Wave and Swell on the North Atlantic Ocean.—Commdr. L. G. Garbett: Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather.—Dr. J. Bartels: On the Determination of Minute Periodic Variations.
ROYAL MICROSCOPICAL SOCIETY, at 8.—F. Haynes: (*a*) A Note on a Rapid Method of Staining in Heidenhain's Hæmatoxylin; (*b*) A Note on an Improved Method of Preparation of Weigert's Elastin Stain.—Dr. A. Piney: The Principles of Hæmatological Differentiation.—Dr. R. S. Clay and T. H. Court: The Wilson Microscopes.
ROYAL SOCIETY OF ARTS, at 8.—J. E. Taylor: The Propagation of Electric Waves.
C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street), at 8.—R. B. Kerr: What Malthus said and what Malthusianism is To-day (Lecture).
INSTITUTE OF CHEMISTRY (London Section).
SOCIETY OF GLASS TECHNOLOGY (at Sheffield).

THURSDAY, FEBRUARY 18.

ROYAL SOCIETY, at 4.30.—Prof. A. Fowler: The Spectrum of Ionised Oxygen (O II).—Prof. W. A. Bone and F. R. Weston: New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part I.—Prof. W. A. Bone, R. P. Fraser, and D. M. Newitt: New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part II.—C. S. Beals: Quartet Terms in the Arc Spectrum of Copper.—*To be read in title only*:—J. H. Brinkworth: The Ratios of the Specific Heats of Nitrogen at Atmospheric Pressure and at Temperatures between 10° C and −183° C.—W. R. Dean: The Elastic Stability of a Corrugated Plate.—E. Newbery: The Controlling Factors of Transfer Resistance.
LINNEAN SOCIETY OF LONDON, at 5.—Prof. F. O. Bower: A Scheme of Phyletic Grouping of Ferns.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. L. Myres: Who were the Greeks? (3).
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Anthropological Institute), at 5.30.—H. J. Laski: The Idea of a Pluralistic State.
INSTITUTION OF ELECTRICAL ENGINEERS (jointly with the British Section of the French Society of Civil Engineers), at 6.—H. Parodi: The Electrification of the Paris-Orleans Railway.
INSTITUTION OF STRUCTURAL ENGINEERS (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—Prof. J. Husband: Transverse Bracing of Bridges.
INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry) (Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Open Meeting.
CHEMICAL SOCIETY, at 8.—J. H. Gardiner: The Ultra-violet Spectrum of the Rare Earths, Neodymium, Praseodymium, Samarium, Europium, Erbium, and Some Others.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. P. A. Buxton: The Depopulation of the New Hebrides and other Melanesian Islands.
LONDON CLINICAL SOCIETY (at London Temperance Hospital), at 8.45.—Sir Arbuthnot Lane: Is Civilisation a Failure?

FRIDAY, FEBRUARY 19.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Michael T. O'Dwyer: Religions and Races in the Punjab (Sir George Birdwood Memorial Lecture).
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. A. Pincy: The Importance of Hæmatology in Surgery.
BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Anthropological Institute), at 5.30.—Prof. T. H. Pear: The Nature of Intelligence and Intelligence Tests.
INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (West Midland District) (at Council House, Birmingham), at 5.30.—H. V. Overfield: Concrete in Modern Road Construction.
SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at University, Liverpool), at 6.—Dr. A. C. Cumming: Cane Sugar Refining.
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—E. G. Herbert: The Measurement of Cutting Temperatures.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Bell: Address.
PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Members' Evening.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. Reilly: Coal-cutting Machinery.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—P. G. Corin: Electricity applied to the Motor Car.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hon. J. W. Fortescue: George III. in his Papers.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Swansea).—E. A. Tyler: Some Notes on Pure Chemicals.

SATURDAY, FEBRUARY 20.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at National Institute of Industrial Psychology, 329 High Holborn), at 11.30.—Prof. Pear: What is meant by Skill in Industry.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. Macdonald: Roman Britain (1).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—G. Avenell: A Glance at Richard Jefferies (Lecture).
PHYSIOLOGICAL SOCIETY (at King's College).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Sea-Shells and their Makers.

MONDAY, FEBRUARY 15.

KING'S COLLEGE, at 5.30.—Dr. F. A. P. Aveling: The Human Will (5): Modern Views—Experimental Work.
DYERS' HALL (Dowgate Hill), at 6.—R. Fraser Thomson: Vat Dyes and Some Recent Developments.

TUESDAY, FEBRUARY 16.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: Philosophy and History (3): The Problem of Truth in History.
GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on February 17, 18, 19.)

WEDNESDAY, FEBRUARY 17.

UNIVERSITY OF LIVERPOOL, at 5.30.—Sir Frederick Mott: Heredity in relation to Mental Diseases and Mental Deficiency (Chadwick Lecture).
UNIVERSITY COLLEGE, at 5.30.—J. Haantjes: The Frisian Country, Language and Literature.

THURSDAY, FEBRUARY 18.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. B. Malinowski: The Aims of Social Anthropology.

FRIDAY, FEBRUARY 19.

KING'S COLLEGE, at 5.30.—Prof. R. Ruggles Gates: Vegetation on the Amazon. (Succeeding Lecture on February 26.)

SATURDAY, FEBRUARY 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Gordon V. Childe: Ancient Crete and the Myths of the Greeks.