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Problems of Immunity and Infection: the Filter-passing Viruses.

IN investigations on the effects produced in the body by invading micro-organisms, much attention has been directed towards an analysis of the defensive reactions of the former, but fewer observations have been made with regard to the offensive powers of the latter. Thus it is well known that the leucocytes or white cells of the blood, the wandering cells of the tissues, and certain of the endothelial cells lining the blood capillaries, are a part of the defensive mechanism of the body against bacteria or other particulate matter, which they ingest, and, if possible, destroy, whilst a further line of defence is represented by the different types of immune bodies which are present in the cells and tissue fluids or are developed therein in response to the invasion. The factors on which the infectivity, or virulence, of an organism depends are, however, less certainly understood, although variations in virulence quite apart from variations in the defensive powers of the host have been frequently observed. The "Report of the Medical Research Council for 1924–1925" lays stress on this aspect of the question, which has assumed considerable importance from the recent work of Gye and Barnard on cancer.

It has been known for some time that certain organisms are, by themselves, non-virulent: thus, the bacilli or spores of tetanus, or lockjaw, and those of gas gangrene, if thoroughly washed, produce no ill-effects on injection into the animal body. Gye and Cramer found that a minute quantity of a calcium salt, or of silica, both common constituents of the soil in which the organisms occur, injected along with them enabled them to act with their full virulence. A somewhat similar relationship was observed by Gye and Kettle with regard to the growth of the tubercle bacillus in the presence of silica, a relationship which is seen clinically in the association of pulmonary tuberculosis with silicosis in 'miners' phthisis.' It is of interest that some protozoa also seem to require the presence of some associated factor before they become virulent: thus, Dobell has found the *Entamœba histolytica*, the amœba responsible for one type of human dysentery, in the intestine of many people in Great Britain, yet the disease itself is very rare.

It will be recalled that the work of Gye and Barnard on cancer offers a very close analogy to the above-mentioned examples of the association of an organism with some 'specific' factor necessary for the development of the power of infectivity. The difficulty facing the hypothesis of the infective nature of cancer has always been the impossibility of transferring the tumour from one animal to another of a different species, and even in the case of animals of the same species,

transference is only possible with the living tumour cells. On the other hand, the microscopical appearances of a single variety of cancer in different species are the same, suggesting definitely a similarity of origin. The investigations of Gye and Barnard reconcile these two points of view by showing that the disease depends on the presence of a micro-organism acting in association with a 'specific' chemical factor.

Although usually the inoculation of an animal with a tumour only produces a growth when the living tumour cells are implanted, a few exceptions to this statement are known; thus, the Rous fowl sarcoma is caused by an agent which passes through the finest filters and has for long been believed to be a filter-passing micro-organism. Gye proved that this virus is actually corpuscular, since it can be shifted in fluids by the application of a centrifugal force and in pure culture, in the technique of which he was also successful, can be photographed by means of ultra-violet light by the method devised by Barnard. The presence or absence of the organism, determined experimentally by Gye, was confirmed microscopically by Barnard, thus increasing confidence in the results obtained by each author. But the greatest interest, perhaps, lies in the demonstration that the organism itself failed to produce any tumour when inoculated into fowls: it was only when an extract of tumour tissue in which there were no living organisms was inoculated together with the virus that a growth appeared. It was found on further work that the microbe could be obtained from other animals or tumours, but that the second non-living factor was 'specific,' in the sense that the type of tumour and its actual occurrence in an inoculated fowl depended upon the former's presence. The work suggests that the organism can only produce a tumour when the 'soil' is suitable for its growth: the many agents to which the origin of different cancers is ascribed, such as various irritants, may perhaps act by production of a favourable 'soil,' in other words, by causing the cells of the tissues to form, in the course of their, probably abnormal, metabolism, a chemical substance, which, in the present state of our knowledge, can only be described as the 'specific factor.'

The work of Gye and Barnard lends additional importance to investigations of the other filter-passing viruses and the diseases caused by them, among which may be mentioned canine distemper, 'sleepy sickness' (*Encephalitis lethargica*), herpes, vaccinia (cowpox) and variola (smallpox). That methods which are used for the investigation of the properties and effects of ordinary bacteria are applicable to the study of these viruses has been shown in the case of vaccinia and variola by Gordon. He has found that different samples of vaccine lymph obtained from calves and used in the vaccination of human beings against smallpox contain the same virus, and that the viruses from different smallpox epidemics tested against anti-vaccinia serum, all gave positive results. The fact that the immunity reactions given by this group of 'ultra-microscopic' organisms are similar to those given by the more common bacteria suggests that investigations on the other filter-passers, such as the viruses of cancer and canine distemper, can be undertaken with the hope of adding greatly to our knowledge concerning them. Work in connexion with the latter disease is being carried on in association with the *Field* Distemper Fund. It has been found that the disease can be transmitted to ferrets, which may thus be used for much of the experimental work; the virus is undoubtedly a filter-passer, although it has not yet been isolated or cultivated *in vitro*; the disease is extremely infectious, and it appears possible that the virus is air-borne, at any rate over short distances, necessitating adherence to a scrupulous technique on the part of all those concerned in the investigation.

Two further points may be very briefly considered. Although the chemical nature of Gye's 'specific factor' is quite unknown, there is no reason why further research should not throw light upon its general chemical properties, in the same way that recent work has brought an increased knowledge of the chemistry of the compounds involved in the immunity reactions of the body. Dudley and Laidlaw have obtained from tubercle bacilli a substance which forms precipitates in high dilutions with the serum of animals immunised against the whole protein constituents of the bacilli, although it will not itself evoke the production of such a serum. On analysis, the substance was found to be a complex carbohydrate of the nature of a gum, yielding pentoses and a more resistant nucleus on hydrolysis. Again, Hartley has shown that certain of the reactions between diphtheria toxin and antitoxin are caused by the ether-soluble constituents of the serum, whereas others occur independently of this fraction.

Finally, mention should be made of the question of treatment: the work on the filter-passing viruses having shown their close relationship with the microscopic bacteria, so far as the responses of the body are concerned, the outlook for a specific therapy is brighter than might otherwise have been the case. Meanwhile, the investigation of chemical compounds with a bactericidal action is being continued, especially in connexion with tuberculosis: both sanocrysin and certain oils have claimed the particular attention of numerous workers. An interesting point in connexion with the latter is the discovery by Griffith that the germicidal power of the oils is increased by exposure to the sun's rays, owing to chemical changes which they undergo in the light. One may recall the formation of the anti-rachitic vitamin

in similar circumstances, and the beneficial effects of sources of the fat-soluble vitamins in this disease.

The many points on which our knowledge of micro-organisms is advancing suggest a hopeful outlook with regard to the treatment of cancer and tuberculosis, two of the great scourges of mankind. Although a certain cure is not yet obtained, and may be still far distant, a cautious optimism with regard to the position appears to be justified.

Spitsbergen Papers.

Spitsbergen Papers. Vol. 1. Scientific Results of the First Oxford University Expedition to Spitsbergen (1921). Pp. xi+454+17 plates. (London: Oxford University Press, 1925.) 30*s.* net.

BRITISH tradition in Spitsbergen dates from Stuart times, when English sailors explored the coasts and fiords of that northern land. Later, Phipps, with whom was the midshipman destined to be Lord Nelson, and Lord Dufferin, added to our associations. Scientifically, however, the tradition is barely half a century old, Sir Martin Conway's expedition being virtually the first serious attempt of British men of science to grapple with the problems—geographical and geological—of Spitsbergen. Within the last few years, the exploration work of the late Dr. W. S. Bruce, the detailed geological investigations of the Scottish Spitsbergen Syndicate, and the results of the several Oxford University expeditions, have put the seal upon our interest and research.

The present work, which is the first volume of the results of the four Oxford expeditions and is devoted to the researches of the first (1921) party, consists of thirty-two reprints of papers, retaining the format and pagination of the scientific journals in which they originally appeared, with an appendix on Polyzoa and Tunicata which has not previously been published.

In the preface to the volume, the writer states that the original idea was that the expedition should be purely ornithological. Later, however, the personnel was increased to include representatives of the other natural sciences, with the result that the book contains articles on subjects ranging from rotifiers and lichens to topography, glaciology, and the courtship of birds. The party finally consisted of eighteen men under the leadership of the Rev. F. C. R. Jourdain, and with the title of the Oxford University Expedition to Spitsbergen.

The expedition consisted of two parties which spent almost three months in the archipelago, visiting Bear Island, Prince Charles Foreland, and the west coast of Spitsbergen generally, and Ice Fiord in particular. The scientific results obtained were published as soon as possible in the appropriate journals, so that specialists have already seen the results that most concern them.

The results may be divided into two groups: those which deal with topographical and geological work, and those concerned with the zoological and botanical observations made by the expedition. The former is represented by three papers of great interest. Mr. R. A. Frazer gives an account of the topographical work of the expedition, which was mainly in the nature of a reconnaissance and consisted principally of a sledge journey into the area north-east of Ice Fiord known as Garwoodland and New Friesland. In another paper Messrs. Huxley and Odell describe in detail the nature, and their theories of the formation, of the peculiar stone and fissure polygons and other surface markings seen so well in Spitsbergen. This paper is of special importance in view of the fact that it was only so recently as 1914 that Högbom, for the first time, put forward a feasible explanation of the phenomena. Mr. Slater's observations on the Nordenskiöld and neighbouring glaciers are also worthy of close study in view of the analogies (already noted by Garwood and Gregory) to be drawn between certain glacial phenomena in Spitsbergen and British drift deposits.

The biological papers are of exceptional interest from an ecological point of view. Spitsbergen occupies a peculiarly favoured position for such study, being a fairly accessible region for the explorer, yet sufficiently isolated to maintain a relatively simple fauna and flora. In addition, a great number of observations had already been recorded by other workers. Full advantage was taken by the Oxford Expedition of the opportunities thus afforded, as is evidenced by the published results. In a work of this kind, it is an invidious task to select papers of outstanding merit, but the "Contributions to the Ecology of Spitsbergen and Bear Island" by Messrs. Summerhayes and Elton is one of the most striking contributions yet made to Arctic biology. In this paper the authors describe the plant and animal communities of part of Bear Island and Spitsbergen (Prince Charles Foreland, Cape Boheman, and various parts of Ice Fiord). The succession of plant communities is traced, a noteworthy feature being the relative abundance of cryptogams, especially Bryophyta. The proportion of this group is particularly high upon the maritime coasts, which is no doubt due to the increase in humidity. The number of species, both plant and animal, is small, the severity of climatic conditions, geographical isolation, and the absence of distinct night and day being the chief factors held responsible. In addition, the authors give a sketch of the food cycle in Bear Island.

The remainder of the papers, apart from a few on ecological problems, are devoted to additions to systematic zoology and botany.

The volume, since it unites a somewhat scattered

literature, will prove useful to libraries, universities, and other institutions, besides appealing to the ever-increasing number to whom Spitsbergen is more than a geographical name. The absence of an index in a work like this is of no real importance, but one hopes that the printers, not the authors, are responsible for the occasional lapses in the spelling of geographical names and for the 'die-hard' form "Spitzbergen," which once or twice makes its way into the text.

The results of the further Oxford expeditions will appear as the second volume of these papers, while other results, notably ornithological, will appear in book form. Perhaps one can say nothing better for the present part than that one looks forward with interest to the arrival of these future works. In the preface, the committee expresses the hope that other young scientific workers may have equal opportunities for similar experience. All who read these results will heartily echo this wish. Few countries offer so much of value for the young natural historian as Spitsbergen, and the work of the Oxford expeditions will prove an admirable guide. W. E. SWINTON.

Products from Coal.

The Industrial Applications of Coal-Tar Products. By H. M. Bunbury and A. Davidson. Pp. xi+284. (London: Ernest Benn, Ltd., 1925.) 42*s*. net.

THE numerous products obtained from coal-tar are ever increasing in importance, not so much, perhaps, because of the isolation of new substances or new derivatives of the older materials recognised as being present therein, but more by reason of the utilisation of compounds hitherto known to be present, which have previously found no industrial application. In the preface to the book under review, the authors direct attention to the fact that no commercial use has yet been found for phenanthrene and fluorene, and it is indeed remarkable that this should be the case when it is remembered that phenanthrene is the basis of some of our most important natural alkaloids. Nevertheless, the other side of the picture tells a different story, and there can be no question that in the near future use will be found for these hydrocarbons just as use has now been found for such substances as acenaphthene and carbazole, compounds at one time regarded as laboratory rarities.

The materials required by the chief users of the coal-tar products, the fine chemical industry and the dyestuffs industry, are steadily advancing in complexity and intricacy, because the competition between the various interests leads to the production of new compounds possessing some small advantage over the older ones which enables them to compete successfully in the world's markets. It does not necessarily follow that complexity of structure implies commercial advantage, because some of the simpler products—for example, aniline black—still retain their places among the foremost of the dyes in use. But when the field of choice is so wide and the number of products so great, research will always find some particular substance which has special industrial advantages leading to a demand for its production, and the manufacturer is often prepared to meet this demand even though it entails a financial loss.

The progress of the dyestuffs industry, which is based on the products from coal-tar and the "intermediates" derived from them, is indicated by well-defined steps, each involving the utilisation of a new series of products. The initial production of the triphenylmethane dyes found employment for the coal-tar bases aniline, the toluidines, and so forth. The introduction of the substantive cotton dyes provided a use for naphthalene and the sulphonic acids of the naphthols and naphthylamines. The production of synthetic alizarine brought in anthracene and the tremendous step in advance made when Bohn discovered indanthrene provided a use for a variety of products hitherto either unknown or not utilised. Without question, the development of the industry depends on the production of new and suitable intermediate products or the preparation of old "intermediates" in a new and more economical manner, and it would seem that we are now about to enter a new era in this connexion which may affect our existing conditions of manufacture, because it entails a completely new kind of chemical technique.

The successful production of methyl alcohol (methanol) provides the "writing on the wall" and indicates the direction synthetic organic chemistry will take in the future. Every manufacturer interested in organic chemical reactions, and every organic research chemist, should keep the phrase "reactions at high temperatures and pressures in the presence of a catalyst" always before him, because we as a nation must not be behindhand in the new development.

The book under review is a well-thought-out attempt to group the industrially important material among the dyestuffs, explosives, and so forth, under the head of the industrial parent substance. The method is a good one, and enables the reader to find with little trouble any substance concerning which he may require information. The use of charts wherever possible facilitates reference and helps the reader to see at once the relationship between the various derivatives of some single parent substance. For example, Chart v. on pp. 116 and 117 gives a very clear and concise picture of the derivatives of naphthalene. The book is well printed, and the formulæ are clear and not too elaborate. It should find a place on the shelves of all those who are interested in the subject with which it deals. J. F. T.

South American Pit-Vipers.

A General Consideration of Snake Poisoning and Observations on Neotropical Pit-Vipers. By Afranio Do Amaral. (Contributions from the Harvard Institute for Tropical Biology and Medicine, 2.) Pp. vi+64+16 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1925.) 10*s.* 6*d.* net.

THE work under notice is a collection of four papers on the classification of the South American pit-vipers, prefaced by an essay on snake poisoning in general. In the preface, the nature of the poisons of the principal venomous snakes, their complexity, their action, the quantity of venom ejected, the symptoms seen in victims bitten by serpents of different kinds, and the serum treatment of snake bite is all surveyed in 20 pages. The materials for this survey have been selected with discretion, the information is accurate, and it forms a useful introduction to the subject of snake poisoning, but has no particular relation to the four short papers which follow it.

Of the serum treatment of snake poisoning, the author has had first-hand experience at the Butantan Institute at Sao Paulo, where he has been an assistant for some years. The Butantan Institute is the only place where the serum treatment of snake poisoning has been thoroughly exploited, first by Vital Brazil and latterly by Gomes. Here four classes of serums—anti-crotalic, anti-micrurus, polyvalent anti-bothropic, and polyvalent anti-ophidic—are manufactured and issued in concentrated form. Snake poisons are highly specific, and a serum produced against one species of snake is generally of little use against another, although some amount of overlapping occurs. Polyvalent sera are, therefore, necessary for treatment, as the particular species of serpent responsible for the bite cannot usually be identified and there is no time to spare, if the treatment is to be effectual.

As with poisoning by bacterial toxins, early administration of serum is essential. We do not agree with Dr. Amaral that the dosage and method of administration should be adapted to the "estimated" quantity of poison inoculated. We believe this to be dangerous advice, and that a full dose should be administered as soon as possible after the accident and by the intravenous route. If this is impracticable, the serum should be injected deeply into the muscles of the buttock. Anti-serum is but slowly absorbed from the subcutaneous tissue, and is at least twenty-five times as effective when injected directly into the circulation. Unfortunately, intravenous injection is rarely possible until some time afterwards, as the doctor is not usually present at the time of the accident. Notwithstanding all the disadvantages pertaining to the treatment of snake poisoning, the results in Brazil have been very encouraging.

The value of the preface would have been increased if a short bibliography had been attached to indicate to the serious student where the literature on snake poison may be found. Should such a one read this review, he may be glad to know that it is completely reviewed in vol. 2 of Marie Phisalix's wonderful book, "Animaux venimeux et venins" (Paris: Masson et Cie, 1922).

The four systematic papers contain a reasoned criticism of the present classification of the commoner pit-vipers and suggestions for their better arrangement, based upon the examination of upwards of 6000 living specimens of all ages. It may seem strange that one individual has had such a wealth of material at his disposal. This is explained by Dr. Amaral's connexion with the serum institute at Butantan, Brazil. Quantities of living snakes are procured by the Institute to supply venom for the immunisation of horses, and many are also sent for identification in order that the victim of snake bite may receive the appropriate anti-venom.

A re-examination of the classification of these South American vipers will be welcomed by herpetologists and others interested in their identification, as at present there is some confusion. The wealth of synonyms, too, is bewildering. In the British Museum catalogue of snakes, under *Lachesis lanceolatus*, there appear more than thirty synonyms. Dr. Boulenger, who is responsible for the catalogue, does, indeed, suggest that, under this designation, two or three different species may be confounded. In the opinion of Dr. Amaral, much of the confusion is due to the fact that European herpetologists have generally had only spirit specimens at their disposal, which had lost their colour, and have not had means of differentiating young from old snakes. As he shows in the second article in the book under review, "On the Evolution of Dorsal Markings," the pattern at different ages varies so greatly in some species, *e.g. Bothrops jararacussu*, that it might be supposed that one was dealing with different species.

The principal paper in the series is on the differentiation of the species *Bothrops atrox*, *B. jararaca*, and *B. jararacussu*. The author concludes that "echis" of most of the Spanish-American countries, the "fer-de-lance" of Martinique, the "barcin" of Trinidad, and the "caissaca" of Brazil are all one species, *Bothrops atrox* (Linné). The "jararaca" of Brazil and the "yarara" of the Argentine he found to be *B. jararaca* (Wied), and the "jararacussu" of Brazil and the "yararaguassu" of Argentine, Paraguay, and Bolivia to be *B. jararacussu* (Lacerda). He prefers the generic term "Bothrops" to that of "Lachesis," on

the ground that this name was the first used, namely, by Linné so long ago as 1758. The three species differ in their habits of life. *B. atrox* prefers humid, wooded, and rocky places, and feeds on small rodents. *B. jararaca* prefers the open and is commonly encountered in hay-fields. It also devours small rodents. *B. jararacussu* is amphibious and feeds almost exclusively on batrachians. Their poisons are different. These three species are described in detail. The last of the series of papers deals with *Bothrops Neuwiedii*, which Dr. Amaral proposes to divide into four subspecies, on the ground of the fixity of their chromatic characters. Here he would appear to be on uncertain ground. The characteristics on which the proposed subdivision is based are associated with the habitat of the snakes, and there is no evidence that if they were translated from one locality to another the supposed fixity would be maintained.

The papers are accompanied by excellent plates. The coloured pictures of *B. atrox*, *B. jararaca*, and *B. jararacussu*, drawn from life, are beautiful.

C. J. M.

The Newcomen Society.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 4, 1923–1924. Pp. xii + 153 + 21 plates. (London: Secretary, Newcomen Society, Science Museum, 1925.) 20*s*.

THIS latest volume of *Transactions of the Newcomen Society* is one of wide interest. The subjects dealt with range from chain pumps of the seventh century to the earliest locomotives in America; from the dynamics of Leonardo da Vinci to the bibliography of the history of engineering and applied science. As a frontispiece there is a reproduction of the earliest known print of a Newcomen engine. This print is not only the earliest drawing, but also the earliest document of any kind known showing the construction of the engine. The original by Henry Beighton was only recently discovered in the Library of Worcester College, Oxford, by Mr. L. de M. Johnson, of the Oxford University Press. Though in the *Transactions* the drawing has had to be folded, copies can be obtained unfolded, and we think this historical drawing should be exhibited wherever mechanical engineering is taught.

The philosophical view of the work of the Society is well stated in the presidential address of Mr. Loughnan St. L. Pendred, while the biographical side is illustrated by a paper on the Rastricks—a family in which engineering skill was in some degree inherited. John U. Rastrick was a contemporary of George Stephenson, and his best memorial is the London and Brighton Railway.

Just as it is the aim of the Newcomen Society to further the study of the history of engineering and technology, so it was one of the objects of the Royal Society in its earliest years to collect and chronicle a history of the minor arts and trades. In his diary of January 16, 1660, John Evelyn wrote: "I went to the Philosophic Club where was examined the Torricellian experiment. I presented my circle of Mechanical Trades"; and in Dr. Birch's History of the Royal Society is an entry of the same date: "The Catalogue of Trades brought in by Mr. Evelyn and that of Dr. Petty were referred to them and Dr. Merret to be compared, methodised and returned to the Society." Evelyn's "Circle" has been preserved, and with a prefatory note by Mr. Forbes Sieveking is reproduced in this volume.

Two very different aspects of the iron industry in England are given in Mr. Rhys Jenkins' "Sketch of the Industrial History of the Coalbrookdale District," and in Mr. W. A. Young's paper, "Works Organisation in the 17th Century: some account of Ambrose and John Crowley." Iron founding has been carried out in the Coalbrookdale district for centuries, and here the problem of smelting iron with coke was solved, cast-iron tram lines first used, the first cast-iron bridge erected, and some of the cast-iron cylinders made for Watt's engines. The blast furnace made its appearance in Shropshire about the middle of the sixteenth century, and from 1707 until 1791 the three Abraham Darbys in succession reigned over the Coalbrookdale works.

The Crowleys began as ironmongers in Greenwich and in London, and then became manufacturers of hardware in Durham. The firm was in existence for 170 years, and the picture of the works at Winlaton, where edge tools, files, anchors, nails, spades, etc., were made in very large quantities, is one of a community somewhat resembling that of a great religious house. Innumerable rules were laid down to encourage and admonish, courts of arbitration met at stated intervals, the children were educated, the sick doctored, and the infirm pensioned. Working hours were from five in the morning until eight at night, and curfew rang at nine o'clock. The instructions went so far as to provide for the assistance of those who, by reason of "folly, weakness or extravagance," have had recourse to the pawn shop. Sir Ambrose Crowley died in 1713, a very wealthy man. He had been an alderman and sheriff of the City of London, but Mr. Young's paper shows that he is entitled to be considered the pioneer of industrial welfare work. He made a very remarkable experiment, and the principles laid down by him sufficed for guidance for more than a century.

Our Bookshelf.

The Rigid Airship: a Treatise on the Design and Performance. (The Specialists' Series.) By E. H. Lewitt. Pp. x+283. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 30*s.* net.

THE airship in aeronautical text-book literature has received but scant attention in the past. Aeroplane and seaplane design and the theoretical problems associated with them compose the subject matter of such works, while airships are dismissed in a few meagre paragraphs under the general heading of "lighter-than-air craft." There is no special reason for this other than that the airship has almost consistently been regarded as the step-child of officialdom and certainly not to be encouraged by any consistent policy of construction and development. Yet, regarded as a scientific problem, the design of the rigid airship, as the present work proves, presents a problem in a type of structure which has not previously occurred in engineering and consequently gives rise to a crop of fresh problems both on the aerodynamic and the structural sides.

The present work is confined to the question of design on the structural side. The earlier chapters analyse the forces on the airship in so far as they affect this question. The types of girders and struts used and the elastic properties of which they are composed are described in Chap. iv. The next two chapters treat of the beam stresses and the temperature stresses in the hull. The author then passes on to consider the tensions in the wiring—transverse, circumferential, and diagonal—and the longitudinal girders. The treatment is completed by a discussion of performance and a detailed analysis of design in a special case.

The author has throughout adopted the sound method of approaching each problem mathematically and comparing the results so obtained with actual experiment. In this respect the treatment is excellent. If a criticism might be offered, it is that the author has tended to keep rather closely to the methods developed in his own contributions to the subject, so that the work of other investigators is scarcely accorded sufficient prominence; otherwise a most satisfying book.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated "The Year Book of Photography and Amateurs' Guide" and "The Photographic Annual," 1926. Edited by George E. Brown. Pp. 848+32 plates. (London: Henry Greenwood and Co., Ltd., 1926.) 2*s.* net.

As this is the diamond jubilee issue of this well-known publication, the editor has considered it a suitable time to make several improvements in it, though a cursory glance shows that it is similar to previous issues in the general nature and arrangement of its contents. There are three notable changes in addition to the use of a rather clearer type. It is no longer an almanac except in title, for it contains nothing of the nature of an almanac or calendar. What was originally subsidiary matter has increased so much that the volume is now a general practical guide and record of progress, and in due time, we suppose, the main title will indicate this. For many years a substantial part of the matter other than the advertisements was a collection of short articles from many contributors giving their experiences and suggestions. This section served its purpose at the time, but changing circumstances rendered it advisable to discontinue it. This year there is tendency to return to it; but the five articles are rather of the review or generally instructive character than of a personal nature. The history of the "Almanac," with a reproduction of the first, which was a wall sheet calendar with a few useful items of information in the margins, is of value from a historical point of view. The editor on "Amateur Cinematography," Mr. T. L. J. Bentley on the use of a hand-camera, and Mr. J. W. Purkis on "Rational Time Development" are authoritative articles on matters of present-day interest. As a celebration of the jubilee the volume includes thirty-two excellent photogravure reproductions, twenty-five of which are from the Paris Salon of Photography.

Electrical-Machinery Erection. By Terrell Croft. Pp. ix+314. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s.* net.

MR. CROFT is concerned with the mechanical features of electrical machinery installation. The average young engineer when he has finished his college training knows little of the mechanical operations that have to be performed between the unloading, for example, of a heavy motor generator set, from the car to its final fixing and aligning in its operating position. As a rule, he allows himself to be guided by the foreman, who generally does everything by a cut-and-dried method. The methods of arranging the slings and of bracing the apparatus prior to lifting he learns from the workmen. The methods learnt in this way are unsuitable in certain cases, and the young engineer is too often thrown on his own resources, sometimes with unfortunate results. We therefore welcome this book, as it should prove useful to every engineer engaged in erecting work. There are 334 excellent illustrations, showing not only the correct methods, but also commonly used incorrect methods, of performing necessary mechanical operations. A section of the work is devoted to "mechanical maintenance," particular attention being devoted to the upkeep of the bearings.

The Dynamical Theory of Gases. By Dr. J. H. Jeans. Fourth edition. Pp. vii + 444. (Cambridge: At the University Press, 1925.) 30*s.* net.

THE intervals at which new editions of this valuable treatise are called for grow shorter, testifying to the continued—in fact, growing—interest of students and investigators in the subject, and to the importance of the service rendered by the author in presenting it so admirably. The second edition, of 1916, was different in important respects from the original work of 1904, the quantum theory having in the interval offered a way of escape from the difficulties surrounding the theorem of equipartition of energy. In the third edition, of 1921, the account of the quantum theory was extended. In the present issue a few recent papers on the kinetic theory are duly remarked on, either in the text or in footnotes, but no important changes are made.

Letters to the Editor.

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The Law of Inertia for Radiating Masses.

RADIATION of amount δE, lost by a body, diminishes its effective mass, on Maxwellian principles, by $\delta E/c^2$: and some perplexity is apparent in recent discussion as to how this tells on the dynamical inertia of a planetary mass. According to the Newtonian doctrine, it is the rate of change of momentum mv which must be equated to the extraneous gravitational or electric force acting on the body: and this principle was taken over by Einstein, in extended fourfold form and in concert with relativity, as the key to his brilliant tentative explorations towards a closer view of gravitation. But

$$\frac{d}{dt}(mv) = m\frac{dv}{dt} + v\frac{dm}{dt};$$

so that if the mass is diminishing by radiation, conservation of momentum seems to demand acceleration of velocity of a body isolated and so free from external force. Yet the doctrine of relativity asserts that no standard can exist on which to measure such change of velocity, whether of translation or rotation: such a conclusion therefore would contradict relativity. On this ground it is claimed that the applied force must be equated, following Dr. Jeans, to $m\frac{dv}{dt}$ and not to $\frac{d}{dt}(mv)$. Yet the latter form is based directly on a very keystone of relativity. One way out of the apparent paradox would be to postulate a frame in the ether with reference to which the velocity of an isolated body could be measured: this would institute an exception to accepted doctrine widely verified. Prof. E. W. Brown (*Proc. U.S. National Academy*, 1926, p. 2) appears to be troubled, and naturally so, by uncertainty as to which formula to adopt with a view to studies on cumulative long-range effects of radiation in dynamical astronomy.

It seems well worth while, in this connexion, to direct attention to a classical memoir by the late Prof. Poynting (*Phil. Trans.*, 1903) on "Radiation in the Solar System" and to his other investigations, theoretical and experimental, on pressure of radiation, in which astronomical effects are considered. In particular, he revealed (by indirect argument) what amounts to the Bradley aberration effect in pressure of extraneous radiation on a moving body: and he showed that it produces a retarding force that would in times quite short geologically suck all small bodies such as cosmical dust revolving steadily round the sun, into that luminary. This is doubtless the explanation, as he remarked, why the celestial spaces are so transparent. Incidentally it may perhaps require that the cosmic dust that reflects the zodiacal light should have some source of replenishment.

This, however, is not directly connected with the inertia question. But in the reprint of Poynting's "Collected Papers" (Cambridge University Press, 1920), the question of the effect of diminution of inertia by radiation had to be gone into, in the notes and corrections then appended to the work, as on the face of things it may be quite comparable in importance (for large masses) to the deflexion of the radiation pressure by aberration. The explanation proceeds on the principles of Maxwell's great "Treatise" of 1873, without any reference to relativity. It is in effect verified (pp. 434, 754-7, referring back to "Math. Congress Report," Cambridge, 1912) that the momentum of the whole system, matter *plus* radiation, is conserved, as it ought to be, in the absence of any extraneous force; but a part of its gradient equal to $v\frac{dm}{dt}$, where $\delta m = -\delta E/c^2$, is momentum carried away by the radiation δE issuing from the system, by the mechanism of radiation pressure, while it is the remainder $m\frac{dv}{dt}$ that is to be equated to the extraneous force, which acts on the material system itself, not on the radiation that has escaped from it.

This seems to be the adequate practical settlement of this question, and may, it is hoped, encourage Prof. Brown to proceed with closer astronomical investigations in improvement of Poynting's pioneer indications: though how far it consorts with an extreme relativist position is a different question. But Poynting's retardation by the aberration influence on pressure of radiation will also have to be taken into account in the cosmical problem of the evolution of the orbits of a double star, as probably of the same degree of importance as change of effective mass by loss of radiant energy.

In Poynting's own special problem there is no change of mass (other than that involved in high velocity in accordance with Least Action), as the loss by radiation is made good by absorption from the sun.

JOSEPH LARMOR.

Cambridge, February 9.

The Structure of Molecules.

WITHIN the past few months there have appeared several papers on band spectra containing results of great theoretical significance. Taken in connexion with the data given in my letter to NATURE of February 13, p. 229, on the energy levels of the carbon monoxide molecule, they appear to indicate a comprehensive analogy between the electronic energy levels of molecules and of atoms. The additional evidence furnished by the rotation and vibration of molecules then makes possible conclusions as to the actual paths of the valence electrons in molecules, and these results may in turn be used as evidence as to the structure of atoms.

Some of the investigations leading up to this situation are as follows. Mulliken (*Phys. Rev.*, 26, 561, 1925) has shown clearly the existence of two types of multiplicity in the band spectra given by diatomic molecules. One type is essentially a function of the rotation of the two nuclei about their common centre of gravity, and has no counterpart in atomic structure. It is not concerned in the present discussion. The other type is essentially independent of rotation and of vibration, and, as Mulliken has pointed out, leads to multiple electronic energy levels in the molecule which may be correlated with the multiple levels of atoms. Thus in the "odd" molecules CO^+, BO, CN, and NO, there is a double level which may be designated as a double "p" level. Mulliken (*Phys. Rev.*, 26, 1, 1925) has found such a double level also in the alkaline earth halides, and has noted that the doublet separation is of the same order of magnitude as in a certain "corresponding" atom, having the same number of valence electrons. Mecke (*Naturwiss.*, 13, 698 and 755, 1925) independently pointed out certain analogies between BO, CO^+, CN, and N_2^+, and investigated also the alkaline earth

halides. For these latter he applied the Landé formula for the doublet separation in the alkalies, and thus obtained an "effective quantum number," and an "effective nuclear charge," for the orbit of the valence electron of the molecule. The result indicated considerable "penetration" of the electron. Hulthén (NATURE, 116, 642, 1925) found doublet separations in HgH, CdH, and ZnH, which are of the same order of magnitude as a certain p separation in Hg, Cd, and Zn.

In the present communication I am considering particularly diatomic molecules with two atoms of more or less equal mass, such as CO, CO^+, N_2, N_2^+, NO, CN, and BO. For such molecules Mulliken has assumed that each atom retains its own K electrons, but that the remaining electrons are held in common by the two atoms, and may have much the same arrangement as in atoms. In the above molecules there are thus eight electrons with a rare gas configuration, plus one, or two, or three "valence" electrons, and the molecular structure is to be compared with one-, or two-, or three-valent atoms. In CO^+, CN, and BO there are, in addition to the double p level, two single electronic levels, one above and the other below the p level, and Mulliken suggested that they might be called s levels. This suggestion resulted from an analysis of the character of the band systems associated with the s-p, s-s, and p-s transitions. (The reader is reminded that an entire system or group of bands corresponds to an electron transition between two major electronic levels, and hence to a single "line" or, more generally, to a single "multiplet" of atomic spectra. All three of the transitions just noted are known in CO^+ and BO, with the s-s transition giving the strongest band system. See Birge, NATURE, 116, 207, 1925, and Mulliken, *Phys. Rev.*, 25, 259, 1925.)

Let us now consider the actual "term" values of the electronic energy levels of molecules, defined just as in the case of atoms as proportional to the work required to carry the valence electron from the level in question to infinity. There are as yet but little data for such calculations, accurate values of the ionisation potential of molecules being especially scarce. CO, N_2, and H_2 are, however, three sources of possible information. The designation of successive levels as X, A, B, C, X', A', etc., as used in my letter on carbon monoxide, is retained here.

Using X'-X in carbon monoxide as 14·2 volts, as discussed in this letter, and writing $\nu = R/D^2$, where R is the usual Rydberg constant, and D the "denominator" of the term ν, one obtains for the X, A, and B levels, values of D of 0·98, 1·48, and 1·97. In this case all three terms are single, and since carbon monoxide should "correspond" to magnesium, the results immediately indicate that these energy levels are really the $1S$, $1P$, and $2S$ levels of the molecule, where $1S$ and $2S$ fit into a *Rydberg formula*. Sponer (*Zeit. f. Phys.*, 34, 622, 1925) has noted from my diagram of the energy levels of N_2 (NATURE, 114, 642, 1924) that A, C, and D fit a Ritz formula, giving very closely the observed value of the ionisation potential. I now find that A is a triple level of spacing approximately 20 and 42. The spacing of the $1p_{123}$ level of the "corresponding" atom Mg is 41 and 20. The C level of N_2 is undoubtedly triple, with intervals roughly of two units. The $2p_{123}$ level of Mg has a spacing probably of 4 and 2. For the $1p_{123}$ level in N_2 the order of spacing is inverted, as compared to that for the atom, and Mulliken has noted, from the relative intensities in the molecular double p level, that it also is "inverted."

In the helium molecule it has long been known that there is a set of electronic energy levels given by the ordinary Rydberg formula (Fowler, *Proc. Roy. Soc.*, A, 91, 208, 1915; see also Curtis and Long, *ibid.* 108, 513, 1925), and in the hydrogen molecule there is a similar set of levels, running to the limit 16·68 volts, which is a reasonable value of the ionisation potential of H_2. This interpretation of the Olson and Glockler results (*Proc. Nat. Acad. Sci.*, 9, 122, 1923) is due to Olson (see Urey, *Proc. Nat. Acad. Sci.*, 11, 618, 1925). Hence in *all* molecules where data are available, we find series of energy levels fitting at least approximately into the customary formulæ of *line spectra*. It therefore seems to me that the time has come to make the following generalisation, which is admittedly based on data only for a few diatomic molecules, confined to definite types.

The energy levels associated with the valence electrons of molecules agree in all essential aspects with those associated with the valence electrons of atoms. The molecular levels may be designated s, p, etc., and levels of the same letter-designation may be represented by the usual formulæ of line spectra, and have the same multiplicity as in the case of corresponding atoms. The actual spacing in the multiple levels is often roughly the same as for the "corresponding" atom. Further examples of this are: for $1p_{12}$ of CO^+, 126, as compared to 91·5 for Mg^+; for the *stable* $1p_{12}$ level of NO, 135, and for the corresponding atom Al, 112. This interpretation of Dr. Sponer's energy levels of NO (NATURE, January 16, p. 81) is due to Mulliken (private communication). In other cases there is no numerical agreement, as in the $1p_{12}$ level of CN and BO ($\Delta\nu = 54$ and 126, compared to 17 for Na). Further points of difference between atoms and molecules are: (1) the multiple molecular levels are "inverted"; (2) s to s transitions in molecules are not only not prohibited, but are especially prominent.

If now the systems of energy levels of the molecule and of a "corresponding" atom are essentially similar, the electronic structure responsible for the two systems must also be essentially similar, as already suggested by Mulliken and by Mecke. But the band spectra data give additional direct evidence as to the character of this structure. Thus in the molecules CO, CO^+, NO, CN, and BO, the frequency of vibration of the dipole for the p state is always *less*, and consequently (from a known invariable relation) the moment of inertia *greater*, than for the s state above as well as below it. Now in an atom, according to current theory, the "penetration" of the electron in the s orbits is greater than in the p orbits. If then the valence electron (or electrons) of the molecules here considered moves in an elongated path which penetrates to the region *between* the two nuclei, the greater penetration of the s orbit would lessen the repulsion of the two nuclei and thus produce a smaller moment of inertia. This gives a picture of the valence electron as one moving in a path which projects beyond those of other electrons, and so gives this electron its valence character, but also penetrates the region between the two nuclei and so plays a definite rôle in determining the strength of the chemical bond. I think that band spectra can thus give evidence as to the character of electronic orbits, the mere existence of which some investigators still seem to doubt.

The above conclusions allow a rough computation of the ionisation potential of CO^+, N_2^+, and similar "odd" molecules, and the results raise many interesting points for which there is no space in the present communication. In particular, the *total* work to remove *both* valence electrons from CO or from N_2 is equal, within the large limits of error, to that

required to remove both electrons from Mg, but the work necessary for the removal of the first electron (and consequently for the second) in the case of the molecules is quite different from that for the atom. So far as I can see now, none of the results are inherently unreasonable or in conflict with the present experimental data, and I hope to consider them in detail in the full report of this work.

I have had the benefit of consultation with the many persons in this University who are interested in these problems, and also of much correspondence with Dr. Mulliken. I am especially indebted to Dr. Sponer and to Dr. Mulliken for helpful suggestions.

RAYMOND T. BIRGE.

University of California,
December 19, 1925.

Effects of Polarised Light on Bacterial Growth.

DURING recent years certain biochemical effects of polarised light as compared with ordinary light have been brought into prominence by Dr. Elizabeth Sidney Semmens (*Journ. Soc. Chem. Ind.*, 42, 954, 1923; also *Bri. Assoc. Rep.*, 1923). She has shown that the hydrolysis of starch proceeds with greater rapidity in polarised light than in ordinary light of the same intensity, all other conditions being identical.

In biological studies of bacteria specially with reference to their pathological and epidemiological significance, heat and various other physical conditions such as humidity, etc., have been put up as factors of fundamental importance. So far as the authors are aware, however, very little attention has been paid to the effects on these aspects of bacterial life of the variations of luminous radiations in Nature. The amount of polarisation of light, as is well known, being subject to marked variations not only from season to season and country to country but also during different parts of the day and night, it occurred to the authors to investigate as to how the bacteria would react to polarised light.

So far preliminary experiments on the growth of *V. Cholerœ* and *B. typhosis* (strains obtained from Kasauli) have been tried. The results obtained were so interesting that it was considered desirable to communicate them without delay.

Emulsions of young *V. Cholerœ* and *B. typhosis* cultures in Dunham's solution and nutrient broth respectively were prepared and thoroughly shaken in a mechanical shaker. Equal amounts of the uniform emulsions so obtained were exposed for a definite period to polarised and unpolarised light of equal intensity in two compartments of a sterilised optically correct cell ordinarily used with a Rayleigh interference refractometer manufactured by Messrs. Adam Hilger. The source of light for both the polarised and the unpolarised beams was a hundred-candle-power half-watt lamp from which two beams of light were obtained by means of a parallelising device. The polarisation of one beam was effected by interposing a Nicol prism in its path, and the intensities of the two beams were equalised by means of glass plates. To test the intensities of the two beams of light, the deflexions produced in a Broca's galvanometer were compared when a Rubens linear thermopile connected to the galvanometer was placed at equal distances in their paths.

The difference in the turbidity of the two compartments after exposure was taken as an index of the difference in their bacterial content. The turbidities were determined by exposing the two compartments successively to a standard source of light (6-volt half-watt Mazda lamp) for half a minute and measuring the intensities of the light, after passing through the cell, by means of the thermopile and Broca galvanometer arrangements described above. The results so obtained were confirmed by plating out 0·5 cc. of the contents of the two compartments on agar and counting the number of colonies in the two cases after forty-eight hours' incubation at 37° C.

Some of the results are shown in the table below. The observations were made at room temperature.

Type of Organism.	Duration of Exposure.	Deflexions of the Galvanometer.		Colonies on Agar.
		Compartment exposed to polarised light.	Compartment exposed to unpolarised light.	
V. Cholerœ. 24 hours' growth on agar emulsified in Dunham's solution . .	2 hours	0·80 cm.	1·10 cm.	
Do.	14 ,,	0·90 ,,	2·60 ,,	
B. typhosis. 24 hours' growth in broth . .	5½ ,,	0·80 ,,	1·15 ,,	Innumerable in both. Distinctly larger number in the case of the compartment exposed to polarised light.
Do.	21 ,,	0·70 ,,	1·25 ,,	

These results suggest that the polarised light favours bacterial life as compared with ordinary light of equal intensity.

What rôle the reactions of polarised light on the binomics of the bacteria—free in Nature, in water and in the body of the carrier—play in the mechanism of their pathogenicity and epidemicity seems to involve large issues and is a subject worthy of consideration. It also suggests problems regarding the reactions of polarised light on the physiological and pathological processes in the body of the host which may throw some light on questions such as the afternoon rise of temperature in normal individuals and in certain fevers. Work on some of these problems is in progress.

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The Nature of Active Nitrogen.

LE problème de l'azote actif a donné lieu récemment à un certain nombre de travaux. Dans un article récent (*Zeitsch. f. Phy.*, 34, 622, 1925) Dr. Sponer reprenant les premières idées de Strutt, émet l'hypothèse que l'azote actif est de l'azote atomique (voir aussi R. T. Birge, NATURE, 117, 81, 1926).

J'ai déjà montré (*C.R.*, 178, 1966, 1924.—Thèse, Paris, 1925, ou *Ann. de Phy.*, sept. 1925) que cette explication des propriétés chimiques et physiques de l'azote actif est la plus simple et la plus logique. Il semble qu'une seule difficulté fasse hésiter les spectroscopistes à admettre l'hypothèse atomique. Au cours de l'activation et de la neutralisation, l'azote n'émet que des spectres de bandes à l'exclusion de tout spectre de raies. Or il est généralement admis que les spectres de bandes ne peuvent être émis que par des molécules polyatomiques. La présence d'atomes dans l'azote actif paraît, dans ces conditions, assez peu vraisemblable. Ainsi s'explique que plusieurs physiciens, à la suite de Saha et Sur (*Phil. Mag.*, 48, 431, 1924) n'aient voulu voir dans l'activation de l'azote qu'une transformation, sans dissociation, de la molécule diatomique en une forme métastable de niveau énergétique élevé.

Or des mesures précises de largeurs de raies faites par Hamy (*C.R.*, 157, 142, 1913) et par moi (*C.R.*, 178, 474, 1924, et *loc. cit.*) ont montré que, si le premier groupe positif de l'azote est effectivement émis par la molécule diatomique de masse 28, le 2e groupe positif et le groupe négatif de l'azote sont certainement émis par l'atome de masse 14. Le 2e groupe positif est précisément celui qui prédomine dans la décharge électrique où l'azote est activé. Je sais que cette attribution de spectres de bandes à des atomes paraît scandaleuse à la plupart des spectroscopistes, mais, dans le cas particulier du 2e groupe positif de l'azote, elle s'accorde avec la plupart des propriétés de ce spectre.

Elle s'accorde avec l'ordre d'apparition des différents groupes de bandes de l'azote. Elle s'accorde avec les valeurs proposées par Sponer (*loc. cit.*) et Duncan (*Astro. Jour.*, 62, 145, 1925) pour les potentiels d'excitation du 2e groupe positif et du groupe négatif, et par R. T. Birge et Sponer pour le potentiel de dissociation de la molécule : ce dernier étant inférieur aux deux autres. J'ai montré qu'elle s'accordait également avec les phénomènes lumineux que l'on observe en dissociant dans la décharge électrique les oxydes NO et NO^2 dont la molécule ne contient qu'un atome d'azote (*loc. cit.*) Enfin cette attribution comble une lacune de la théorie atomique de l'azote actif telle qu'elle est exposée par Sponer.

Si les atomes d'azote jouent le rôle essentiel dans les propriétés de l'azote actif où ils doivent dès lors exister en proportion notable, il devient étrange qu'ils ne manifestent leur présence par aucune émission. La même remarque peut être faite à propos de l'excitation des spectres de bandes de l'azote par chocs électroniques telle qu'elle est décrite par Sponer. Le 2e groupe et le groupe négatif sont émis à des potentiels supérieurs au potentiel de dissociation. Sponer admet que cette dissociation se produit effectivement. Ainsi donc, dans les conditions où ces deux groupes de bandes sont émis, le gaz soumis au bombardement électronique contient des atomes libres, d'autant plus nombreux que, si l'on en juge par les propriétés de l'azote actif, leur vie moyenne doit être beaucoup plus longue que celle des atomes libres d'hydrogène dans les mêmes conditions. Cependant ces atomes, malgré les chocs d'électrons, d'atomes-ions, de molécules-ions, n'émettent aucun spectre de raies, c'est-à-dire, suivant la conception classique, n'émettent rien. Le spectre de raies, le seul universellement attribué à l'atome d'azote, n'est excité que par des potentiels très élevés. Il apparaît de plus en plus comme un spectre d'étincelle d'ordre supérieur, émis sans doute par un atome ionisé, peut-être plusieurs fois, atome dont la structure est dans tous les cas profondément différente de celle de l'atome neutre normal qui existe dans l'azote actif et est détaché de la molécule par un choc d'énergie minimum. Il me semble plus naturel de permettre à cet atome neutre l'émission d'un spectre de bandes que de lui refuser toute possibilité d'émission.

Dès lors le parallélisme est complet entre les phénomènes observés par Wood sur l'hydrogène et ceux observés par Strutt sur l'azote. Pour les deux gaz la forme atomique, chimiquement active, apparaît dans la décharge électrique dès que la densité des chocs suivis de dissociation est assez grande pour que le spectre de l'atome subsiste à peu près seul dans la décharge.

Je me permets de rappeler ici des expériences qui confirment singulièrement la théorie atomique de l'azote actif et qui semblent avoir été oubliées dans les discutions récentes. Angerer (*Phy. Zeit.*, 22, 97, 1921) a montré que la neutralisation spontanée de l'azote actif est une réaction bimoléculaire : la formation d'une molécule phosphorescente exige la destruction simultanée de deux molécules actives. Dans l'hypothèse atomique cette loi est évidente ; elle me paraît difficile à concilier, sans de singulières complications, avec la théorie moléculaire de Saha et Sur.

M. DUFFIEUX.

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Janvier.

Labelling in Public Institutes for the Public.

SIX years' experience of the British public who frequent the Zoological Gardens has given me certain fixed ideas of their requirements, and of their intellectual capacity, which I believe may be of interest to those in charge of museums or any similar public institutions.

In 1917 I took over the management of the Insect House, and during the first month, while considering its possibilities and its limitations, I made a particular study of the types of visitors to the gardens, and came to the conclusion that they might be classed under three headings :

(1) The uninformed seeking information, 60 per cent.
(2) The unthinking, 30 per cent.
(3) The instructed and the experts, 10 per cent.

The only possibility of making the Insect House serve the third section was to maintain a supply of rare insects. This is difficult at any time in Great Britain, and during the War was out of the question.

On the other hand, if the activities and any biological facts of interest concerning even common insects could be exhibited in a manner to make them comprehensible to the first and second sections, then the majority of our visitors would be served. For mere exhibits of insects with their names are of no interest to the general public.

It was, however, several months before I learnt how to word explanatory labels, which, of course, are of primary importance. I gave simple lectures in the Insect House 'in the vulgar tongue,' and found that they were listened to with understanding ; but when the public were left to obtain information from the labels they would frequently not give themselves the trouble to read them. Pictorial labels were of great assistance, but the wording of the explanatory labels had to be very carefully studied ; indeed, after spending many hours in writing labels I have frequently had to re-write them on discovering that the public were not reading them to the end. By many failures I learnt at last that a label to be of service must in the first place be arresting—that is, it must state some interesting matter in the first few words—also that the terms in which facts are conveyed cannot be too simple, and that when any unfamiliar word occurs then the explanation of it must follow immediately. It was a cause of deep satisfaction to me when I discovered members of the working class showing their families or friends round the Insect House *guided by the labels*.

Of recent years much has been done to increase the usefulness of our museums by careful labelling, but it seems to me that much more might be done. When I hear those responsible saying that the public are not sufficiently interested to read labels, I go at once to read the labels myself and draw my own conclusions. I know from experience that the public are ready to be instructed, and actually hunger for instruction ; but I think it is not generally recognised how very easily they are discouraged if it means studying what is to them a new language in order to obtain information.

L. E. CHEESMAN.

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Is the American Slipper-Limpet (*Crepidula fornicata*) an Oyster Pest?

THE shortage of oysters (*O. edulis*) on the European oyster beds has led to the introduction in many places of American oysters, on which the American slipper-limpet (*Crepidula fornicata*) frequently occurs. Oyster-cultivators in various parts of Europe are therefore becoming interested in the possible effects of introducing the slipper-limpet on their beds, so that it has become a matter of economic interest to know the results to date of the introduction of this animal on English oyster-beds since its arrival about 1880 (see Orton, *Proc. Roy. Soc.* B. 91, 1909).

The American slipper-limpet (*Crepidula fornicata*) is undoubtedly regarded as a great pest on the oyster beds in the Thames Estuary at the present time for the following reasons:

(1) It has spread so rapidly and thrived so well in that locality that it is possible to dredge 20 tons a day on some grounds, actually occupied by oysters. In a pit adjacent to—but not actually a part of—the oyster beds the writer took in July 1923 in a few minutes' haul of the dredge 2226 limpets weighing approximately 26 lb. On all grounds it has increased the labour in dredging, while adding only slightly or not at all to the income of the oyster-producer.

(2) The limpets attach themselves in piles or chains on the oysters, which have therefore to be cleaned of limpets as well as barnacles, etc., before sending them away from the beds.

(3) It is impossible to remove Crepidula entirely from the beds, once it is established on the ground, as it has a free-swimming larva—like the oyster—and in addition changes its sex from male to female so that every individual may breed as a female (*loc. cit.*). Moreover, spawning occurs in England from about March to November, and females may spawn more than once in a season.

In favour of Crepidula, it may be said:

(1) That it is not an enemy of the oyster but a competitor for space and food, like sea-squirts, various bivalves, and other plankton-feeding animals.

(2) That where Crepidula occurs in abundance it can be dredged in the normal routine of work, and the shells easily accumulated in great piles and cleaned and bleached to serve as cultch for catching oyster spat. On some beds Crepidula is beginning in this way to pay some of its debts to the oyster-producer.

There can be no doubt, however, that unless Crepidula can be utilised as food—in a small way its shell is utilised in England when crushed with oyster shells as chicken food—it is a great nuisance to the oyster-cultivator. No serious attempt has been made in England to use the slipper-limpet as food, but it is probable that if Crepidula occurred in quantity in France it would be so utilised, and acclaimed as an undoubted benefit.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, January 20.

Photo-electric Polarimetry.

As the use of selenium cells and photo-electric devices is engaging the attention of several workers, a brief account of an application to the polarimeter due to one of our research students—Miss Winifred E. Dickes—may be of interest.

A long series of experiments has led to a simplified arrangement as follows. The apparatus in essentials consists of a spectrometer, for the collimator of which is substituted a polarimeter without eyepiece or half-shadow device, but having a slit over the polariser diaphragm and an electrical photometer behind a slit in the eyepiece of the telescope. An additional eyepiece is placed at right angles to the axis of the telescope for observing the line of the spectrum employed. Half of the field of this eyepiece is fluorescent, for convenience in setting when making determinations in the ultra-violet regions.

The photometer used is a selenium or alkali metal cell, and valve amplification is being tried.

The peculiar novelty of the method is the way in which the observations are taken. A quantitative measure of the light intensity is obtained. Two positions are found, about 90° apart, which give the same current. The mean of the two readings so found gives an accurate value for a minimum or maximum, according to choice, although the minimum as a rule is slightly to be preferred.

The readings 90° apart are taken repeatedly and are averaged in the same way as pointer readings are used in weighing. With a selenium cell, these observations are made at fixed time intervals to allow for the characteristic small secular variation in the current.

Since there is no half-shadow device, the whole of the light can be utilised by the photometer. A magnified image of the polarimeter slit is used for the photometer, in order that a larger (that is, more sensitive) selenium cell may be used.

At the end of 1924, with a rough arrangement, an accuracy had been obtained of 0·01° in the red end of the spectrum and 0·1° in the violet. The work was then interrupted by illness. It is now being resumed, and there is reason to hope that a considerably greater accuracy may be obtained, when a paper will be published.

It is proposed also to investigate two possible extensions, namely, the direct use of the apparatus for absorption measurements, and its adaptation to an automatic or recording polarimeter.

JOSEPH KENYON.

Battersea Polytechnic,
London, S.W.11,
February 2.

Wordsworth's Interpretation of Nature.

THE introductory lines which appear in the complete collection of Wordsworth's poems crystallise, with such singular fitness, the point of view so ably expressed in the supplement to NATURE of January 16 that I think it is important to direct attention to them:

If thou indeed derive thy light from Heaven,
Then, to the measure of that heaven-born light,
Shine, Poet! in thy place, and be content:
The stars pre-eminent in magnitude,
And they that from the zenith dart their beams,
(Visible though they be to half the earth,
Though half a sphere be conscious of their brightness)
Are yet of no diviner origin,
No purer essence, than the one that burns,
Like an untended watch-fire, on the ridge
Of some dark mountain; or than those which seem
Humbly to hang, like twinkling winter lamps,
Among the branches of the leafless trees;
All are the undying offspring of one Sire:
Then, to the measure of the light vouchsafed,
Shine, Poet! in thy place, and be content.

The lines in parenthesis surely indicate once more the possibility that Wordsworth might easily have become a man of science, whilst the following lines display, as effectively as anything in the body of his works, that intense spirituality of the poet's vision, the *particular* quality of which is unique among the great English poets. Can there be any lover of Nature but has felt the influence of that star which scintillates

above the dark line of the hills, or who does not recognise this imagery to symbolise the whole beauty of a sparkling winter evening—when, may be, one is walking along a country road over the crackling puddles. But there is, further, local colour behind the imagery in question. I can never read the line and a half beginning with "Like an untended watch-fire" without experiencing a vivid sense of the stern background of the Cumberland fells, and of the various moods of that northern climate to which the lakeland hills are so exquisitely attuned. Had Wordsworth been reared in some other part of England equally beautiful, only different, would this have been reflected in the general character, apart from local concrete imagery or topographic detail, of his poetry? To some extent one may, I think, infer this; but in such deep aspects of human geography it is necessary to exercise the utmost caution, for we know little of the influences which affect the human spirit or in what direction they may act.

L. C. W. BONACINA.

27 Tanza Road,
Hampstead, N.W.3,
January 31.

The Arabic Text of Avicenna's "Mineralia."

THE production of spurious books on alchemy, claiming to be translations from the Arabic, was undoubtedly practised on a large scale in the Middle Ages. An unfortunate result has been that modern scholars are inclined to view with grave suspicion all Latin chemical treatises which pass under the names of Arab authors, and have thus inevitably rejected many books which are genuinely what they profess to be. An interesting case in point is provided by the tract entitled "Mineralia," ascribed to Avicenna and printed in Manget's "Bibliotheca Chemica Curiosa," 1, p. 636, and elsewhere. This was rejected as a forgery by Kopp ("Beiträge zur Geschichte der Chemie," 3, p. 56) and others, though Hoefer ("Histoire de la Chimie," second edition, 1866, 1, p. 345), with a truer insight, regarded it as genuine.

A careful study of the tract convinced me that Hoefer was right, and after a prolonged search I was fortunate enough to discover the Arabic text. The "Mineralia" is, in fact, a close translation of certain sections of a work by Avicenna which is undoubtedly authentic, namely, "Al-Shifā'," manuscripts of which occur in the British Museum and many other libraries. Since Avicenna's views on alchemy (he was a pronounced opponent of those who maintained the possibility of transmutation) exerted a great influence upon contemporary scientific thought, it has been considered desirable to publish the Latin and Arabic texts together with an English translation; this edition is now in course of preparation.

E. J. HOLMYARD.

Clifton College, Bristol,
February 7.

Intrinsic Brightness.

THE intrinsic brightness of sources of light seemed at one time to be a simple matter, namely, 2½ candle-power per square inch for a candle-flame, 200 to 450 for a carbon filament lamp, 1000 for a tungsten vacuum lamp, and 80,000 to 110,000 for an open electric arc. The areas were the simple measured projected areas of the surfaces.

The question arises, however, whether those areas should be taken. The apparent diameter of a modern intensely incandescent filament is greatly increased by irradiation. The fine spiral filament of a gas-filled lamp appears, visually, to be a very thick filament. The bunch of straight up and down filaments of a tungsten vacuum lamp appear, at a little distance, to be a uniform incandescent patch of many times the area of the filaments, and would be indistinguishable from a flat uniformly incandescent surface of the same apparent area. Considerations of comfort, to say nothing of possible injury to the eyes by too great intrinsic brightness, have become important. Opal glass bulbs absorbing an unimportant fraction of the light, are being used for the purpose of increasing the apparent area, and thus reducing the intrinsic brightness. The definition of this quantity appears to be one for physiological or ophthalmic consideration, rather than for simple physical measurement. If the apparent area is to be taken, how is it to be measured? Is it subjective or objective?

A. P. TROTTER.

Greystones, Teffont,
Salisbury, February 5.

Neglected Early Scientific Instruments and Apparatus.

LIKE many other readers of NATURE, I have been greatly interested in the extracts from the early records of the Royal Society and the Philosophical Society at Oxford which have been appearing in its columns. Those recently published illustrate and supplement Mr. R. T. Gunther's "Early Science at Oxford" and bring into relief the pioneer work done in every department of experimental science by graduates of Oxford and Cambridge during the seventeenth century.

As an old curator I know how many unregarded "rarities" are still stowed away, neglected and forgotten, in the cupboards and corners of every local museum throughout the country. I would suggest to those in charge of such museums that they should look through their "lumber" to ascertain whether there are any pieces of scientific apparatus which should again see the light. This was done with brilliant success at the colleges in Oxford in 1919, and the Ashmolean has, in consequence, come into its own again. I feel sure that a more extended search would lead to even greater results, and if the finds were reported to Mr. Gunther he would make a note of them, and it might be possible to gather them together as a loan exhibition.

D'ARCY POWER.

Cirsium eriophorum.

IN NATURE (November 14, p. 711) Mr. Stuart Thompson alludes to the woolly-headed thistle—*Cirsium eriophorum*—being found at Chewton Keynsham, and remarks that it was from specimens gathered there in 1922 that Dr. Petrak named it sub-sp. *britannicum*. As a matter of fact, Dr. Petrak monographed the genus in 1912 ("Bibliotheca Botanica," Heft 78, Stuttgart), which I reviewed in the *Report of the Botanical Society and Exchange Club*, 361, 1913. There Petrak describes seven subspecies, and he chose an inept name (*Cirsium britannicum*), since *eriophorum* is limited to England (Sibbald's Scottish record was erroneous), and there was already *C. britannicum* of Scopoli, but that is *heterophyllum* and therefore invalid. So far from the subspecies being due to a Somerset specimen, Petrak's details of his drawing are made from a Huntingdonshire plant.

G. CLARIDGE DRUCE.

Oxford.

Eclipse Observations in Sumatra, January 14, 1926.

By Lieut.-Col. F. J. M. STRATTON.

EXCEPT for an Italian expedition to the east coast of Africa, all the astronomical expeditions to observe the eclipse of January 14 stationed themselves in Sumatra. A Dutch expedition under Dr. van der Bilt, with Prof. Pannekoek, Dr. Moll, and Dr. Mynnaert, was at Talangbetoetoe on the central line, near Palembang. Its programme was mainly spectroscopic and spectrophotometric—the distribution of gases in the layers of the corona being a special problem attacked. Most unfortunately, this station was clouded out completely.

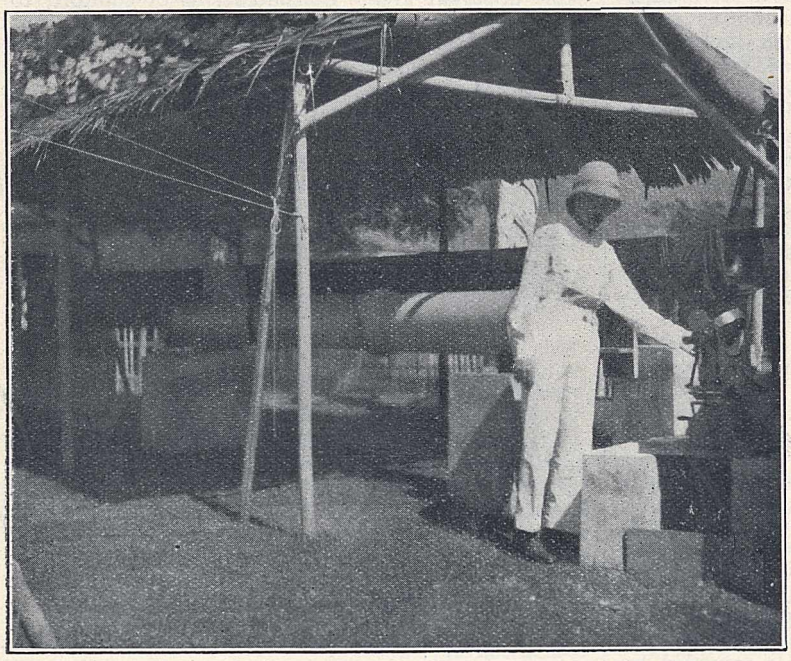

FIG. 1.—Mr. C. R. Davidson, with the 20-foot camera and 40-foot objective prism camera.

A party from the American Naval Observatory, basing the choice of station on experience from the 1901 eclipse in Sumatra, was established at Kepahiang, a station in a high valley amongst the mountains which form the backbone of Sumatra. This party consisted of Capt. Littell, Dr. Peters, Dr. Kellars, Lieut. Ransford of the U.S. Naval Observatory, with Dr. Anderson, of the Mount Wilson Observatory. The party was assisted by a detachment of sailors from the U.S. Navy. A telescope of 70 ft. focal length was erected for direct photographs of the corona, and the programme included grating spectrograms with a moving plate of the flash and of the corona. Unfortunately, the sky at Kepahiang only cleared for the last seventy seconds of totality, but a curtailed programme was carried out successfully. The sky had been clear two minutes before totality, but a passing cloud robbed the observers of the first two minutes of totality.

At Benkulen, on the south-west coast, three or more expeditions placed themselves. The German expedition under Dr. Freundlich consisted of Prof. Keinle, Dr. von Klüber, and Dr. Mollet. Prof. Voûte, of the Lembang Observatory in Java, Mr. Kerkhoven, and Dr. Knol also joined this party. The programme was mainly the Einstein problem with some spectroscopic work as well. The equatorial telescope taken to Christmas Island in 1922 was used again, and in addition two horizontal telescopes, fed by the same cœlostat and giving simultaneously the sun's field and a second star field, were in use. The sky near the sun was clear throughout totality save for slight cirrus cloud passing over the sun, but the complete programme, including all the comparison plates, was carried out, and it is hoped that the required stars figure on the Einstein plates, and that Prof. Freundlich's continued ill luck at eclipses has ended happily. Attached to this expedition, but available for the other parties at Benkulen, was a field workshop under Mr. Verhoeff.

The American expedition from Swarthmore College was also at Benkulen. Prof. Miller was the leader of the party, and his consistent good luck at eclipses held once more. With him was Prof. H. D. Curtis from

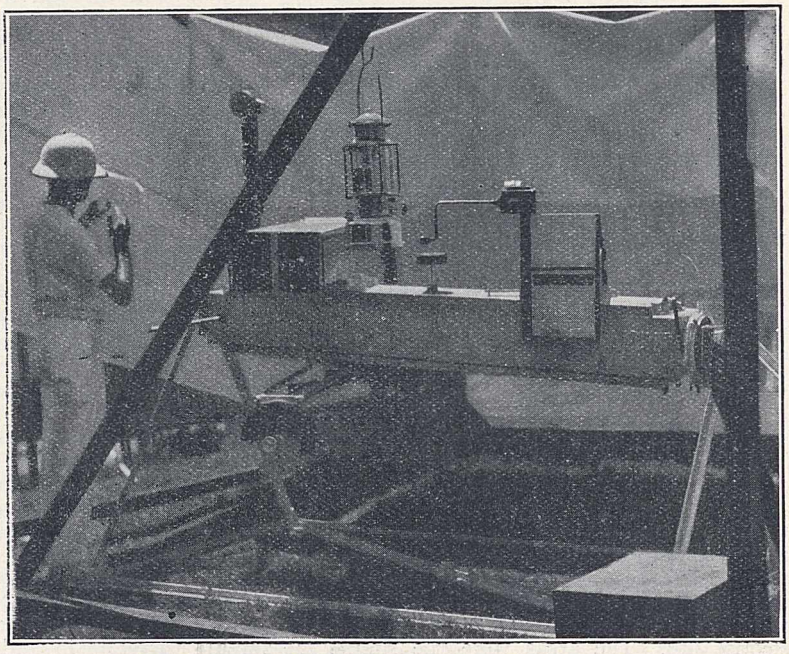

FIG. 2.—Mr. Z. A. Merfield, with spectrophotometric equipment.

Allegheny, Dr. Marriott, Mr. Dominick, Mr. Wilson Powell, Mr. A. Rubel, and Dr. D. B. McLaughlin. Their programme included the Einstein problem, photographs of the corona with a 63 ft. tower telescope, interferometer measurements of the wave-length of the green coronal line, objective grating spectrograms in the infra-red, and colour photographs. The early development of their plates showed general success over the whole programme. Another expedition, camped in the same field, came from Harvard under Prof. Stetson, with whom were Dr. Coblentz, Mr. Weld Arnold, and Mr. W. A. Spurr. Their programme was mainly photometric, and was partially spoiled by the slight haze present in the sky. Capt. Harris, of the U.S. Signal Corps, also joined the American expedition with a cinema camera with which he hoped that he had been successful in photographing the elusive shadow bands as well as the whole eclipse.

The expedition sent out by the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society consisted of Mr. C. R. Davidson and Lieut.-Col. F. J. M. Stratton. There joined the party as volunteers Dr. F. W. Aston, Col. J. Waley Cohen, Mr. E. G. Barton, and Major R. G. R. Davies. The expedition was very appropriately and most happily given accommodation in the old British fort—Fort Marlborough—built more than two hundred years ago and now the barracks of the native police. At this station the sun was absolutely clear during the whole of totality, though there was thin cirrus cloud in the immediate neighbourhood of the sun—cloud which passed over the sun during totality for the American and German expeditions less than half a mile away. The main programme was spectroscopic, both the corona and the flash being examined in the extreme infra-red and ultra-violet. Objective prism spectrograms were also obtained of the flash and of the corona in the photographic and visual regions.

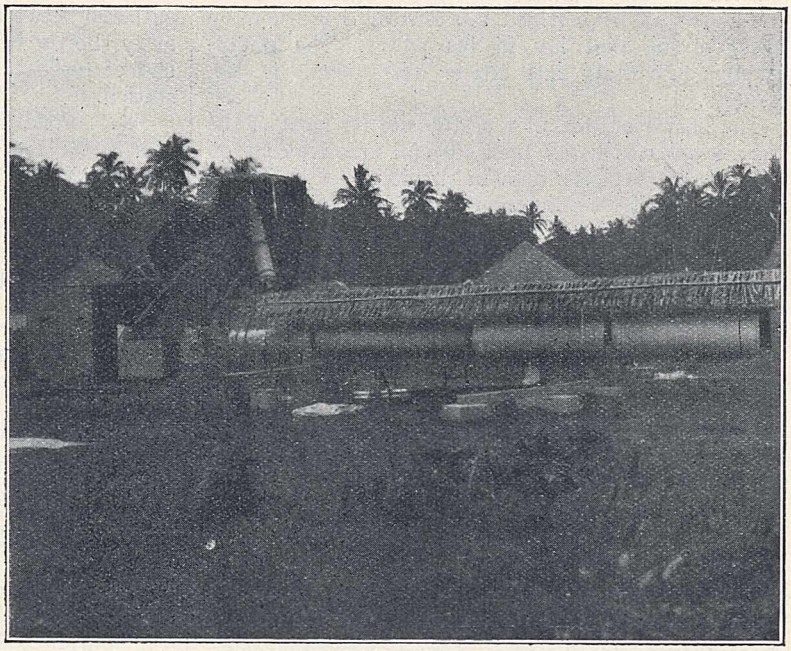

FIG. 3.—Prof. Freundlich's Einstein camera.

FIG. 4.—Prof. J. A. Miller's 63-foot tower telescope with the Einstein telescope in foreground.

At the time of writing, only part of the plates have been developed, but they are sufficient to show that the expedition has been generally successful in its programme. Mr. Barton's programme was mainly photometric, his intention being to measure the total intensity of light from first to last contact; unfortunately, just at the commencement of totality the recording tape broke through a flaw in the paper, an accident which robbed his work of its most important phase.

The British expedition was joined by Mr. Z. A. Merfield, of the University of Melbourne, who was equipped with a moving plate grating spectrograph, a battery of eight cameras with different colour filters to study variation in the corona, and a moving plate colour filter photometer. The instruments were mounted on a polar axis and were all set up and adjusted in time, though owing to a series of accidents they did not arrive until eight days before the eclipse. Here again, general success is indicated by the plates so far developed, and a useful contribution promised to the question of the distribution of solar vapours in

the higher chromosphere. Mr. Bridges, of the *Melbourne Herald*, was also attached to the British party as a volunteer, and a cinema camera of his was used with one of Mr. Merfield's parabolic gratings to get a timed series of photographs of the spectrum at the second and third contact. This instrument was worked by Capt. Akkersdyk, who was in command at the Fort and who helped the British expedition by every means that lay in his power. The photographs illustrating this article were taken by Mr. Bridges.

The choice of Benkulen as the site for most of the expeditions was based upon careful observations on cloudiness at eclipse time in previous years. These were made under the direction of Dr. Braak of Lembang, and they proved a useful guide to the visiting astronomers. It should be added that the facilities at Benkulen, and the friendly help given freely on every side, showed how luckily the choice of a site had been made.

The season—the rainy season—was not at all promising, and for the month preceding the eclipse the numbers of fine and cloudy days were about equal. The day of the eclipse itself was cloudy most of the morning, but the sun cleared up for first contact. Thin cloud gathered between first and second contact, but cleared away shortly before totality. Five minutes after the end of totality, the sun was in cloud for the British station.

The corona was intermediate in type, resembling that of the 1900 eclipse in India. There were several very striking prominences on the limb, and the black moon, ringed with bright red prominences and surrounded by the pearl grey corona with its long irregular rays, made a wonderful picture, well worth travelling thousands of miles to see.

Space, Time, and the Universe.[1]

By J. H. JEANS, Sec. R.S.

SOME of us may remember the story of the children who played truant in order to explore the regions where the rainbow ends. After travelling all day, up hill and down dale, they had to admit failure of the most thoroughgoing kind—the rainbow was, to all appearances, no nearer than when they started. Really scientific children might have thought of estimating their rate of approach to the rainbow by measuring the angle it subtended. If they had measured it in the morning it would have been 42° 23′; it would have been 42° 23′ at noon, and again at night it would still be precisely 42° 23′. If they had done this they must have felt that they were the victims of extreme bad luck, for they had clearly seen the rainbow in front of the nearest hill when they started out; could there be some sort of conspiracy on the part of rainbows, hills, and indeed the whole scheme of Nature, to prevent their getting close up to that rainbow?

In the year 1905 the world of physicists was engaged in a pastime which was, in many respects, very similar to that of chasing rainbows. They believed light to travel through an ether with a speed of 300,000 km. a second. If the solar system were travelling through this ether at a speed of, say, 1000 km. a second, it would partially overtake light travelling in the same direction, so that this light ought to appear to travel at only 299,000 km. a second. On the other hand, light travelling in the opposite direction ought to appear to travel with a velocity of 301,000 km. a second. This suggested an obvious means of discovering both the speed and direction of the earth's voyage through the ether—indeed, it was every bit as obvious as the children's plan for exploring the foot of the rainbow. Experiments were designed to utilise this principle and were tried time after time, not in one form only but in many. Time after time experiment gave the answer that the velocity of the earth through the ether was zero, or at least, to put it in another form, which was at that time thought to mean precisely the same thing, the velocity of light relative to the earth was the same in all directions. No doubt it was conceivable that on the occasion of the first experiment the earth really might have happened to be at rest in the ether, but it was quite inconceivable that this should be the case every time; indeed, the earth's orbital motion alone required a variation of some 30 km. a second, and all the experiments were capable of detecting far smaller variations than this.

At first glance it looked as though the earth must be carrying its own private ether about with it, and I suppose this view would have prevailed had it not been for the astronomers, who were ready with an aberration-constant which at once, and, I think, irrevocably, dismissed the possibility of an ether being dragged about with us. Incidentally, this episode provides an often overlooked instance of the services of astronomy to the other sciences and to the growth of knowledge in general. The physicists on Jupiter may still believe that a luminiferous ether exists which follows Jupiter about wherever it goes; the reason is that there are no astronomers on Jupiter to put them right, their permanent blanket of clouds not encouraging this profession.

I forget the end of the story of the rainbow quest, but am prepared to provide an entirely unauthoritative ending. After the children had got completely tired in their bodies and still more completely bewildered in their wits, they rested for a long time, until they encountered a magician. He was not in the least the conventional magician, ponderous of speech and with a long white beard; indeed, he was a young man of twenty-seven, extraordinarily simple and unassuming in all that he said. What he said in brief was this: "I can tell you what is the matter. You have started to chase the rainbow on the supposition that it is a material arch; in actual fact it is all in your own eyes. Gretchen sees one rainbow and Hans sees a quite different one. But if Hans walks up to where Gretchen is standing, he simply changes his rainbow for hers; you don't get any nearer to a rainbow by walking this distance because there isn't really anything for you to get any nearer to. The angle you have been measuring must always stay at 42° 23′; it is fixed there by the

[1] Presidential address delivered before the Royal Astronomical Society on February 12, on the award of the gold medal of the Society to Prof. Albert Einstein for his researches on relativity and the theory of gravitation.

unalterable laws of Nature, and children cannot alter these by walking about." As the children were tired, and the young magician had perhaps expressed himself in rather unfamiliar ways, they did not at first quite understand what he meant. But then another magician, whose name was Minkowski, came along, and he made it all seem much simpler; he said it was quite true that each child carried its own rainbow about with it, but that behind the subjective vision of the rainbow was an objective reality consisting of a shower of raindrops. These raindrops were the same for everybody, but out of the whole lot each person's eye selected, or rather the sunshine selected for each person's eye, a small group of drops which appeared to him to form a bright arch. If all space were filled with children standing in different spots, then the aggregate of all the raindrops seen in all the children's eyes would constitute the reality behind the whole phenomenon, a shower of rain. When the second magician put things in this way the children began to understand; they saw that the first magician, whose name was Einstein, had been right.

I doubt if the Royal Astronomical Society has ever had its medallist introduced to it in so disrespectful a way before, but my little parable may remind you of the way in which our present medallist made his entry into the scientific world, and also of the way in which the scientific world made their entry into the changed universe in which science moves to-day. Time and space, as separate entities, the time and space we wrote about and thought about previous to 1905, have gone, or, as Minkowski puts it, have become shadows, while only the product of the two remains as the framework in which all material phenomena take place. Time and space separately may mean something to us subjectively, but Nature knows nothing of them until they have been multiplied together into a four-dimensional space-time continuum; it is in this that she has set her laws. If I have seemed to treat Einstein's great early work too lightly, I would plead, first, that it has already suffered enough serious exposition, and, secondly, that only really great work permits of being treated lightly, and that it is well to take a chance when it offers itself. But let not the lightness of treatment be thought to imply lightness of esteem for the work. By his single 1905 paper, Einstein started a revolution in scientific thought to which as yet we can see no end, to which, indeed, we can scarcely yet imagine any end. Had he written only that one paper, his position as one of the great figures of science would, in my opinion, have been secure. He would, perhaps, not have been awarded the gold medal of our Society, but that would be because he had not yet become an astronomer.

If the magicians had given the right explanation of the rainbow, then everything the children saw in the rainbow ought to admit of explanation in terms of the ultimate reality provided by the shower of rain. Obviously there would have been something radically wrong if Gretchen had seen a circular rainbow while Hans, standing by her side, had seen a square one; something wrong, too, if Gretchen had said that the colours ran from red to blue as you passed inwards, while Hans said they ran from blue to red. In the same way, if Einstein and Minkowski were right about time and space, there must have been something radically wrong when Isaac Newton had said that every particle in the universe attracted every other particle with a force that varied as the inverse square of the distance, and again when he had said that the path of a planet about the sun was an endlessly repeated ellipse. When the last of these statements, for example, is expressed in terms of the four-dimensional framework which Einstein and Minkowski regarded as the ultimate objective reality, it is found to make sheer nonsense, to be inconsistent with itself. Viewed in that framework, an endlessly repeated ellipse becomes a sort of helical curve, a spiral staircase climbing up into eternity, the projection of which on one particular cross-section is the single ellipse in question. View it at any angle you like and it is still a helical curve, but project it on some other cross-section and you will find that the radius vector relative to the sun no longer describes an endlessly repeated ellipse. In brief, the Newtonian law of gravitation could not be true because it could not be expressed in terms of the ultimate four-dimensional reality in such a way as to be true for more than one person at a time.

When Einstein had this brought to his notice he at once became an astronomer. His task, rather a heavy one for the first piece of work of a young apprentice to astronomy, was to find out what was the matter with Newton's law of gravitation and to put it right. Of course, in a sense, there was not very much wrong: Halley's comet had come back when it was expected, and Jupiter's satellites could be seen every night exactly as the pictures in the "Nautical Almanac" predicted that they ought to be seen if Newton had been right, and all the planets seemed actually to be describing endlessly repeated ellipses except that Mercury wandered very, very slightly from its proper place. Yet, in another sense, there must be everything wrong with a law that did not fit properly into the four-dimensional reality, or at least there was as much wrong as the difference between truth and error, which the true man of science regards as the biggest magnitude with which he ever has to deal. And, just as Kepler, starting from the established error of 8′ in the observed position of Mars had set out "to construct a new theory that will explain the motions of all the planets," so Einstein set to work to construct a new theory which was incidentally to explain the motion of the planets but was destined also to change our whole interpretation of the fundamental significance of these motions.

Every astronomer is familiar with this part of Einstein's work. By 1915 he had found the modification needed in Newton's view of gravitation, and had shown that the orbit of a planet, instead of being the impossible endlessly repeated ellipse, was an ellipse which kept slowly turning round in its own plane. He had also found that the theoretically predicted rate of turning for Mercury was exactly the 43″ a century by which Leverrier had found that the planet's perihelion advanced over and beyond the advance caused by the pull of the other planets. He announced two further physical consequences of his theory. Rays of light passing through a gravitational field ought to be bent by a calculable amount, 0·745″ for light which has just grazed the sun's limb; and spectral lines emanating from atoms in a gravitational field ought to be displaced

towards the red, the displacement of lines from the solar photosphere being that corresponding to a velocity of 0·634 km. a second, or, say, 0·008 Å.U. at the cyanogen band, λ3883. Newton had queried in his "Optics" whether rays of light would bend in obedience to gravitational force, but Einstein was the first since Newton to make any definite physical predictions arising out of a theory of gravitation.

Our two British expeditions put the first of these predictions to the test at the 1919 eclipse, and, as we know, brought back the news that the prediction was amply verified. The testing of the second prediction was a more difficult matter, not so much because the small displacement of 0·008 Å.U. was difficult to measure, as because it was masked by bigger displacements of unknown amount. Even to-day the problem can scarcely be said to be solved with absolute finality so far as solar light is concerned, although probably Evershed, St. John, and others have done all that it is possible to do. But the prediction which it was found almost impossible to test by the light of our sun has been tested by the light of one of the faintest of stars. Sirius has, as companion, a smaller and far fainter star which describes an orbit round it. Its effect on the motion of Sirius shows its mass to be 0·85 times that of the sun, and its distance is for all practical purposes the same as that of Sirius. The amount of light it emits is so small that Seares had calculated its radius to be only about 20,000 km. or one thirty-fifth of the radius of our sun. Now Einstein's theory predicts a shift proportional to M/r, so that whereas the predicted shift in the solar spectrum corresponds to a velocity of only 0·634 km. a second, the light from the companion to Sirius ought to show a shift corresponding to a velocity of 20 km. a second, something like a third of an angstrom. Here then was a shift the magnitude of which was suitable for measurement. The measurement was undertaken at Mount Wilson, and the observed shift was found to agree almost exactly with that predicted by theory. This experiment not only established the validity of Einstein's theory of the gravitational displacement of spectral lines, but also showed its usefulness as an instrument to be utilised by the practical astronomer in his everyday work.

The ultimate importance of Einstein's work was not, however, that it gave astronomers new tools for the measurement of stellar diameters, or for the prediction of the position of Mercury; it was not even that it gave the true law of gravitation; it was that it gave a new conception of the meaning of gravitation and of gravitational force. Strictly speaking, Einstein did not amend Newton's law of force; he abolished it. He put something else of a quite different nature in its place, something which was consistent with itself when looked at in the four-dimensional continuum and agreed with the observed facts of Nature, including the then untested bending and reddening of light. At first he had tried to amend Newton's law to fit the continuum, but he soon found it was a case of amending the continuum so as to fit Newton's law. Or rather, since a perfect fit was impossible, this being the cause of all the trouble, he amended the continuum so as to fit Newton's law in the only region where it could fit, namely, at infinity, and then found that the misfit for nearer distances gave just the needed 43″ a century for Mercury's orbit. Just as completely as, some three centuries earlier, the kinematical explanation of cycles and epicycles had crumbled to nothing in the hands of Kepler and Newton, so now the dynamical explanation of a gravitational force crumbled in the hands of Einstein. The story of this part of Einstein's work has been so often told and is so familiar to all astronomers that you will scarcely wish to linger over it. It opened up a path into entirely new scientific territory along which Weyl and others have advanced, attempting, so far as can at present be seen with success, to extend Einstein's fundamental conceptions so as to explain the "forces" of electromagnetism in terms of a still further generalisation of the geometry of the continuum. If they have succeeded, the mechanism of the whole universe is transformed; dynamics disappears from science and the laws of Nature are those of geometry alone.

We need scarcely spend time over the threadbare and rather meaningless question of whether Einstein has performed the feat of "abolishing the ether." So much depends on what we mean by "ether." As soon as the term is defined, the question as to whether or not that particular ether exists almost answers itself—generally in the negative. The luminiferous ether of Kelvin, Maxwell, and Faraday, largely as the result of Einstein's new outlook on the universe, may be described as dead; it is no longer a serious scientific hypothesis, but merely an item in the unscientific jargon of popular expositions of "wireless."

Let us take a glimpse at the new universe into which Einstein's work has led us. Until the seventeenth century the majority of men believed that terrestrial life was the prime reason for the existence of the myriads of stars that lighted the firmament; they had indeed been created just a few days before man so as to be ready to minister to his pleasure on his arrival. In the twentieth century the majority of men believe that there is a sort of flow of time which is regulated by our consciousness. We live now in the year 1926, and therefore speak of 1925 as dead and past; 1927 is not yet born, but will spring into life for us just as soon as we need it, which will be when we reach the end of 1926. So the traveller journeying west through Devon might suppose that Somerset had fallen out of existence at the moment he left it, and that Cornwall was waiting only for his arrival to come into existence. Foolish, perhaps, when expressed in terms of space, and yet our everyday belief in respect of time.

Einstein's theory eliminates the supposed essential difference between space and time; what is one man's space is another man's time. Not only so, but what is the past in time for one man is the future for another man. According to the view thrust upon us by the theory of relativity, the space-time landscape does not spring into life in front of us and die behind us; it is unalterably there. Existence becomes a picture rather than a drama, and the year 1927 has the same sort of existence as the county of Cornwall. Probably no one would regard this as a final statement of the matter; it goes as far as the theory of relativity carries us, but the theory of relativity is concerned only with inanimate Nature; it takes no cognisance of life or consciousness. It is for us to go further if we can.

Does the theory, however, leave room for us to go

further? Does it leave room for life and consciousness, and for the attributes, such as free-will, which we attach to them?

The materialistic philosophy of a generation ago used to insist that the picture which science then presented of the universe left no room for such things. That picture has no doubt been torn to shreds, but what about the new picture? Does this look with any more favour on our instinctive belief that we can guide our actions and make the universe in some small degree different by our presence? Or are we mere passive spectators, carried—in a train the speed of which we cannot regulate and the course of which we cannot alter by an inch—out of a Devon with which we can do nothing except gaze at it through a window, into a Cornwall which is already in existence and has been unalterably created by other hands than ours? To this last question the answer of the theory of relativity would seem to be in the affirmative, but relativity is not the whole of natural science; it is not even the whole of Einstein's work. His contributions to science fall into two columns which, unhappily, are parallel and show no signs of meeting. The first column contains his contributions to the theory of relativity, the red-letter years being 1905 and 1915; the second column contains his contributions to the theory of quanta, the red-letter years being 1905 and 1916. It is not yet altogether clear which of these columns will figure most prominently in the history of present-day science when this is finally written in its proper perspective. But it already seems possible that the second column of Einstein's work may contain the needed antidote to the determinism and automatism to which the first column, if it stood by itself, would seem to condemn us.

This room contains, let us say, a thousand atoms of uranium. The chances are that after five million years only 999 of these will be left, the other one having been transformed into an atom of lead, eight atoms of helium and about 10^{-27} grams of radiation or heat. One of the thousand atoms is fated to be transformed in this way, but what determines which particular atom it is to be? Are we tempted to conjecture that it will be that one that gets most knocked about in the interval, or that gets into the hottest places, or what not? If so, we are wrong; for if blows or heat could disintegrate the one atom they could also disintegrate the other 999, and yet every physicist is firmly convinced that no possible treatment can retard or expedite the disintegration of the uranium atoms in the least degree. Once every five million years fate knocks at the door of one atom and it breaks up. Why fate chooses this interval, why she selects one particular atom rather than its fellow, we simply do not know; we seem to be beyond the domain of what have heretofore been called natural laws.

Now let us think of a more familiar, although more complicated, phenomenon. The hot filament of an electric light bulb receives energy from a dynamo and discharges it as radiation. Inside that filament millions of atoms are jumping up and down between different energy levels, and Einstein has investigated what may be called the statistics of their jumping about. Most of the knocks now are just those of ordinary radiation. The temperature radiation of the filament knocks some atoms up and some down; double the stream of radiation and the atoms will be knocked up and down twice as frequently. But this is not the whole story; if it were, the emission of light from the filament would not be what exact experiment shows it to be. Einstein finds that to explain the observed stream of radiation from the filament, fate must be invoked here also. Some atoms are knocked down from the high energy level to the lower because the stream of radiation pushes them down, but others stumble down by processes analogous to those by which the uranium atom disintegrates. They stumble, if you like, of their own clumsiness, or, if you like, because fate beckons them down. Put it anyhow you like, and you will almost certainly be wrong; Einstein has shown that it happens, and beyond this we know nothing.

It is, however, clear that we may be in the presence of something here which is quite beyond the inflexible cause and effect of the older mechanics, and possibly equally beyond the precreated tangle of events of the theory of relativity. A single instance will perhaps suggest how far beyond. The lines of the hydrogen spectrum result from the falling down of the atoms of hydrogen from one energy level to another, and in the determination of the wave-lengths represented by these lines, the future of the atom enters as an equal partner with the past, although, as we have seen, the future of an individual atom can no longer be regarded as a consequence of its past in the sense in which an effect is the consequence of the cause. We are here in unfamiliar regions of thought where our minds get frozen and refuse to operate. But one thing at least seems possible. It seems as though the deadly inevitability of cause and effect has ended, and we are in the presence of new possibilities of freedom which as yet we do not understand. Einstein's work on relativity changed the universe from a drama into a picture. It seems possible, as Weyl first suggested, that his work on quanta may have provided the clue which is destined to change it back again into a drama—no longer a drama in which all the parts have been written and the gestures prearranged before the curtain went up, but a drama in which all the actors choose their actions as the play proceeds—in fact, not a staged drama, but life.

No doubt the great mass of the universe must always follow a predestined path; nothing but predetermined forces can bind the cluster of the Pleiades or loose the bands of Orion or guide the Bear with its train, but there is now, for the first time since Newton, room in the universe for something besides predestined forces. No doubt this is only a possibility, only a conjecture if you like. We do not understand quantum phenomena well enough to go beyond conjectures. Perhaps a hope is dawning that some quite recent investigations of an abstruse mathematical nature are going to provide an answer to the puzzle, but if so it seems probable that the answer will not be in terms of ordinary time and space, and so will come from outside the regions surveyed by the theory of relativity. In any event it seems that there must be room for much in the universe about which relativity knows nothing. Perhaps the two columns of Einstein's work, which never clash because they never meet, provide a true symbolical picture of the universe which he has done so much towards elucidating.

Obituary.

DR. W. BATESON, F.R.S.

BORN in 1861, William Bateson was educated at Rugby School and at St. John's College, Cambridge, of which college his father was Master. He obtained first-class honours in both parts of the Natural Sciences Tripos, and took his degree in 1882. It was at the time when the genius of Francis Balfour had given a great impulse to the study of comparative embryology, and it was natural that Bateson's first efforts in research should be along such lines. As a subject for investigation he chose Balanoglossus, the position of which in the phylogenetic scheme was then one of uncertainty. To obtain material he visited America in 1883, and again in 1884. His results, which appeared in a striking series of papers in the *Quarterly Journal of Microscopical Science*, definitely fixed the position of Balanoglossus, and are now incorporated into every text-book of zoology. In 1885 he was elected a fellow of his college.

Not the least important outcome of Bateson's visits to America was the meeting with W. K. Brooks, who undoubtedly influenced his thoughts towards the direction they were now to take. The age-old problem of the nature of species gripped and held him for the rest of his life. Though fully appreciative of the value of morphological inquiry, he came to distrust the phylogenetic speculations that were based upon it, involving as they did the assumption of hypothetical variations to fit the case. He demanded reality, and set to work to search it out. Holding that the facts of variation must be the test of phylogenetic possibility, he started to collect records of such variations as actually exist. The literature was searched, museums were visited at home and abroad, collections were made in the field, and it was at this period that as Balfour Student of the University of Cambridge he made a journey to the western parts of Central Asia and Siberia. The immediate outcome was the "Materials for the Study of Variation" (1894), a book which marked an era in the development of biological thought.

At that time it was generally held by professed authorities that variation was of the nature of a continuous process, and that the discontinuity of species was brought about by the operation of natural selection on such material. Logically this amounted to a denial of the existence of species as recognised by the systematist. Bateson reaffirmed the reality of species, emphasising the discontinuity between them, and pointed out that such discontinuity was paralleled by discontinuity in variation. As to the existence of this phenomenon the collected evidence left no doubt, and it was reasonable to suppose that the observed discontinuity in species was based upon discontinuity in variation.

To the naturalist the book was at once a warning and a call—a warning that the quest upon which he was engaged might be based upon illusion: a call to the study of variation, which at that juncture seemed to offer the fairest hope of progress in connexion with the species problem. Looking back, it seems surprising that the forceful reasoning of this remarkable book should not have made immediate converts. Yet so it was, and though the cause lay partly in mental inertia and indifference, it lay partly also in the rise of the biometrical school of evolutionists. Basing their methods upon the conception of variation as a continuous process, it was not unnatural that they should show a lack of sympathy with the evidence for discontinuity and all that it implied. Controversy became keen, and Bateson was more than once called upon to defend the position he had taken up. The ability with which he conducted his case, and the freshness of his outlook, began to attract to him the allegiance of some of the younger men, who felt that a new force had entered into their studies.

Meanwhile Bateson had started on another line. Satisfied as to the existence of discontinuity in variation, he felt that the next step was to discover how such varieties behave on crossing. He carried out an elaborate series of breeding experiments in Lepidoptera, especially with the *bryoniæ* form of *Pieris napi*, and certain geographical races of *Pararge egeria*. The results were difficult to interpret and he came to the conclusion that, if headway was to be made, material must be chosen in which the problem was reduced to its simplest form. In collaboration with Miss E. R. Saunders, a series of experiments was begun with plants where a sharp discontinuous variation existed together with the normal form, and a year later experiments planned on similar lines were undertaken with poultry. The aims underlying this work, and the hopes entertained of it, are set out in an address to the Hybrid Conference held in London during July 1899. Noteworthy is the announcement that discontinuity in heredity had already been detected, as also is the stress laid upon the necessity of examining the outcome of a cross *statistically*, and of marshalling the offspring in respect of each differentiating character separately. It was precisely this method of analysis that led to Mendel's success, and even if his famous paper had remained unknown, it is likely that the world would not have had long to wait for that guiding principle which lifted the study of heredity into its place among the exact sciences. Be that as it may, the discovery of Mendel's work in 1900 found Bateson well prepared. He intuitively recognised its high quality, and at once seized upon the essential truth of the purity of the gametes in respect of definite characters. In the following year he communicated to the Evolution Committee of the Royal Society an illuminating report, summing up the evidence and indicating the bearing of Mendel's discovery upon cognate lines of work. It was a report that opened men's eyes to the greatness of the achievement, and it exerted a strong influence in inducing others to pursue such investigations.

In Great Britain, however, there was opposition from one quarter, and that an influential one. The biometricians had already given evidence of hostility to the idea of discontinuity in variations. Exponents and upholders of what was known as the law of ancestral heredity, they could not but realise that the acceptance of the doctrine of gametic purity must shatter the very foundations upon which they were striving to build. With the revelation of discontinuity in heredity, it was open to them either to throw

over the law of ancestral heredity, or to combat the new doctrine in whatever way they could. The latter course was chosen, and in *Biometrika* for January 1902 appeared a paper by Weldon minimising the importance of Mendel's discovery, and stating that neglect of ancestry was a fundamental mistake vitiating all work based on Mendel's methods. A challenge of this sort coming from such a quarter could not be overlooked. A great cause was at stake, and some few months later appeared "Mendel's Principles of Heredity: a Defence," a book in which Bateson gave free scope to his great powers of analytical criticism and to his remarkable gifts for controversy. The issue was joined, and Mendel was at any rate assured of his hearing. Two years later came the great clash at the meeting of the British Association in Cambridge. Bateson, as president of the Section of Zoology, delivered a stirring address vindicating the methods of Mendelian research, and challenging the conceptions of the biometrical school. The heated debate which succeeded it was keenly followed by a crowded audience, and at the end of it there was no mistaking the feeling that the exponents of Mendel had made good.

Meanwhile, Bateson had thrown himself wholeheartedly into the exploration of the fresh field that had been opened up, and the next few years were fruitful in discovery. To this period belong the formulation of the presence and absence theory, the solution of the old problem of reversion on crossing, and the demonstration of the nature of sex-linked inheritance. Another discovery of the first importance was that of linkage of characters. Originally detected in the sweet pea, the phenomenon was first fully explored in this material, and eventually fitted into an orderly scheme. Its later development in the hands of the American school of geneticists, and its translation into terms of the chromosomes, are now part of the history of science.

Bateson stood, however, for more than discovery. The new spirit that he breathed into the work, and the freshness of his outlook, were an irresistible attraction to many younger workers who desired nothing better than to cast in their lot with his. He became the founder and inspirer of a Cambridge school, and in 1908 the University recognised his peculiar position by creating for him the chair of biology. In the following year appeared "Mendel's Principles of Heredity," a critical survey of the state of genetical knowledge. Nevertheless, immersed as he was in breeding work, the problem of species was always with him; and when he was invited to deliver the Silliman lectures in 1907 he elected to give, not an exposition of Mendelian heredity, but a fresh consideration to the problems of variation and of species. The lectures eventually took permanent form in the "Problems of Genetics" which appeared in 1913. Perhaps the most valuable part of the book is the illuminating discussion on variation in connexion with locality and climate, though at the time of its publication the chapters which attracted most attention were those dealing with adaptation and the effect of changed conditions on the organism. About that time there had appeared several plausible accounts of the induction of a variation through a change of conditions, and of its subsequent inheritance. The searching criticism to which Bateson subjected the evidence was of the greatest service in checking any easy acquiescence on the part of biologists and others less familiar with such branches of inquiry.

The Cambridge period came to an end in 1910 on the acceptance of the directorship of the newly founded John Innes Horticultural Institution at Merton. It was a great opportunity, and Bateson made magnificent use of it. When he went there was nothing: in a few years there grew up a splendidly equipped station, and, of far greater moment, an enthusiastic and devoted band of workers. Here, too, his position gave him better facilities for promoting that co-operation between the practical breeder and the man of science upon which he had so often insisted. He made the breeder feel that his problems were also the problems of science, and out of his sympathy begat trust. Of his own inquiries at this period, and of those directly inspired by him, the key-note was segregation, its nature and the time of its occurrence. To this impulse we owe the striking series of investigations on variegation, bud sports, and root-cuttings, and on the phenomenon of anisogeny, accounts of which appeared from time to time in the *Journal of Genetics*; and it is in the fitness of things that his matured judgment on these phenomena should have appeared in that journal only a few days before his death.

Such in brief outline was Bateson's record of scientific achievement. Fearless in criticism and generous in appreciation, he stood above all for that spirit of freedom in inquiry through which alone the world may progress to better things. In that noble passage which concludes the preface to his greatest book, he has recorded for us in unforgettable words his lofty conception of the calling of the naturalist. By no man has this been more finely set forth: by none has it been more truly lived.

PROF. J. F. GEMMILL, F.R.S.

JAMES FAIRLIE GEMMILL was born at Mauchline in Ayrshire, and went from the village school and Kilmarnock Academy to the University of Glasgow. After a long and distinguished course in arts (honours classics, 1890), medicine (M.D. honours, 1900), and science (D.Sc. 1910), a period in Germany, a taste of medical work, and some travel, he became a research fellow in embryology in the University of Glasgow and a teacher of zoology to training college students. He was greatly influenced by the anatomical teaching and evolutionary thinking of Prof. John Cleland, for whom he had a very strong affection.

It was early in the Glasgow period that Gemmill became keenly interested in the Millport Biological Station, to which for many years, with extraordinary persistence, he devoted much of his time, not only contributing to the output of research, but also encouraging others to join in, and otherwise helping in the educational side of the Station's work. Until he was called to the Dundee chair of zoology in 1919, Gemmill was a disinterested and loyal friend of the Millport institution, which after many ups and downs of youth has at length attained to a vigorous maturity. Others have greatly aided, but Gemmill's patient fostering in early days should never be forgotten.

Gemmill had wide zoological interests—anatomical, faunistic, ecological, and embryological; but the last was strongest. His researches on the development of echinoderms will form his chief zoological monument; they are masterly in their precision of observation and shrewdness of judgment. But one remembers also his embryological studies among cœlenterates, and his big memoir on the teratology of fishes (1912). When he went to Dundee, he told us that he had passed a self-denying ordinance, and was going to devote himself for some years to a study of practically important farm-pests; and so he became immersed with his usual enthusiasm in the unravelling of the life-history of a species of Bibio, and of some other parasites, such as an elusive tapeworm that is common in lambs. He had a great interest in mechanical devices, of which his little marine aquarium was the simplest—a study aquarium in which he kept sea-animals flourishing in the heart of Glasgow, and even discovered new Clyde species from there. We hope his technical ingenuities will not be lost sight of.

Prof. Gemmill was very happy in his Dundee years. He enjoyed the concentration of his academic work and the opportunities it gave him for diffusing and fostering an interest in biology through the Natural History Society, and the like. His election to the Royal Society came as another encouragement. He found great delight in furnishing an interesting old house, and he was helped at every turn by his niece, to whom he was devoted. He was never the same after her sudden death in 1924.

We should like to be allowed to pay a more personal tribute of affection to one whom we have been proud to call friend for many a year. Gemmill was a singularly lovable man, quiet and gentle, but very strong in grip and firm in judgment. Even for Scotland he was unusually thoughtful, always pondering; even for a scientific investigator, he was unusually cautious. Thus his clear-cut judgments, when the evidence seemed to him sufficient to warrant a conclusion, were always worth waiting for. Of judgments on persons we never heard him give one, though he had his share of fighting, and when an outspoken personal condemnation was uttered in his hearing, his grave face would become graver still and sad. Yet he was no 'Heaven and Hell Amalgamation Man'; on the contrary, a very clear-headed discriminator of persons.

What a fine companion Gemmill was, radiating cheerfulness, enlivening on a long walk, heartening when the dredge was coming up, magnanimous on the golf course, but always in his own peculiarly restful quiet way. Never of the strongest, he was very wiry, with great power of physical endurance, and on his holiday in Norway last summer, with a great sorrow, not even dulled, as his shadow, he probably walked harder than was wise. Whether over-tired or specifically infected, he came home under a cloud of nervous depression which became darker and darker until at the last it overwhelmed him.

Gemmill was an upright man, reverent, good through and through; he was frugal and abstemious, fond of his kindred and friends, full of kindliness to all men of good-will. He liked simple pleasures—always keen on a walk; he loved children; he delighted in his garden, his study-aquarium in Glasgow days, the flowers of the field, his pets—the dog most of all. He enjoyed meeting people when the day's work was done and he had a talent—perhaps a genius—for friendship. That he was pre-eminently interested in zoology is obvious, and he once told us that he was glad that amid ups and downs he had been able to hold by an early resolve that he would allow nothing—even teaching—to come between him and investigation. Often we pressed him to write a book, for he had very individual ideas, about organic evolution, for example, combining Lamarck's outlook with Goethe's, but he always resisted what he smilingly called a "temptation." We must think of Gemmill as one who made a great success of life, for he had the joy of many red letter days of discovery along the line which he had proposed to himself as his. Amid all his profound seriousness he greatly enjoyed Nature and many of the pleasures of human life; and was he not greatly beloved?

Why was it that we all, so different from one another, liked the man so much? Perhaps part of the reason was our quick discovery that he was thinking more about us than about himself. It was not only that he was overflowing with kindness, but he had also the rare gift of affectionate interest—half a naturalist's, half an artist's—in individuality. He took pleasure in our eccentricities; he delighted in our ruggednesses; he enjoyed our upsetting enthusiasms. Alas, alas, that there was no staying the Fury with the abhorred shears; but we doubt not that our friend will live on for his full span in the minds of many made better by his presence.

J. A. T.

We regret to announce the following deaths:

Prof. A. C. Eycleshymer, Dean of the College of Medicine of the University of Illinois, distinguished for his work on vertebrate embryology, on December 30, aged fifty-eight years.

John K. Hillers, an early member of the United States Geological Survey who, while in charge of the Photographic Laboratory of the Survey, was responsible for many photographs of noteworthy geological features of the western United States which have passed into text-books and reports, on November 14, aged eighty-two years.

Dr. Martin Murphy, president in 1902–3 of the Canadian Society of Civil Engineers, distinguished for his work on railway bridge-building, on January 10, aged ninety-four years.

The Hon. Sir H. A. A. Nicholls, lately Principal Medical Officer of Dominica, West Indies, known for his work on tropical diseases and on tropical agriculture, aged seventy-four years.

Prof. H. Kamerlingh Onnes, For. Mem. R.S., for many years Director of the Physical Laboratory at the University of Leyden, and Nobel prizeman for physics in 1913, on February 21, aged seventy-two years.

M. Adrien Robert, of the Sorbonne, secretary of the Zoological Society of France, on November 16, aged fifty-eight years.

Dr. M. B. R. Swann, fellow of Caius College and demonstrator in pathology in the University of Cambridge, from blood poisoning contracted during a *post-mortem* examination, on February 16, aged thirty-two years.

Mr. J. Whytock, first president of the Botanical Society of Edinburgh and a recipient of the Victoria Medal of Honour of the Royal Horticultural Society, on February 1.

News and Views.

THE president and council of the Royal Society decided at their meeting on February 18 to recommend for election into the Society the following fifteen candidates: Dr. J. A. Arkwright, Dr. E. J. Butler, Lieut.-Col. S. R. Christophers, Prof. F. J. Cole, Mr. A. C. G. Egerton, Dr. Ezer Griffiths, Mr. H. B. Hartley, Dr. H. Hartridge, Prof. G. B. Jeffery, Prof. O. T. Jones, Prof. W. C. McCullagh Lewis, Prof. E. A. Milne, Mr. L. F. Richardson, Mr. H. T. Tizard, Prof. R. S. Troup.

THE following have been recommended for fellowship of the Royal Society of Edinburgh: Prof. K. W. Braid (Glasgow), Prof. A. E. Cameron (Saskatchewan), Mr. R. T. Francis (Purley), Mr. J. D. Gardner (Edinburgh), Prof. J. G. Harrower (Singapore), Lieut.-Col. W. F. Harvey (Kasauli), Dr. S. R. Khastgir (Edinburgh), Dr. N. S. R. Lorraine (Hull), Mr. J. A. M'Bride (Glasgow), Very Rev. Dr. D. MacKichan (Edinburgh), Dr. D. C. T. Mekie (Edinburgh), Mr. J. A. Morris (Ayr), Dr. D. Patton (Glasgow), Dr. B. Prashad (Calcutta), Mr. J. A. F. Roberts (Edinburgh), Mr. W. H. C. Romanis (London), Colonel Sir Bruce Gordon Seton (Edinburgh), Prof. J. Small (Belfast), Dr. W. N. Stokoe (Edinburgh), Prof. G. H. Thomson (Edinburgh), Dr. J. Thomson (Glasgow), Mr. C. P. G. Wakeley (London), Mr. S. Williams (Glasgow).

A FURTHER stage in the development of the comprehensive scheme of irrigation for Egypt and the Sudan, forming a corollary to the work recently carried out at the Sennar Dam and described in the issue of NATURE of February 6, is detailed in the report, just issued by the Public Works Department of Egypt, relating the results of the mission despatched in 1920 to Lake Tsana, in Abyssinia, for the purpose of considering the possibility of converting the lake into an artificial reservoir. Lake Tsana is the source of the Blue Nile, which is controlled on the Gezira Plain by the Sennar Dam. The verdict of the mission is that the lake is eminently suitable for the purpose in question. The annual discharge during normal years is estimated at 3500 million cubic metres, and this is the amount that could generally be stored. But by certain engineering operations, including excavation of the rock sill at the outlet, it would be possible to increase the reserve storage to 8000 million cubic metres, which would be sufficient to meet deficiencies, if two seasons of low supply were experienced in succession. This reserve storage of 8000 million cubic metres, added to the annual supply of 3500 million cubic metres, would therefore give the reservoir a total effective capacity of 11,500 million cubic metres. The report estimates the cost of the work at £E2,300,000, and it is indicated that the work could be completed without the necessity of establishing any permanent means of communication with the Sudan; but if a railway or road to Gedaref should be found necessary, an increase in expenditure would follow. The Abyssinian Government has regarded the matter favourably and given its co-operation in the investigations. It is hoped, therefore, in view of the fact that the waters of the lake are of no service to the inhabitants for irrigation of its shores, while they would undoubtedly be of considerable value to Egypt and the Sudan, that the Abyssinian Government will grant at an early date the desired facilities for constructing the proposed regulation works.

THE Department of the Interior, United States Geological Survey, has just published the statistical summary of petroleum production and consumption for the year 1923, from the compilation of Mr. G. B. Richardson. In this memorable year all previous records for the output of crude petroleum in the United States, and, incidentally, for the world, were broken by the production in that country alone of 732,407,000 barrels of oil, constituting 72 per cent. of the total world's output for that year. This figure also implies a 31 per cent. increase on the output of the United States for the previous year, and was attained largely as the result of flush production from a number of rich pools, the maximum yield of which occurred during this year. The domestic production of the country was further augmented by imports of crude oil amounting to 82,015,000 barrels, thus creating a record total supply of oil in America of 814,422,000 barrels. Consumption, on the other hand, was less than domestic production, for the first time since 1914.

THIS extraordinary output of petroleum in 1923 created a serious phase of over-production and brought with it a corresponding slump in prices of crude oil and a depressed state of the oil industry generally, from which recovery has been slow. Since 1923 a considerable body of opinion has been expressed that that year's production of petroleum represented the 'peak' of the United States, and probably of the world, and some rather gloomy forebodings regarding the future of petroleum supplies have been voiced, both in the United States and in Europe. For many reasons there may be expressed some doubt on this point, though it is not denied that once the peak is definitely passed, the life of petroleum supply may be a comparatively short one at the present rate of consumption. On the other hand, the advent of a new pool comparable with any one of those responsible for the flush production of 1923 would quite possibly bring an annual total up to that of that particular year; and as there is no reason to suppose that the last 'bonanza' oil-pool has been found, there is still some hope that 1923 was not the 'peak-year' of either United States production or of that of the world.

A REFRIGERATOR which is claimed to be the only known contrivance for the continuous production of cold without the use of mechanical moving parts was brought before a large gathering at the Savoy Hotel in London, on February 23. The machine is being put on the market as the Electrolux Refrigerator (153-155 Regent's Street, London, W.1). It operates

on the Platen-Munters system, ammonia being used as the working fluid, and hydrogen is employed to keep the pressure uniform throughout the plant. A cylindrical iron vessel containing a solution of ammonia is heated, preferably electrically; the water vapour is condensed and runs back into the 'generator,' and the ammonia passes on, being condensed in a water-jacketted tube leading to the 'evaporator.' Here it descends over baffle plates and evaporates, producing a lowering of temperature of the 'evaporator' and non-freezing solution surrounding it, and so of the chamber which it is required to cool. Ammonia gas, with the hydrogen filling the plant, passes down the 'evaporator' to the 'absorber,' where it meets a weak solution of ammonia running under gravity from the 'generator.' The ammonia is absorbed and passes back to the 'generator' by an ingenious 'trap' actuated by the heating element, while the hydrogen released goes on again to the 'evaporator.' The whole apparatus is of iron and is sealed, and there are no mechanical parts to require attention. Small plants only were shown, but other models are being produced.

THE prevalence and danger of insect pests in connexion with the growing of cotton led the Department of Agriculture in the Tanganyika Territory in 1922 to establish rules concerning the cotton crop. Two of the rules provide for the uprooting and destruction of all cotton refuse remaining at the end of the cotton growing season. A leaflet entitled "What to do at the end of the cotton season and why?" has been issued recently to planters and native cultivators. The dangers and breeding habits of insect pests, such as the red cotton-stainer and pink boll-worm, are pointed out, and reasons are given for the rules prescribing the uprooting of cotton and the destruction of wild plants allied to cotton at the close of the season. 'Ratoon' cotton in Tanganyika tends to harbour such insect pests and provides a ready source of infection for the new crop in the succeeding season, for such 'ratoon' plants produce bolls much earlier than the plants of the new crop. Similarly, dead stalks and other refuse from the cotton crop, if not destroyed, harbour the pests during the period between crops. Weeds such as Hibiscus and trees like Bombax (Eriodendron) may also enable the pests to carry over from season to season. The leaflet thus advocates thorough cleaning up of all plantations, as early as possible, pointing out that the earlier the clean-up the longer will be the famine period for the insects. The leaflet is printed in English and in the native language.

SEASONAL forecasting in India has been developed for some years, and considerable progress has been made in the application of statistical methods to weather prediction. A memorandum on the probable character of the weather in north-west India in January, February, and March was issued last month by Mr. J. H. Field, Director-General of Indian Observatories. Out of four principal factors available, two are practically neutral; these are the December rains at Port Blair and the pressure at Seychelles in November and December. The December rains in the western region were adverse, while the factor of rainfall at Seychelles in November and December and at Zanzibar in December was favourable. The seasonal change of the upper-air currents in northern India at a height of 3 to 5 miles above sea-level promises to prove of importance as observations accumulate; the prospect of winter rains from November to March for north-west India bears a close relation with the relative vigour of these high-level winds during the latter half of September and in October. The factor of the upper winds indicates a slight excess of precipitation. The final conclusion from all data available is that the winter precipitation, rain and snow, in north-west India is likely to be normal.

UNDER the title of "The Botanical Case for Evolution," the veteran palæobotanist, Dr. D. H. Scott, writes entertainingly and instructively in the *Nineteenth Century* for February. Pointing out that the experience of plant-breeding, whether carried out by the cultivator or the experimenter, shows that species are often not unchangeable, he bases the case for evolutionary change in Nature upon the following grounds: (1) Classification and its recognition of affinity, most readily interpreted in terms of descent; (2) the fundamental unity of organisation throughout the living world; (3) the comparison of organs and structures in different groups of plants, which show us an organ functional in some species, useless in others, turned to fresh uses in yet other species, etc.; (4) the geological record, in spite of such 'abominable mysteries' as the sudden appearance of the flowering plants in the Cretacean period. In his concluding remarks Dr. Scott quotes with evident sympathy from Witham of Lartington, the first to investigate the structure of fossils, who wrote in 1833: "To lend my aid in bringing from their obscure repositories the ancient records of a former state of things with the view of disclosing the early and mysterious operations of the Great Author of all created things will ever be to me a source of unalloyed pleasure." There can be little doubt that for Dr. Scott, too, it has been an unalloyed pleasure to attempt to disclose the "early and mysterious operations" in the history of the vegetable kingdom, and the result has been the great series of monographs, and still more the 'Studies' through which most of the present younger generation of botanists first make their acquaintance with the flora of the past.

THE anthropometric measurements made in the schools of England and Wales as a part of medical inspection are intended primarily as a test of physique and, except in a limited degree for specific purposes, or experimentally, their correlation with mental characters has not been attempted. The difficulty of any extended investigation of mental characters lies in securing uniformity in standard when anything involving a process which is not susceptible of a straightforward mechanical record is attempted. This difficulty vitiates to a certain extent some interesting investigations made by Dr. Arthur MacDonald of Washington, D.C., in which he has attempted to

correlate mentality with physical measurements. A summary of his results was given in the *Medical Times* for November. According to his figures, dolichocephaly both as an individual and as a racial character appears to be associated with dulness and unruliness; brachycephaly with brightness; further, that both dolichocephaly and dulness increase after puberty, while brachycephaly decreases. He also records some interesting and rather surprising results relating to the correlation of physique and individual history of disease in students. Dr. MacDonald's figures must be taken for what they are worth, and although based upon a large number of observations, his inferences should be accepted with reserve. He attributes to anthropologists some sweeping conclusions on head form which few would endorse without qualification. It is scarcely necessary to point out the value to educationists of research which would show a valid correlation between physique and mentality to be generally applicable, even on the broadest lines, and not confined to abnormalities.

THE latest annual report of the Bristol Museum and Art Gallery records the offer of Sir George A. Wills to provide an extension of the building on the recently acquired site of the old Drill Hall, at a cost not exceeding 75,000*l*. The offer, which was accepted "with intense gratification," provides for a new Art Gallery to the plans of Messrs. Frank W. Wills and Sons; the architects of the existing gallery. This will occupy a little more than one-third of the whole site; the present gallery will be devoted to ethnography and antiquities, again about one-third; while the remaining third will be entirely available for the natural history collections, except for the large lecture-theatre serving the whole. Important bequests recorded comprise a collection of foreign lepidoptera, formed by the late Mr. G. C. Griffiths; a collection of big-game heads and native weapons, from the late Sir William Garstin; and a collection of British and foreign birds and 120 Baxter and Le Blond prints, from the late Mrs. Dalton-Burgess. The fine collection of engravings formed by Mr. Heber Mardon and presented by deed of gift in 1919 together with his extra-illustrated copy of Nicholls and Taylor's "Bristol Past and Present," in fourteen large volumes, was handed over by the family on Mr. Mardon's death in 1925. All this has thrown much work on the staff, and it is the more satisfactory to note that the valuable geological collections of the Museum are being made more accessible than they have been for many years, and that important specimens have been brought to light. Alderman Eberle and Dr. Herbert Bolton are to be congratulated on a report that shows progress in every direction.

THE British Museum (Natural History) is issuing a remarkable series of picture postcards illustrating many of the most interesting specimens contained in the Museum collections. A particularly attractive set of these cards, lately published, includes selected representations of exotic butterflies, moths, beetles, homoptera, heteroptera, and orthoptera. The figures are admirably executed in colour, and each packet of five cards (price 1*s*.) is furnished with an explanatory leaflet giving a concise account in general terms of the group or subject illustrated, and directing especial attention to any points of interest shown by the specimens represented. Thus, the letterpress contained in one of the packets devoted to butterflies gives a general account of the curious phenomenon of seasonal variation in these insects, and then proceeds to a brief but accurate description and discussion of the examples represented on the accompanying cards. These comprise figures, beautifully executed, of three striking African forms, in two at least of which, *Teracolus achine* (a "white" butterfly, or Piernie) and *Precis octavia* (a nymphaline allied to our Peacock and Red Admiral), the differences between the seasonal phases are so great that they were long held to be distinct species. Another packet contains excellent figures of some of the splendidly coloured Swallowtails of South America, and directs attention, in its accompanying notes, to the mimicry of other South American butterflies adopted by some members of the group. The brilliant colours exhibited by several of the grasshoppers, beetles, bugs, and moths represented in other packets will be a revelation to many whose acquaintance with these groups is only slight. These features are well brought out by the method of representation employed, and the claim of the Museum, that as much care has been taken with the figures as if they were destined to illustrate scientific monographs, is completely justified.

WE are informed that the Museum of Practical Geology, 28 Jermyn Street, S.W.1, is closed for repairs until further notice. Access to the Library and Offices of H.M. Geological Survey may be obtained through the entrance in Piccadilly.

PROF. KARL VON DEN STEINEN, Berlin, world known by his anthropological explorations in Central Brazil, and Baron Erland Nordenskiöld, of the Göteborg Museum, have been elected honorary members of the Paris Société des Américanistes.

DR. F. A. BATHER, keeper of the department of geology, British Museum (Natural History), has been elected a foreign member of Die Kaiserliche Deutsche Akademie der Naturforscher zu Halle. This is the oldest scientific academy in the world, having been founded in 1652.

WE learn from *Science* that a physico-chemical institute, to serve as central laboratories for scientific work in Spain, is assured by a gift of 40,000*l*. from the Rockefeller Foundation. The site of the building will be provided by the Spanish Government. It will probably be near the Museum of Natural Sciences in Madrid.

PROF. A. S. EDDINGTON will deliver the Bakerian Lecture of the Royal Society on May 6, taking as his subject "Diffuse Matter in Inter-stellar Space." The Croonian Lecture will be delivered by Prof. A. V. Hill on the "Laws of Muscular Motion" on May 20. On March 4, a discussion on "The Electrical State of the Upper Atmosphere" will be opened by Sir Ernest Rutherford.

THE Botanical Society of America, at its recent meeting in Kansas City, Missouri, elected the following corresponding members: Profs. A. Engler and K. Correns, of the University of Berlin; Prof. C. Sauvageau, of the University of Bordeaux; S. Nawaschin and Prof. R. Willstätter, of the University of Munich. Previously elected corresponding members are Profs. V. H. Blackman, F. C. Bower, Hugo De Vries, K. von Goebel, and A. C. Seward.

A MEETING will be held at the rooms of the Linnean Society on Wednesday, March 10, at 3.30 P.M., to consider a suggestion that the fifth International Botanical Congress should be held in London in 1930; and, in the event of the suggestion being adopted, to formulate an invitation to be submitted to the ensuing fourth International Botanical Congress at Ithaca, U.S.A., in August next. The Hooker Lecture of the Linnean Society will be delivered this year by Prof. Carl Schröter, foreign member of the Society, of Zurich, on April 15, and will be entitled "The Swiss National Park and Scientific Researches into its Nature."

THE Empire Council of Mining and Metallurgical Institutions, Cleveland House, 225 City Road, London, E.C.1, on behalf of ten constituent bodies, has accepted the invitation of the Canadian Institute of Mining and Metallurgy to hold the second Empire Mining and Metallurgical Congress in Canada in August-September 1927. It will be recalled that the first Congress, from which the Empire Council arose, was held at the British Empire Exhibition, Wembley, in 1924, under the presidency of the late Viscount Long of Wraxall.

THE Royal Academy of Sciences in Sweden has appointed a committee, consisting of Prof. Osten Bergstrand, of Upsala, Prof. C. V. L. Charlier, of Lund, and Profs. Karl Bohlin and V. Carlheim-Gyllensköld, of Stockholm, to organise the celebration of the 350th anniversary of the foundation of Tycho Brahe's "Uraniborg"—the city of the heavens. This magnificent observatory, famous in the history of astronomy, was built in 1576 on the island of Huen, which was granted to Tycho Brahe for life by Frederick II., King of Denmark. The island now belongs to Sweden.

IN the House of Commons on Thursday, February 18, Mr. MacDonald presented a petition at the request of his co-Trustees of the British Museum. The petition recited the capital holdings which the Trustees had and the income derived from the holdings, and stated that the income was not sufficient to enable the Trustees to carry out their trust efficiently. In conclusion, the Trustees asked for "further support towards enabling them to carry on the execution of the trust reposed in them by Parliament for the general benefit of learning and useful knowledge."

ON the initiative of the Orientalists' Association of Leningrad, it is proposed to hold the first International Exhibition of Buddhism at Leningrad in the autumn of 1926. The nucleus of the exhibition will be furnished by the rich Buddhist collections of the Russian Museum of the Orientalist Association and of the Asiatic Museum of the Academy of Sciences. Japan, China, Tibet, Mongolia, and other countries will be represented. The Academy of Sciences has despatched Prof. Stcherbatsky to Japan and Prof. Alexeiev to China to collect exhibits.

IT is announced that further collections of objects discovered by Col. Kozlov in Mongolian mounds have been received at Leningrad. These include both Greek objects and objects of local manufacture showing Greek influence. Among the more remarkable are Greek fabrics and embroideries with designs of flowers, birds, and human figures in the Greek style. Particularly noteworthy is a piece of embroidery showing a group of horsemen. The Greek ornament and the Scythian dress, headgear, and harness of the horsemen suggest that the embroidery is derived from one of the Græco-Scythian settlements of South Russia.

THE Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation was established in the first place for the encouragement of medical and allied research, grants being made for the purchase of special apparatus and supplies and preference being given to researches on a single problem. According to the second annual report recently issued, thirteen grants varying from 40*l.* to 340*l.* were made last year, four of which were for investigations on chronic nephritis. Five of last year's grants were to workers in Europe. Applications for grants for the year 1926–27 should reach the secretary of the committee of the Foundation at Boston City Hospital, Boston, Massachusetts, before May 15.

TWO awards are announced in the January issue of the *Journal of the Franklin Institute*; the John Price Wetherill Medal to Mr. F. Twyman, London, and the Edward Longstreth Medal to Mr. T. Midgley, Dayton, Ohio. The award to Mr. Twyman is for the Hilger interferometer, which provides a simple and accurate method of locating and correcting imperfections in prisms and lenses. It will be recalled (NATURE, July 14, 1921, p. 635) that in this instrument a beam of monochromatic light is divided into two parts, one of which is passed twice through the object under test. The two beams are recombined so as to produce a set of interference bands which form a "contour map" of the imperfections of the optical element under test. The award to Mr. Midgley is for the Midgley optical indicator. This instrument is a high-speed indicator for use with internal combustion engines. A beam of light falls upon a mirror the position of which is determined by the position of the piston in the cylinder. The light is reflected to a revolving mirror the position of which depends on the second element required, and a pressure-volume or pressure-time curve can be obtained. Novel methods of reducing inaccuracies due to inertia of moving parts are adopted and the use of a spring and piston in the pressure element makes it possible to use a uniform scale for the entire height of the pressure card.

THE provisional programme of the Optical Convention, 1926, which has now been issued, shows that every effort is being made to ensure that the Convention will provide a comprehensive and complete survey of British contributions to optics in recent years, and of the position of optical science and the optical industry at the present time. The Convention will be held, under the presidency of the Astronomer Royal, at the Imperial College of Science, South Kensington, on April 12-17 inclusive. Scientific and technical papers, dealing with every branch of theoretical and applied optics, will be read and discussed, and special discourses will be given, including lectures of a popular character accompanied by demonstrations. The most modern types of optical instruments and apparatus will be exhibited by British manufacturing firms in all branches of the optical trade. There are also to be exhibits illustrating the results of recent optical research and the application of optical methods in the laboratory. Demonstrations and dramatic performances, incorporating various interesting optical illusions and projection effects, are being specially composed for presentation during the Convention. Particulars of membership of the Convention and forms of application may be obtained from the Secretary, 1 Lowther Gardens, Exhibition Road, S.W.7.

THE technical programme has now been issued of the sectional meeting organised by the Swiss National Committee of the World Power Conference to be held at Bâle on August 31–September 12 next. The work of the meeting will be divided into five sections dealing with the utilisation of water power and inland navigation, exchange of electrical energy between countries, hydraulic and thermal production of electrical energy, electricity in agriculture, and railway electrification respectively. Contributions will be regarded as National Papers (presented on the initiative of a national committee or of a member of the International Executive Committee) or Reporters' Papers (prepared by general reporters appointed by the Swiss National Committee, summarising national papers presented before April 1 and emphasising definite aspects of the subjects discussed). Papers and discussions are to be published in a volume of proceedings. Communications for the British National Committee should be addressed to the Secretary, World Power Conference, 36 Kingsway, London, W.C.2.

H.M. STATIONERY OFFICE announces for publication at the end of the month a special edition of the "Nautical Almanac 1928" bound in cloth boards; the edition in wrappers is also available. The edition in cloth will be continued in future years if it is found to meet a public need. Both editions may be obtained from Mr. J. D. Potter, 145 Minories, E.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in pharmaceutical and general chemistry at the School of Pharmacy of the Pharmaceutical Society of Great Britain—The Secretary of the Society, 16 Bloomsbury Square, W.C.1 (April 12). A professor of zoology in the University of Calcutta — The Registrar, University of Calcutta, Senate House, Calcutta (April 12). An assistant lecturer in mathematics in the University of Leeds—The Registrar (April 21). A principal for the proposed University College for Hull—The Secretary to the Board of the College, Guildhall, Hull (May 1). Lecturers in historical geography and physical geography at University College, Reading—The Registrar. An honours graduate in physics as assistant under the British Research Association for the Woollen and Worsted Industries—The Secretary, Torridon, Headingley, Leeds.

Our Astronomical Column.

RECENT SUNSPOTS.—In our issue of February 20, p. 282, mention was made of the third appearance of a spot in south latitude 21°. When more fully on the sun's disc, it could be seen with the naked eye, and should therefore be included in the list of naked-eye spots, as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
4	Feb. 13–25	Feb. 19·1	21° S.	1/2000

The spot was typical of a regular spot with well-defined filamentary structure of the penumbra and stable outline. It may be expected to return at least once again, though probably as a telescopic object only.

As noted last week, the great spot of January returned, but it was only about one-sixth of its previous size. It was accompanied, however, by a very extensive region of bright faculæ, seen easily when near the sun's limbs with a small telescope.

Spot No. 3, which was on the sun's central meridian on February 15, decreased rapidly and was of less than naked-eye visibility by February 16.

THE TEMPERATURES OF THE PLANETS.—The issue of the *Physikalische Zeitschrift* for December 23, 1925, contains a report by Dr. E. Schoenberg on the present state of our knowledge of the temperatures of the planets. For planets still in the gaseous state there is as yet no satisfactory theory connecting the radiation sent out with the temperature distribution, but for those having solid crusts, either with or without atmospheres, Milankowitsch in his recent book has provided a satisfactory theory, which the author reproduces in the earlier sections of his report. He then describes the radiometer measurements made during the past twelve years at the Lick and Arizona observatories, and gives as the most reliable values of the surface temperatures: Venus 45° C., Mars − 15° C., Jupiter and Saturn − 80° C., the value for Venus being somewhat doubtful, but the others much more trustworthy. Dr. Schoenberg concludes his report by describing a method he has devised, and already applied to the visible portion of the spectrum, for determining the density and temperature of the atmosphere of a planet at any depth below the visible surface, by photometric measurements of the twilight band at the terminator, his theory being that the brightness of this band is due to diffusion only, and not to absorption.

Research Items.

MEGALITHIC WORKS IN FIJI.—In *Man* for February, Mr. James Hornell figures and describes some of the megalithic sea works and temple platforms at Mbau in Fiji. Mbau is the most historic place in Fiji and was the seat of government of Chief Thakombau, who in the middle of the last century brought many of the other chiefs under subjection. The sea works which are described consist of a number of docks and piers into which the big outriggers and double canoes were run. Of these docks there are now twenty-five, some of which were made during the latter part of the last century by dividing up the larger docks. The sides of the wharves are protected in three different ways, of which the most characteristic is by means of large slabs of rock set on edge, of various sizes running up to 11 feet 8 inches in height. Little attempt has been made to shape them. The most important of these docks was probably the ceremonial landing-place of the head of the dominant community. Prisoners of war were possibly also landed here and brained for the ceremonial feast. As regards the age of these structures, a comparison with a similar structure at Mua (Tongatabu), which may be connected with the sons of the Tongan king Tui-ta-tui, suggests the end of the thirteenth century as a possible date.

PSYCHICAL METHODS IN MEDICINE.—In *Psyche* (January 1926) Dr. F. G. Crookshank contributes an interesting article entitled "Spiritual Healing in the Light of Modern Medicine." He directs attention to the lamentably slack use of terms implied in such phrases as organic versus functional disease, suggestion and faith healing, physical versus psychical methods of cure, which phrases, he thinks, have long outlived their usefulness. He pleads for a stabilisation of verbal symbolism on a basis of real values. Although physicians profess to have no metaphysical prejudices, much of their actual practice is based, not on any assured basis of observation, but on the dregs of the psycho-physical parallelism of the last century. The result has been a neglect of the functional neuroses by the orthodox physicians. The antinomy between functional and organic disease was invented in order that "we might say that organic disease is what we say we cure but don't, while functional disease is what the quacks cure and we wish to goodness we could"! Actually, the so-called physical and the so-called psychical methods are indistinguishable objectively, and the prescriber of drugs is often aware that faith plays no small part in procuring the efficacy of the drug. He believes that the scope of psycho-therapy is coterminous with the whole range of disease, though never to the exclusion of what we call physical methods. Wherever there is scope for psycho-therapy there is a mental conflict, and this is present far more frequently than is imagined in cases deemed to be suffering from organic disease only. But it is necessary to adopt a changed attitude in respect of the mind and matter controversy. Dr. Crookshank protests against the assumption that the rational foundations of science are all well laid, and he maintains it is unscientific to reject testimony of strange occurrences just because such are thought incompatible with what we call science. The article is thoughtful and provocative, and is worthy of consideration by all those whose work involves dealing with people, whether in the capacity of physician, teacher, preacher, or employer. It is well at times to revise one's assumptions.

ACTION OF X-RAYS ON THE DEVELOPING CHICK EMBRYO.—Drs. Colwell, Gladstone, and Wakeley (*Jour. Anat.* 60, pp. 207-28, January 1926) give an account of a series of experiments designed to test the effect of X-rays on the developing embryos of the fowl. In an earlier paper the authors concluded that, in embryos irradiated immediately before incubation and then daily for several days, the action was always inhibitory, the irradiated embryos being invariably smaller than the controls. Those which received the full pastille dose of X-rays were most affected, six out of nine showing no development at all. In all those showing development, all tissues and organs which should normally be developed were differentiated but smaller in size. The effect was therefore one of retardation or diminution of growth. In the present paper the authors give the results of experiments in which the embryos were allowed to develop normally for four days and then subjected, in two groups, to daily irradiation of three and five days respectively. In these cases there did not seem to be any marked effect on the average length of the embryos compared with controls. The principal action of the rays appeared to be their destructive effect on the tissues, exerted chiefly on the cutaneous ectoderm, the neural tube and its associated structures, the epithelium of glandular structures such as liver and mesonephros, and on the red blood corpuscles. The effects showed themselves in detachment of the epithelium, in a diminution in the transparency of the cytoplasm, and in the formation of granules or vacuoles in the latter.

CITRUS FRUIT IN THE PHILIPPINES.—According to A. H. Wells, F. Agcaoili, and Maria Y. Orosa of the Bureau of Science, Manila, there are about eight hundred types of citrus growing in the Philippines, including the valid indigenous species, the hybrids, and the introduced species. At the same time there is not a single citrus plantation on modern commercial lines in the islands, whilst, on the other hand, the Filipinos seem to appreciate the fruit as the returns of the importation of citrus into the islands demonstrate. The Lamao Experiment Station has now shown that quite good produce can be obtained upon trees of commercially valuable types when grown under Philippine conditions, and the authors urge that citriculture should be taken up by the inhabitants upon a commercial scale. Their paper in the *Philippine Journal of Science* (vol. 28, No. 4, December 1925) contains particulars of the very complete selection of types of citrus under experimental cultivation in the Philippines, and also of chemical analyses of the fruits of selected varieties.

CONTRIBUTIONS TO PLANT PHYSIOLOGY.—The numerous investigations recorded in Year Book No. 24, issued by the Carnegie Institution of Washington, include reference to the continuation at the laboratory of plant physiology at Tucson, Arizona, of work on desert succulents. V. Ulehla shows, by auxograph records of the swelling of succulent tissues in solutions of different concentration, that the methods developed by Ursprung and Blum for determining suction pressure, require supplementing by further experimental methods before valid conclusions as to suction pressure values can be drawn with safety. The work also emphasises once more the very complicated nature of the phenomenon of plasmolysis. H. A. Spoehr and Paul C. Wilbur show that in the presence of disodium phosphate and sodium pyrophosphate the aldose sugars are converted into the ketoses, and vice versa. A noteworthy feature of this form of the von Eckenstein reaction is the disappearance of reducing power with time; this suggests that the

reaction is not a true equilibrium but that the hexose molecule itself is being split. An interesting contribution to our knowledge of the absorption of carbon dioxide by leaf-powder is made by H. A. Spoehr and William Newton. From an ether water extract of the leaf-powder an equal volume of 95 per cent. alcohol throws down a precipitate of a substance which absorbs considerable quantities of carbon dioxide, and of which some of the reactions are given.

BRITISH POST-PLIOCENE UNIONIDÆ.—Owing to the fragile nature of their shells, the Unionidæ found fossil in the Pleistocene deposits are commonly fragmentary and the discrimination of the species is difficult. A. S. Kennard, A. E. Salisbury, and B. B. Woodward (*Proc. Malacol. Soc.* 16, 1925, p. 267) give an account, illustrated by twelve photographic plates, of the British species, which will be of value to workers in Pleistocene geology. The external form of the shell, owing to its variability, is of little use in distinguishing species. The features of specific value are seen in the muscle scars, the hinge, and the umbonal rugæ.

AMMONITES FROM THE UPPER KIMMERIDGE CLAY.—A pleasing quarto-publication by Dr. E. Neaverson on the Ammonites from the Upper Kimmeridge Clay has been issued as one of the Papers from the Geological Department of the University of Liverpool. The memoir deals mainly with the small group of the so-called *Ammonites biplex* (more recently referred to as *Olcostephanus pallasianus* auct.) of the Upper Kimmeridge Clay. They are now described in detail and with care for the first time, and they are referred to a number of genera and species; but Dr. Neaverson remarks that the large majority of specimens are flattened by pressure and form "hopeless" material for investigation. The characters relied on by the author for subdivision are the general form of the suture-line and the developmental stages shown by the ammonites. Unfortunately, the author has not been able to dissect any species of, for example, his first genus (Virgatosphinctoides), and he figures only one complete suture-line, belonging to an undetermined species of doubtful generic affinity. The genus Virgatosphinctoides, we are told, includes Mr. Pringle's Pseudovirgatites from the Oil Shales of Kimmeridge; and Dr. Neaverson, whilst expressing the "belief" that the phenomenon of homœomorphy is responsible for the similarity between the two groups, leaves the determination of possible relationship to future research. There is no indication that the author has studied the Volgian Virgatitids of Russia any more than the Mediterranean genera, except in published figures; and recent literature is not sufficiently noticed. The arrangement of the various ammonites into separate lineages thus reflects a somewhat limited outlook. The work, however, was obviously done conscientiously, and the four plates are good.

GRASS MINIMUM THERMOMETERS.—The Meteorological Office, Air Ministry, in Professional Notes, No. 43 (London: H.M. Stationery Office, 1925, price 6*d*. net), publishes "Some Effects produced by Protective Shields on the Readings of Grass Minimum Thermometers," by Mr. J. M. Stagg. At cold periods in such winters as the present, the thermometer exposed at night to radiation over grass gives some low readings of interest, at times 10° F. or even more below the reading of the ordinary air temperature in the Stevenson screen close by. The position of the grass minimum thermometer screened by a wire cage is well shown by illustrations, and observations are made of the thermometer screened and of a similar thermometer outside the cage, but unscreened, near by. The results are obtained from five series of experiments conducted at Kew Observatory, which is ample guarantee of correctness, and the observations are carefully collated. The paper sums up with final recommendations for observers. It is asserted that any form of screen in the vicinity of a grass minimum thermometer will result in an increase of the temperature recorded, and it deprecates a screen even situated entirely on one side of the grass thermometer. To those accustomed to obtaining radiation temperatures, it is well understood that lower temperatures and a greater difference between the Stevenson screen thermometer and the radiation temperature is obtained by placing the radiation thermometer, filled with clear white spirit, on short grass, with the bulb just touching the tops of the blades of grass, but on no account embedded in the grass. The stem of the thermometer should rest on a small fork of wood to raise the bulb.

THE COMPTON EFFECT.—The issue of the *Journal de Physique* for December 1925 contains a summary of the spectrographic observations of M. de Broglie and A. Dauvillier on this effect during the last two years. Compton discovered in 1923 that when homogeneous X-radiation is scattered by a solid, the scattered radiation contains, in addition to rays of the same wave-length as those incident, rays of longer wave-length; he explained this effect as due to the impact of a quantum of the incident radiation on an electron, which recoils carrying with it some of the energy, and the decreased energy of the scattered quantum manifests itself in an increase of the wave-length of the radiation it emits. Duane and his colleagues failed to verify Compton's observations, but the researches of de Broglie and Dauvillier on the scattering of the *K*-radiations of tungsten, silver, tin, copper, and zinc by graphite, boron, glucinium, and aluminium confirm the original observations and are in agreement with the theory by which Compton explained them.

SEPARATION OF PLATINUM GROUP METALS.—A new method of separation of iridium, rhodium and platinum, one of the most difficult tasks in chemical analysis, is published in the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*. Titanous sulphate solution precipitates rhodium and platinum, while iridium remains in solution with the titanium. The iridium is precipitated by reduction of the acid solution with hydrogen sulphide in the presence of a suitable amount of glycerol. The platinum and rhodium mixture is treated with aqua regia, the undissolved rhodium filtered off, the solution reprecipitated using an aluminium plate, and the precipitate fused with potassium hydrogen sulphate, which on treatment with water leaves the platinum in an insoluble form.

MIXED CRYSTALS OF SILVER HALIDES.—The results of X-ray analysis of mixed crystals of silver chloride and bromide and silver bromide and iodide by R. B. Wilsey have been published in the *Journal of the Franklin Institute* for December 1925. The powder crystal method of Hull was employed and showed that the chloride-bromide mixtures have the simple cubic structure, while most bromide-iodide mixtures contain two mixed crystals, one the bromide with enlarged lattice spacing, and the other the iodide with a slightly smaller lattice constant. The enlargement of the bromide lattice predicted by Trivelli seems to be connected with the increased speed obtained with photographic emulsions of silver bromide with small amounts of silver iodide.

The Report of the Medical Research Council.[1]

A FIRST perusal of the report of the Medical Research Council for 1924–1925 shows its many-sided activities: there appears to be scarcely a branch of medical science in which investigations have not been carried on by members of the Council's staff or by other research workers receiving whole- or part-time grants. The great volume of work performed is due in great measure to the utilisation of facilities provided by the universities and other institutions, by means of grants-in-aid to the investigators working therein. Research work, therefore, throughout the country is co-ordinated through the medium of the Council; and as specific problems arise, plans for their investigation can be formulated and the work entrusted to those most qualified to deal with it. In addition, grants have been made for work within the programmes of the Department of Scientific and Industrial Research, the Miners' Welfare Fund, the Dental Board of the United Kingdom, the League of Nations, the *Field* Newspaper Distemper Research Council, and the British Empire Cancer Campaign. The Council also makes the annual awards of the Rockefeller Fellowships, tenable in America by scientific workers in the British Isles.

It must not, however, be supposed that any distinction is made between 'pure' and 'applied' research. Every advance in knowledge leads, sooner or later, to a practical application, even though the latter may not be at first apparent.

It is obvious that it is impossible to deal with all the many-sided activities of the Council in the space at our disposal; stress will be laid on certain outstanding pieces of work, more especially those which have not been recently considered in these columns.

An extremely important function of the Council is the regulation of biological standards: that is, standards for certain substances of unknown chemical constitution, or, if of known constitution, presenting difficulties in chemical estimation, or possibly showing a varying therapeutic potency, although apparently of the same composition. Two important steps have been taken during the year: the Therapeutic Substances Bill has received the Royal Assent, and the second International Conference on the standardisation of biological products was held at Geneva in September under the auspices of the Health Section of the League of Nations, when a gratifying measure of agreement was reached as to the standards for a number of products. The president of the Conference was Dr. H. H. Dale, to whom, to a large extent, the success achieved was due.

At present the only substances which are required to be biologically standardised in Great Britain are salvarsan and insulin; and this is only due to the fact that the patent rights are vested in a public department. The international conference agreed on standards for pituitary extracts, thyroid gland, digitalis and *Filix mas* and other anthelminthics; investigation is still proceeding with reference to standards for suprarenal preparations and adrenaline, ergot, and vitamin preparations. It may be anticipated that the compounds in the former group will shortly be scheduled under the Therapeutic Substances Act, so that preparations of or containing them will only be allowed to be marketed if they comply with the requisite standard. In this connexion it may be mentioned that Dr. Hartley has prepared a standard sample of diphtheria antitoxin; this is the only serum for which a standard and a method of assay have been accepted by international agreement at the present time.

The Standards Laboratory at Oxford, under Prof. Dreyer's direction, has supplied standard agglutinable cultures and standardised agglutinating sera made with certain of the enteric and dysenteric organisms; the quantities issued have been 195 litres of the former and nearly four litres of the latter. The National Collection of Type Cultures maintained at the Lister Institute under the direction of Dr. Ledingham has been increased during the year, and more than 4000 type cultures have been distributed to research workers both at home and abroad.

Research work has been carried out in a number of specific subjects by numerous investigators. The oxygen chamber at Guy's Hospital has been in use again during the year, and great benefits are reported from this treatment in bronchitis and asthma. Dr. Edith Willock, working with Prof. Raper, has demonstrated the existence of an anoxæmic type of infantile atrophy, which is treated by means of oxygen-enriched air.

The physiology of hæmoglobin, the respiratory pigment of the blood, has been further investigated by workers under the direction of Prof. Barcroft. Anson and Mirsky have shown that hæmochromogen —often called reduced alkaline hæmatin—is really a conjugated protein, consisting of a base, named 'hæm,' and globin, and have been successful in synthesising it. The base unites with many other nitrogenous substances besides globin, and gives a series of pigments, some of which are found in invertebrate animals. Dr. Keilin, investigating a respiratory catalyst called 'cytochrome,' has found it to be present in the cells of all ærobic organisms so far examined, including animals, higher plants, yeasts and bacteria; it appears to be formed of three hæmochromogen compounds and so to be closely related to the respiratory pigment hæmoglobin.

Prof. Shaw Dunn, working with Drs. Lovett, Dible and McSwiney, has investigated some aspects of acute experimental oxalate nephritis; it was found that water diuresis in this condition favourably influenced the urea retention, producing a copious elimination of the latter by the glomeruli. No diminution in the rate of blood-flow through the kidney was observed in this type of nephritis. Dr. Baker has described two cases of obstruction of the renal tubules caused by excretion of hæmoglobin following the intravascular hæmolysis of transfused blood. Experiments made later showed that hæmoglobin, excreted through the glomeruli in solution in an alkaline medium, is precipitated in the tubules, probably in the form of hæmatin, owing to the increase in acidity and salt concentration. This intrarenal obstruction probably occurs also in blackwater fever. The treatment suggested is the production of an alkaline diuresis. Prof. Maclean and Drs. Urquhart and Forest-Smith have been able to show that rabbits given an exclusively protein diet for long periods do not develop nephritis or, in fact, show any sign of renal impairment, provided they are also given small amounts of cabbage; previous results pointing to the opposite conclusion appear to have been due to a lack of vitamins or some other constituent of fresh food. Thus an excessively protein dietary does not appear to be harmful to the kidneys.

Prof. Korenchevsky and Miss M. Carr have been engaged in a research on the influence of the internal secretions of the sexual and prostate glands upon metabolism. They conclude that the former contain hormones which increase the nitrogenous metabolism;

[1] Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1924–25. Pp. 164. (London: H.M. Stationery Office.) 3s. 6d. net.

the variable effects observed after injections of emulsions of either testes or ovaries are due not only to the specific hormones, but also to the presence of non-specific substances such as insulin, and to the varying efficiency of all the other endocrine glands in aiding or opposing the action of the hormones injected. Drs. Gardiner Hill, Jones and Forest-Smith have engaged in a study of different types of obesity and their relationship to the various glands of internal secretion. They consider that certain patients who present similar appearances to the diabetic receiving large amounts of insulin may be suffering from an excessive production or release of insulin from the pancreas.

Dr. Fletcher, working at Kuala Lumpur, has found that quinidine is as effective as quinine in the treatment of malaria, that the two alkaloids do not act specifically on one type of the malarial parasite, and that there is no difference in their toxicity. The question of the effectiveness and toxicity of the different cinchona alkaloids and their proportions in different species of bark is of considerable economic importance.

Drs. Henry, Lewis, Chalmers and Harries have been investigating the toxin of the *Streptococcus scarlatinæ*; a stable preparation was obtained by precipitation with alcohol. Intradermal inoculation into human beings enables those who are susceptible to be distinguished from those who are relatively resistant; most young children are in the former group, and most adults in the latter; but children who have had the disease are also resistant. An antitoxin has been prepared the clinical trials of which are at present in progress.

A short section is devoted to some of the main aspects of the work of the Industrial Fatigue Research Board. The direct practical applications of much of this work, carried out 'in the field,' need scarcely be emphasised. The scientific study of workers in the factories leads to the formulation of conclusions as to the most beneficial methods of carrying out the various types of work examined, which should lead both to greater comfort for the worker and also to an increased output. Thus Mr. Wyatt and Mr. Fraser have shown that the judicious introduction of rest pauses almost always has a good effect, the workers unconsciously responding by increased efforts, so that the output is greater in spite of the shorter time worked. Thus shorter hours with higher wages seem to be no remote possibility.

University and Educational Intelligence.

CAMBRIDGE.—The death, in tragic circumstances, of Dr. M. B. R. Swann, the senior demonstrator in the Department of Pathology, has been a serious blow to the University in general and the Department in particular. It is not yet a matter of common knowledge that during the last few years this particular school, under Prof. Dean's guidance, has been the centre of renewed activity. In the first place, pathology has been introduced as a subject in the second part of the Natural Sciences Tripos. Students who wish to obtain a more detailed knowledge of pathological problems and a closer insight into modern research than is entailed by the crowded medical curriculum can now receive well-organised instruction. In addition, they have a definite status and also the advantage of receiving some acknowledgment for their trouble; as a result, competent research workers are being trained. The new pathological and veterinary building will, when completed, afford suitable accommodation for more workers. The staff is very keen and not over-encumbered with elementary teaching, so there are good prospects of considerable progress.

LONDON.—A course of three free public lectures on "Hygiene" will be given (in English) by Dr. Gustave Monod, at the Middlesex Hospital Medical School, on March 2, 3, and 4, at 5.30 o'clock, and one of four (also in English) on "The Evolution of the Nervous System," by Dr. C. F. Ariens Kappers, at University College, on March 9, 10, 11, and 12, at 5.30 o'clock.

MANCHESTER.—Dr. John Samuel Dunkerly, senior lecturer in zoology in the University of Glasgow, has been appointed Beyer professor of zoology and director of the zoological laboratory in succession to Prof. S. J. Hickson, who will retire in September next. Dr. Dunkerly, who was a student of Birkbeck College, London, graduated in 1908, and later studied under the late Prof. Minchin at the Lister Institute of Preventive Medicine. He became an assistant-lecturer at Birkbeck College, and in 1911 was appointed lecturer in zoology in the University of Glasgow. He was on military service from 1914 to 1918, and in 1920 was appointed senior lecturer in zoology at Glasgow, obtaining the degree of doctor of philosophy there. A number of Dr. Dunkerly's papers have been published in the *Transactions of the Royal Society of Edinburgh*, the *Quarterly Journal of Microscopical Science*, and in other journals. His investigations have dealt mainly with Flagellata and other Protozoa.

THREE fellowships, each of the annual value of 200*l.* and tenable for two years, are being offered to graduates of the University of Wales. Particulars are obtainable from the Registrar, University Registry, Cathays Park, Cardiff. The latest date for the receipt of applications for the fellowships is May 31.

APPLICATIONS are invited for the Grocers' Company's research scholarships in sanitary science, each of the annual value of 300*l.* and an allowance to meet the cost of apparatus, etc., in connexion with the research carried out. The scholarships will be tenable for one year, but renewable for a second or third year under certain conditions. Forms of application (returnable not later than April 13) may be obtained from the Clerk of the Grocers' Company, Grocers' Hall, E.C.2.

FROM the Universities Bureau of the British Empire we have received a 40-page pamphlet containing lists of students from other countries in the universities and university colleges of Great Britain and Ireland, and of interchanges of teachers in 1924–25 between the universities of Great Britain and Ireland and those of other countries. A numerical summary of students from abroad discloses some interesting facts. The total number of the students in these lists is 4669. To this total Asia contributes 1718 (including 1301 from India, Burma, and Ceylon, 110 from China, 102 from Japan, 77 from Siam, 42 from Palestine, and 41 from Malaya), Africa 1150, America 815, and the Pacific 332. Of countries within the Empire, Canada and Newfoundland are represented by only 151, including 45 (chiefly Rhodes scholars) at Oxford; the West Indies, having no university of their own, send a much larger contingent proportionally to their population, namely, 139; South Africa and Rhodesia send us more than any other part of the Empire except India—716; from Australia there are 217, and from New Zealand 114. From foreign countries, the most notable contributions, other than those already mentioned, are: Egypt 351, United States 434, Russia 99, Germany 78, Switzerland 64, France 47. Of the universities most frequented by students from abroad, London is easily first with 2158 (including 673 in the medical schools). Next come Oxford 530, Edinburgh 525, Cambridge 493, Glasgow 207, Manchester 179.

Contemporary Birthdays.

February 27, 1864. Prof. Arthur G. Green, F.R.S.
February 28, 1858. Mr. James Swinburne, F.R.S.
March 1, 1864. Prof. G. H. Bryan, F.R.S.
March 2, 1870. Sir Frederick W. Keeble, F.R.S.

Prof. ARTHUR G. GREEN was educated at Lancing College and University College, London. He was, from 1902–16, professor of tinctorial chemistry at the University of Leeds, afterwards director of research, British Dyestuff Corporation, resigning in 1923. Early in his career he was research chemist to a firm of aniline colour manufacturers in London, leaving to take up the post of chief chemist and manager of the colour works of the Clayton Aniline Co., Manchester. He has produced a number of new coal-tar colouring matters. For some years he was examiner in coal-tar products to the City and Guilds of London Institute.

Mr. SWINBURNE was born at Inverness and educated at Clifton College. He was apprenticed at engineering works on the Tyne. Afterwards he was associated with Sir Joseph Swan in the erection and equipment of glow-lamp factories in Paris, and Boston, U.S.A. In 1886 he took up the post of technical manager and designer to Crompton and Co., Ltd., becoming afterwards a consulting engineer. He was elected president of the Institution of Electrical Engineers for 1902–3. His inaugural address was entitled "Some Limits in Heavy Electrical Engineering." Mr. Swinburne remarked that "the sort of tacit assumption that an engineer can never be a 'scientific man,' while a 'scientific man' can teach the engineer his business, cannot fail to annoy the engineer, and this feeling of annoyance is largely the cause of a great deal of opposition to technical, that is to say, really scientific education. The work of the electrical engineer is manifold. We should understand steam-engines, gas-engines, tramway matters, fuel questions, parliamentary matters, railway management."

Prof. BRYAN, who has just resigned the chair of mathematics in the University College of North Wales, Bangor, was born at Cambridge and graduated at Peterhouse, of which college he is an honorary fellow. He was elected a fellow of the Royal Society in 1895 for his work and papers on thermodynamics and other branches of mathematical physics. In 1900 he was awarded the gold medal of the Institution of Naval Architects, for his paper "The Action of Bilge Keels." In the discussion on the memoir Mr. R. E. Froude described it as "most masterly" and a valuable contribution to the theoretics of rolling. Prof. Bryan is particularly well known for his pioneer mathematical work relating to problems of aeroplane construction and stability. In "Stability in Aviation," he brought together much original work on this subject, and the conclusions reached were of great value in indicating how exact knowledge of the principles of dynamical stability could be applied to the movements of aeroplanes. He was awarded the gold medal of the Aeronautical Society in 1904.

Sir FREDERICK KEEBLE, Sherardian professor of botany in the University of Oxford, was educated at Alleyne's School, Dulwich, and Caius College, Cambridge. Formerly he was Assistant Secretary, Board of Agriculture (1919); Director of the Royal Agricultural Society's Garden, Wisley (1914–19); and editor of the *Gardener's Chronicle*, 1908–19.

Societies and Academies.

LONDON.

Royal Society, February 18.—A. **Fowler**: The spectrum of ionised oxygen (O II). The spectrum of oxygen in the region λ 6750—λ 1850 has been investigated under different conditions, and particulars are given of about 400 lines which are attributed to the singly ionised atom (O II); 90 lines have been assigned to the doublet system and 68 to the quartet system. On the supposition that three of the doublet *p* terms form a Rydberg sequence, with 4R for the series constant, the value 93952 has been assigned to the term $2\,^2p_2$, and the values of other terms have been deduced. The term 2*s* thus derived suggests about 240,000 for the 1*s* term. The tabulated quartet terms depend upon an arbitrary value assigned to one of them. So far as a comparison can at present be made, the spectra of O II and N I, as expected, show a close similarity, the wave-numbers of several of the groups of lines in O II being approximately double those of the corresponding groups of N I.—William A. **Bone**, F. R. **Weston**, R. P. **Fraser**, and D. M. **Newitt**: New experiments upon the combustion of well-dried carbon monoxide and oxygen mixtures. Pts. I. and II. As water vapour is progressively removed from a $2CO + O_2$ mixture, the 'minimum spark energy' necessary to fire it by condenser discharge sparks increases until, with a calcium chloride dried mixture, it becomes twenty-or thirty-fold as great as that required to fire it when saturated with moisture at 15° C. A $2CO + O_2$ mixture, dried by six months' contact with pure phosphoric anhydride, can still be ignited and exploded, provided that a spark of sufficient energy be passed through it, although the gases display a much greater 'resistance' to combination than when even a minute amount of moisture is present. Phosphoric anhydride-dried $2CO + O_2$ mixtures can be easily exploded by increasing the pressure up to a certain point (5 to 10 atmospheres). The spectrum of the flame produced by the explosion of such a mixture at an initial pressure of 25 atmospheres, shows a continuous and diffused band spectrum, extending up to 2780 Å.U. in the ultra-violet *without any 'steam lines' being discernible*. The conclusion is drawn that steam is not *essential* to the ignition and explosion of carbon monoxide and oxygen mixtures. Probably the ionisation of one (or both) of the combining gases is a necessary precedent to their combination, and the presence of even a minute quantity of steam promotes such 'ionisation.'—W. A. **Bone**, D. M. **Newitt**, and D. T. A. **Townend**: Gaseous combustion at high pressures. Pt. VI. The explosion of argon- and helium-diluted knall-gases. In mixtures represented by $2H_2 + O_2 + 6R$, $2CO + O_2 + 4R$, and $2CO + O_2 + 6R$, where R represents helium or argon, at initial pressures of 10-150 atmospheres, in the hydrogen series, helium and argon act as monatomic diluents only, but in the carbon monoxide series, helium is also exercising some other influence.—P. A. M. **Dirac**: Quantum mechanics, and a preliminary investigation of the hydrogen atom. The quantum theory of multiply periodic systems is developed from the fundamental assumption that the dynamical variables do not satisfy the commutative law of multiplication, but satisfy instead certain quantum conditions. Applied to the hydrogen atom, it is necessary, in order to make the motion degenerate, to assume that the Hamiltonian of this system is the same function of the dynamical variables as on the classical theory when expressed in Cartesian co-ordinates, but not when expressed in polar co-ordinates.—C. S. **Beals**:

Quartet terms in the arc spectrum of copper. A series of observations of the magnetic resolutions shown by copper arc lines has led to the identification, in the spectrum of copper, of a number of quartet terms. The combinations between the quartet terms give rise to a number of multiplets, and combinations also occur between some of the quartet terms and the previously determined doublet levels. This is the first instance of the spectrum of an element of the first group of the periodic table containing terms of multiplicity higher than 2. It is thus an exception to the general rule, that the maximum multiplicity of the terms in the spectrum of an element is 1 greater than the group number of the element in the periodic table. It also raises the question as to whether the previously held ideas concerning the atomic structure of copper are correct.—J. H. **Brinkworth**: The ratios of the specific heats of nitrogen at atmospheric pressure and at temperatures between 10° C. and −183° C. The ratios of the specific heats are calculated from experimental measurements of the cooling effect in adiabatic expansion. By combining the results of experiments by Dixon, Campbell and Parker, on nitrogen at high temperatures, with Callendar's theoretical expression for the variation in the specific heats, values of these quantities at any temperature and pressure may be calculated.—W. R. **Dean**: The elastic stability of a corrugated plate. The elastic stability of a shallow corrugated plate under thrust along its generators is considered. The depth of a bay of the plate is assumed to be a small multiple of the semi-thickness of the plate; a formally correct solution of the equations of stability can then be found. The critical stress is determined from the vanishing of an infinite, but rapidly convergent, determinant. When the ratios of depth of bay to semi-thickness are 5 and 10 respectively, critical stresses 30 and 130 times that of a plane plate of the same thickness and height can theoretically be obtained. The solution breaks down if the ratio of depth of bay to semi-thickness is too large, or if the corrugation is so rapid that the curvature is large. —E. **Newbery**: The controlling factors of transfer resistance. The variations of transfer resistance due to condition of electrode surfaces and changes of current density have been investigated with copper, silver, gold, nickel, and platinum. Transfer resistance is made up of two parts: (1) The resistance of a film of gas over the electrode surface; (2) the resistance of a layer of partially exhausted electrolyte surrounding the electrode. It is almost independent of the chemical nature of the electrode, but is high with polished surfaces and low-current densities. At very high current densities it is very low, due to the increase of conductivity of the gas film, but is greatly affected by changes of concentration of the electrolyte. Overvoltage is essentially a chemical, transfer resistance a physical, phenomenon.—R. L. **Smith-Rose** and R. H. **Barfield**: An investigation of wireless waves arriving from the upper atmosphere. Owing to the high conductivity of the earth, it was impracticable to distinguish between waves propagated horizontally along the earth's surface, and others which might arrive in a downward direction, after deflexion from the upper atmosphere. By repeating the experiments on shorter wave-lengths, these directional measurements made it possible to establish directly that, under certain conditions, a portion of the wireless waves arriving at a receiver comes from the upper atmosphere. Systematic experiments have demonstrated the arrival of wireless waves at night at angles of incidence from 13° to 34°, for a wave-length of 385 m. and a range of transmission of 77 miles. Assuming the simplest case of a wave symmetrically deflected from the upper atmosphere in its passage from transmitter to receiver, the height of the deflecting layer is about 88 km. Evidence was obtained during the experiments of the arrival of waves after two and three deflexions from such layer.

Royal Statistical Society, January 19.—R. J. **Thompson**: The productivity of British and Danish farming. Statistical comparison shows that the average output per 100 acres of agricultural land is more than 50 per cent. higher in Denmark than in Great Britain. As compared with Great Britain, Denmark carries a heavier head of stock in combination with a high arable area, and feeds this stock to a greater extent from her own soil; this is combined with higher yields. Costs of production in Denmark may be lower than in Great Britain owing to the co-operative purchase of feeding stuffs, etc., and to greater personal labour by the farmer, while Danish labour may be cheaper owing to longer hours and greater efficiency. The smaller size of the holdings (in Denmark some 56 per cent. of the cultivated area is in farms of between 37 and 128 acres, while in England and Wales some 53 per cent. of the area is in farms of 150 acres and upwards), combined with the psychological effect of ownership, is the primary source of the difference in the agricultural systems of the two countries.

Mineralogical Society, January 19.—C. E. **Tilley**: Some mineralogical transformations in crystalline schists. Attention is devoted to the pelite isochemical rock series with special reference to the mode of origin of the index minerals biotite, almandine, staurolite, etc., in crystalline schists. A fuller recognition of the element of progression in metamorphism brings inevitably in its train this genetic problem, hitherto greatly neglected. Mineral and rock analyses are graphically represented in triangular plots. Examination shows that the mechanism of the mineralogical transformations is something much more complex than is explained away by the customary simple equations. Further insight into the prevailing reactions depends very largely on a closer chemical investigation of these common metamorphic minerals occurring in the ground-mass of the crystalline schists.—A. **Brammall**: Primary gold and silver in the Dartmoor granite. Occurrences of minute flakes of native gold in the normal grey biotite-granite were shown to be independent of quartz-veins, tourmaline veins, and zones affected by pneumatolysis, and flakes occur as inclusions in felspar and quartz. A suite of assays of apparently barren tor- and quarry-granites, graphic granite, pegmatites, and vein pyrites shows that both gold and silver are widely distributed throughout the granite, the values ranging from 1-10 grains of gold and 1-161 grains of silver to the ton. A sample of biotite yielded 108 grains of silver to the ton. Both metals are undoubtedly primary.—A. F. **Hallimond**: On the chemical classification of the mica group. (ii.) The basic micas. In continuation of previous work on muscovite, the analyses of biotite and phlogopite are recalculated in molecular proportions, SiO_2 being made equal to 600. The ratio of potash is approximately constant, as in the acid micas. Values for the R_2O_3 and RO groups are plotted in a diagram which makes it possible to compare any new analysis with existing data. On this diagram biotite and phlogopite form a continuous series, covering a very well-defined area and separated from muscovite by a wide interval. The representation of alumina in the form of basic groups, AlO, etc., leads to the classification of the

micas in a range of increasing acidity from muscovite to phlogopite. This arrangement corresponds generally with the gradation in acidity of the rocks from which the respective micas were derived. The micas can be represented either by hexasilicic or trisilicic formulæ; evidence from certain phlogopites somewhat favours the latter type.—G. **Greenwood**: The construction and use of an X-ray goniometer. Crystal-structure of glyoxaline compounds. A new form of X-ray spectrometer has been constructed. It embodies the principles of the optical goniometer. The crystal is mounted on a goniometer head rotating about an upper scale, and the adjustments are made optically by means of a telescope and collimator. In using the apparatus, a source of X-rays is used instead of a source of light and an ionisation chamber instead of a telescope. The ionisation chamber rotates round a second scale, concentric with the upper crystal scale.' Small and transparent crystals are generally used and it is then possible to measure the crystallographic angles, *i.e.* angles between crystal faces or lattice planes of the structure, and in this way to make the ordinary angle measurements even when the faces are not actually present. It is also possible to measure glancing angles and spacings, and thus to make determinations of the space-group to which the crystalline structure belongs. Two substances were investigated: (*a*) Glyoxaline-4-sulphonic acid. The space group was determined and the crystal class—previously determined from the alternating presence of minute faces—was confirmed. (*b*) Glyoxaline. This substance does not form complete crystals. It was possible to measure crystal angles, and deduce the axial ratios, etc. The symmetry is monoclinic.

Geological Society, January 20.—T. O. **Morris** and W. G. **Fearnsides**: The stratigraphy and structure of the Cambrian slate-belt of Nantlle (Carnarvonshire). The Nantlle Slate-Belt is the south-western part of the outcrop of the Cambrian rocks of northern Carnarvonshire, which rest with appreciable unconformity upon the late pre-Cambrian volcanic rocks running south-westwards from Llanberis. A succession has been established by the mapping, and is constant in all its divisions along the length and strike of the district. It is argued that the Lower Cambrian sediments are land-waste from the pre-Cambrian rocks of north-western Carnarvonshire and Anglesey, whereas the latter Middle and Upper Cambrian material was brought in from an unknown source away to the east and south. Ordovician sediments are faulted against the basal member of the Upper Cambrian. A buttress of Ordovician volcanic rocks flanks the Nantlle area on the south-east side; but, within the area mapped, there are only altered dolerite-dykes, later than most of the impressed structures, to represent (and that a very late stage in) the cycle of Ordovician-Devonian igneous activity. The Nantlle district was deeply involved in the making of the Devonian alpine range, the basal wreck of which is now Snowdonia, and all sedimentary material within the slate-belt was compelled to fold, and then to crush until, both in bulk and in detail, it began to shear and creep. Cleavage in the slate-belt is almost vertical. More boundaries of slate 'veins' and quarry properties are determined by slides than by bedding-planes. Between slides the slate-beds have characteristic anticlinal structures, the synclines being suppressed. With removal of load by denudation, joints and other tensional fractures have appeared. The latest cross-faults are master-fractures, which traverse all other structures as also the pre- and post-Cambrian formations that flank the slate-belt. The direction of these is north of north-west, as the geometry of the half-dozen which cross the quarry-region suggests that block-movement was associated with northward shift on the eastern side of each. Petrographic evidence establishes the existence of secondary (authigenic) micaceous minerals with or without re-crystallised quartz in all the rocks of the slate-belt, and especially in those slates which are of greatest economic value.

Optical Society, January 21.—R. **Kingslake**: The interferometer patterns due to the primary aberrations. In order to obtain a rapid estimate of the quality of a lens by observing its behaviour in the interferometer, it is necessary for the observer to be familiar with the characteristic patterns of the various primary aberrations under various conditions of adjustment. These patterns are easily calculated for any required case. J. **Guild**: (1) A trichromatic colorimeter suitable for standardisation work. The three working primaries of the instrument are obtained by means of filters. The mixing of the primary colours is effected by a periscopic prism which rotates past three stationary sectors. Provision is made for adding any of the primaries to the colour under test, where this may be necessary in order to obtain a match. In this way colours of higher saturation than it is possible to match directly may be dealt with. (2) A criticism of the monochromatic-plus-white method of colorimetry. From the practical point of view of quantitative colorimetry, hue and saturation are not the fundamental elements of colour quality but must be regarded merely as derivatives of the trichromatic constitution of the colour. Whatever may be the advantage of specifying colour quality by hue and saturation, there are grave objections to practical methods of colorimetry involving the direct measurement of saturation. (3) On a new method of colorimetry. A new method and instrument are described for determining the quality of a colour, as defined by its position on the trichromatic colour chart, in which only the colour-matching properties of the eye are involved. The determination depends on two colour-matches in each of which the test colour is matched by a mixture, in unknown proportions, of a standard colour and a monochromatic colour obtained spectroscopically, a different standard colour being used for the two matches.

Physical Society, January 22.—T. H. **Laby**: Critical discussion of the determinations of the mechanical equivalent of heat. The principal recorded determinations of the mechanical equivalent of heat are critically discussed, and an attempt is made to correct them for errors not fully taken into account at the time when they were made. The results are weighted according to the relative importance attached to them by the author, and the weighted mean is given as 4·184 joules per calorie at 20°.—F. Ian G. **Rawlins**: The present status of theory and experiment relating to specific heats and the chemical constant. Possible lines of advance have been indicated for solids in view of the progress now being made in X-ray crystallography; further experimental work on compressibilities and elastic constants is suggested. Tentative views on the specific heat of liquids are given. In gases the quantum theory of rotational heat fails to account satisfactorily for the behaviour of hydrogen at low temperatures. The chemical constant of monatomic and diatomic substances is discussed and current views on its nature are described. The theory of gaseous degeneracy and its bearing upon specific heats and chemical constants is reviewed.

PARIS.

Academy of Sciences, January 18.—Paul **Marchal**: The conditions of aerial or subterranean life of the Aphides, and in particular of *Eriosoma lanuginosum*.—M. **d'Ocagne**: The classification of all the methods of calculation derived from geometry and mechanics.—E. **Mathias**: Contribution to the study of the fulminating material. The energy per cubic centimetre and per gram at the moment of explosion. The theory of globular lightning.—Charles **Jordan**: New formulæ for comparing two probabilities *a posteriori*.—Julius **Wolff**: The iteration of limited functions.—J. F. **Ritt**: Meromorph functions which admit of a theorem of addition of multiplication.—G. **Valiron**: A theorem of M. P. Levy.—A. **Liénard**: A generalisation of the spherical vortex of Hill.—André **Samuel**: A new electrical insulator. The condensation product of formaldehyde with cresol is arrested at the viscous stage and this product treated with sulphur chloride. The substance thus obtained is named thiolite and can be polymerised by heating under pressure. The material has a resistivity of 300×10^6 megohms per cm. and a dielectric constant of 4·5.—Gustave **Bessière**: A method leading to the production of 'peristereoscopic' images.—L. **Vegard**: The interpretation of the spectra emitted by solid nitrogen and by solidified mixtures of nitrogen and inert gases.—Pierre **Bricout**: The production of ultra-violet light by the impact of electrons of low velocity on the surface of a metal. A detailed account of an experiment giving evidence in support of the emission of ultra-violet rays of wave-lengths between 2300 Å.U. and 2100 Å.U. as the result of the bombardment of a metal surface by electrons.—P. **Pascal**: The magnetic properties of the carbonyl radical. The diamagnetic exaltation produced by nitrogen is further accentuated when it is substituted by a negative radical, and is clearly attenuated when it is substituted by a positive radical. From this it follows that compounds containing doubly linked oxygen are no longer inexplicable anomalies in the laws of additivity of diamagnetism.—B. **Bogitch**: Iron-iron sulphide alloys. From the experiments described it is concluded that no iron-iron sulphide mixture, melted in the absence of foreign substances, gives rise to the formation of two liquid phases.—Francis **Perrin**: Determinations of the average life in the activated state of fluorescent molecules.—Al. **Favorsky** and Mlle. A. **Tchilingaren**: The dehydration of the α-glycols. Molecular transpositions of ketones into ketones. Phenylisopropylketone is transformed into methylphenylacetone under the influence of zinc chloride.—M. **Bourguel** and J. **Yvon**: The synthesis of some *cis*-ethylenic compounds.—P. **Fallot** and R. **Bataller**: The tectonic of the southern border of the basin of the Ebre and of the mountains of the Mediterranean littoral between Tortosa and Castellon (Spain).—G. **Mouret** and E. **Raguin**: The prolongation to the west of the zone of dislocation of Boussac (Creuse).— — **Rey**: The collection of a mineral water by the method of reciprocal hydrostatic pressures.—H. **Buisson** and C. **Jausseran**: The ozone variations of the upper atmosphere. Spectrographic observations were made daily at Digne (height 600 metres) under good conditions of atmospheric purity between July 24 and September 29. The average amount of ozone, expressed as the thickness in centimetres of pure ozone at atmospheric pressure, was 0·3 cm., in agreement with earlier results. The extreme variation was about 15 per cent. from the mean. These changes cannot be connected with the atmospheric conditions. In particular, the local barometric pressure is without influence on the variation in the ozone.—E. **Tabesse**: Magnetic measurements in the Loire basin.—**Garsaux, Malassez** and **Toussaint**: Vertigo due to rotation.—C. F. **Muttelet**: A method for distinguishing preparations of 'regenerated' dried peas from preserved fresh peas.—Jacques **Benoit**: Histological studies of the right genital gland of the fowl ovariotomised into a testicle.—Jean C. **Faure**: The relative specificity of polyphage parasitic insects.—G. **Ramon** and Ch. **Zoeller**: The antigen value of the tetanus anatoxin in man. The injection of the tetanus anatoxin in man is absolutely innocuous. As a result of the injection, some tetanus antitoxin is produced in the blood, but the amount varies in different men. The possibility of immunisation against the tetanus infection is discussed.—C. **Levaditi, S. Nicolau**, and I. A. **Galloway**: The passage of the virus of foot-and-mouth disease through collodion membranes.

Official Publications Received.

Aeronautical Research Committee. Reports and Memoranda, No. 954 (Ae. 173): International Trials. Report on Aerofoil Tests at National Physical Laboratory and Royal Aircraft Establishment. (A.3.s. International Trials, 6—T. 1698 and T. 1936.) Pp. 46+5 plates. 2*s*. net. Reports and Memoranda, No. 1000: The Lateral Control of Stalled Aeroplanes. General Report by the Stability and Control Panel. (D.1. Special Technical Questions, 135—T. 2110.) Pp. 43+15 plates. 2*s*. net. (London: H.M. Stationery Office.)

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 4, 1923–1924. Pp. xii+153+21 plates. (London: The Secretary, Newcomen Society, Science Museum.) 20*s*.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 1, No. 5: The Addition Theorem for the Legendre Functions of the Second Kind. By Dr. T. M. MacRobert. Pp. 30-35. 9*d*. Vol. 46, Part 1, No. 6: On the Theory of Graduation. By Dr. A. C. Aitken. Pp. 36-45. 1*s*. Vol. 46, Part 1, No. 7: The Theory of Continuants from 1900 to 1920. By Sir Thomas Muir. Pp. 46-70. 2*s*. Vol. 46, Part 1, No. 8: Electrosynthesis in the Series of Normal Dibasic Acids. By Dr. David A. Fairweather. Pp. 71-75. 9*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18, N.S., Nos. 10-16. 10: The Variations in the Quantity of Food required by Cattle for Maintenance and Production with different kinds of Rations (Second Paper), by J. Wilson; 11: Report of the Irish Radium Committee for the Year 1924; 12: A Contribution to the Geology of Great Orme's Head, by Dr. Louis B. Smyth; 13: The Action of Radon on Mixtures containing Ammonia and an Oxide of Carbon, by Dr. Kenneth C. Bailey; 14: Methods for Investigating the Virus Diseases of the Potato and some Results obtained by their Use, by Dr. Paul A. Murphy and Robert M'Kay; 15: An Examination of the Errors introduced by the various Approximate Methods used for Estimating the Total Quantities of Milk and Butter Fat produced during a Lactation, by E. J. Sheehy; 16: Preliminary Note on the Physiological Aspects of certain undescribed Structures in the Phloem of the Greater Yam, *Dioscorea alata*, Linn., by Dr. T. G. Mason. Pp. 117-198+plates 3-11. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 10*s*.

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 3, 1926. Pp. 120. (London: Ernest Benn, Ltd.) 5*s*. net.

Department of Commerce: Bureau of Standards. Miscellaneous Publication of the Bureau of Standards, No. 67: Kilocycle-Meter Conversion Table. $15\frac{3}{4}$ in. × 11 in. (Washington: Government Printing Office.) 5 cents.

R. Comitato Talassografico Italiano, Istituto Geofisico, Trieste. Memoria 110: La clorometria dell' acqua nelle indagini talassografiche. Per Dott. Mario Picotti. Pp. 34. (Venezia: C. Ferrati.) 1.50 lire.

The Story of Minerals. By Herbert P. Whitlock. (The American Museum of Natural History. Handbook Series No. 12.) Pp. 144. (New York: American Museum of Natural History.)

Istituto Idrografico della R. Marina. Estratto dagli Annali Idrografici, Vol. 11. Campagna Idrografico-Scientifica nel Mar Rosso R.N. *Ammiraglio Magnaghi* 1923-24. Ricerche di oceanografia fisica. Parte 1ª: Correnti e maree. Per Prof. Francesco Vercelli. Pp. viii+188. (Genova.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 5: Hydrografiska mätningar i Sverige. Pp. 26+4 planscher. (Stockholm.) 5 kr.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 5: De Svenska flodernas vattenmängder. Av Gustav Slettenmark. Pp. 56+6 planscher. (Stockholm.) 5 kr.

The Carnegie Trust for the Universities of Scotland. Twenty-fourth Annual Report (for the Year 1924–25), submitted by the Executive Committee to the Trustees on 10th February 1926. Pp. iv+121. (Edinburgh.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 298: Radio-Frequency Resistance and Inductance of Coils used in Broadcast Reception. By August Hund and H. B. De Groot. Pp. 649-668. (Washington: Government Printing Office.) 10 cents.

Ministry of Public Works, Egypt. Report of the Mission to Lake Tana, 1920–1921. By G. W. Grabham and R. P. Black. Pp. xix+207+35 plates. (Cairo: Government Publications Office.)

Diary of Societies.

SATURDAY, FEBRUARY 27.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—F. J. Johnston: The Use of Breathing Apparatus in Mines.—Paper open for Further Discussion—P. F. Hope: The Sinking of the Monkton Shaft.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. Macdonald: Roman Britain (2).

MONDAY, MARCH 1.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. B. N. Switzer: Some Biblical Discoveries relative to the Universe and its Origin.

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

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—W. M. Beckett: Tidal Power on the River Severn—Some Notes and Suggestions on its Utilisation.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.—H. D. Dickinson: State Ownership of Waterways.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 6.—T. Carter: The Engineer: His Due and His Duty in Life.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Lieut.-Col. H. W. G. Cole: The Paris Exhibition of 1925.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—G. D. H. Cole: Loyalties: A Study in Social Obligation.

ROYAL SOCIETY OF ARTS, at 8.—Dr. G. W. C. Kaye: The Production and Measurement of High Vacua (Cantor Lectures) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (jointly with Oil and Colour Chemists' Association) (at Chemical Society), at 8.—Prof. J. W. Hinchley, Dr. G. Martin, Dr. C. Beavis, C. A. Klein, and others: Discussion on Methods of Grinding.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. G. Monod: From Cagliostro to Coué; or, Imagination as a Method of Treatment.

TUESDAY, MARCH 2.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Sir Basil Clarke: Publicity in relation to the Problems of Empire Settlement and Trade.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. W. W. C. Topley: Experimental Epidemiology (Milroy Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Egg (3): The Yolk.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. M. Lewis: Electrical Deck Machinery.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—J. A. Aiton: Steam Pipes for Extra High Pressure and Temperature.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.—J. L. Thompson and H. Walmsley: Notes on the Testing of Static Transformers.

INSTITUTE OF METALS (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.—Dr. L. Aitchison: Light Alloys.

ROYAL PHOTOGRAPHIC SOCIETY (Pictorial Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—L. H. Dawtrey: Some Problems we Meet.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—R. T. Rolfe: Bearing Metals.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Mrs. J. B. M. McGovern: The Head Hunters of Formosa.

RÖNTGEN SOCIETY (at Cancer Hospital), at 8.15.—Major C. E. S. Phillips: A Method of Increasing the Contrast of Shadows on Fluorescent Screens.

WEDNESDAY, MARCH 3.

ROYAL ANTHROPOLOGICAL INSTITUTE (Edinburgh and the Lothians Branch) (at Royal Scottish Museum, Edinburgh), at 3.—R. Kerr: Demonstration on Recent Acquisitions in the Ethnographical Section of the Royal Scottish Museum.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—H. E. Lightfoot: Road Construction.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—R. A. Watson Watt: The Directional Recording of Atmospherics.—R. A. Watson Watt and J. F. Herd: An Instantaneous Direct Reading Radiogonimeter.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—J. Meech: The Design and Application of Electric Motors relating to Heating and Ventilating Installations.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—L. A. Selvey: Permanent Mouldings and Die Castings.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow), at 7.30.—Prof. J. R. Currie: Iodine and Goitre.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—H. Droop Richmond and J. A. Eggleston: The Analysis of Acetic Anhydride.—A. L. Bacharach: Notes on the Determination of Moisture, Calcium, and Phosphorus in the Bones of Rats.—Dr. B. S. Evans and S. G. Clarke: An Accurate Method for the Determination of Mercury in Solution.—Dr. B. S. Evans: An Apparatus for Continuous Percolation and for Filtration in Neutral Atmospheres.

ROYAL SOCIETY OF ARTS, at 8.—P. Dunsheath: Science in the Cabl Industry.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—B. N. Schwanwitsch: On the Evolution of the Wing Pattern in Butterflies.

ROYAL SOCIETY OF MEDICINE (Surgery, Medicine, Electro-Therapeutics, and Therapeutics Sections), at 8.30.—Prof. Mellanby, Prof. Fraser, Mr. Dunhill, and Dr. Salmond: Discussion on The Treatment of Exophthalmic Goitre.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, MARCH 4.

ROYAL SOCIETY, at 4.30.—Sir Ernest Rutherford and others: Discussion on The Electrical State of the Upper Atmosphere.

LINNEAN SOCIETY OF LONDON, at 5.—The President: Abnormal Specimen of *Typha latifolia*.—E. Heron-Allen: The Iconography of a Myth: The Barnacle Goose.—C. J. Stubblefield: Development of a Trilobite, *Shumardia*.—Dr. H. G. Cannon: Development of the Fairy Shrimp.—H. W. Pugsley: Revision of *Rupicapnos* and *Fumaria*.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. W. W. C. Topley: Experimental Epidemiology (Milroy Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.15.—Dr. F. G. Crookshank: Airs, Waters, and Places.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. C. D. Ellis: The Atom of Light and the Atom of Electricity (2).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. P. B. Ballard and Mrs. B. Drake: The Curriculum for Children from 11 to 14 years.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow and West of Scotland Branch) (at Royal Technical College, Glasgow), at 7.30.—S. H. W. Dawson: The Oil Engine: Its Weaknesses and Advantages.

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—S. Bylander: Steel-work Specifications.

CHEMICAL SOCIETY, at 8.—S. Sugden and H. Williams: An Experimental Study of Protective Colloids. Part I. The Influence of Concentration.

FRIDAY, MARCH 5.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.—W. M. Mollison and others: Discussion on Atrophic Rhinitis.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—Prof. I. M. Heilbron: Recent Investigations on Fish Oils.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Institution of Rubber Industry) (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—W. J. S. Naunton: The Accelerator Action of the Di-*abd* Tri-Arylguonidines.

ROYAL PHOTOGRAPHIC SOCIETY (Pictorial Group) (Annual Meeting), at 7.—M. O. Dell: The Use of Filters and Panchromatic Plates in Landscape.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—E. A. Robins: Parasites.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. M. Seddon: Tendencies in Modern Electric Practice.

JUNIOR INSTITUTION OF ENGINEERS (at Engineers' Club, Birmingham), at 7.30.—C. H. Woodfield: Hoisting Appliances.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. L. Leach: The Dolmen Region of South-Western Brittany (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Henry Maybury: London Traffic.

SATURDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (1).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Annual Conversazione.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—G. C. Robson: Squids, Cuttlefishes, and their Allies.

MONDAY, MARCH 1.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.—Dr. R. A. O'Brien: Active and Passive Immunity. (Succeeding Lectures on March 5, 8, and 12.)

UNIVERSITY COLLEGE, at 5.15.—Prof. W. H. Lang: The Morphology of the Vascular Cryptogams in the Light of Pre-carboniferous Plants. (Succeeding Lectures on March 3 and 5.)

TUESDAY, MARCH 2.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. G. Monod: Hygiene. (Succeeding Lectures on March 3 and 4.)

WEDNESDAY, MARCH 3.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. A. Sommerfeld: Atomistic Physics. (Succeeding Lectures on March 9 and 10.)

THURSDAY, MARCH 4.

KING'S COLLEGE, at 5.30.—C. J. Gadd: The Science of Divination (2).

SATURDAY, MARCH 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Other World of the Ancient Egyptians.