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Science, the Church and Disease.

THERE appears to be little or nothing recondite in the widely advertised dispute concerning missions of "spiritual" healing which has developed within the Church of England. The point at issue was expressed with great clearness and ability by a committee of the Lambeth Conference at the beginning of the year. That committee was at great pains to define its attitude towards the problem which had been submitted to its consideration. It strove boldly and without equivocation to set forth its view of what "spiritual" meant or could mean in relation to the cure of disease. It was to mean primarily and principally a healing of the "spirit"—and the committee explicitly set aside the claims of spiritual healers to any power not evidenced as strongly in ordinary medical practice by persons who professed no religious belief. The committee emptied the ritual of all meaning save as a suggestive technique, but recommended its use.

It is clear, however, from recent events at Bradford and London, that the situation is one of grave concern to many highly placed members of the Church. The Bishop of Manchester says the cures among those who attended the Bradford Mission were "rather few in proportion to the number of cases attending." Dean Inge, in the course of a vigorous protest against "the craze for miracle-mongering, which is part of a widespread recrudescence of superstition among the half-educated," says "only those who have attempted to sift the evidence for a miraculous cure know the shuffling and prevarication with which they are met. In nine cases out of ten the evidence breaks down utterly." Other dignitaries of the Church have uttered warnings which sound merely gloomy and indistinct beside the ironical sentences of the Dean. Their conjoint testimony is sufficient to lead us to the conclusion that a superstitious tendency is being combated by enlightened and informed leaders.

In so far as respect has been shown for the method and results of science, there is no cause for complaint but rather some for satisfaction. If we minimise it, we do so because we are aware that science does not advance either in discovery or in its place in the life of the people merely in proportion to the applause or even the popular assent which it receives, but because each of its revelations constitutes itself at its birth part of man's environment. If any one believes that in certain circumstances of miraculous intervention there are no limits to the suggestibility of the individual human being, positive knowledge will soon come to correct him unless he is right.

Faced with the astounding evidence of credulity which newspaper discussions and public conferences

afford, it is not easy to get near to those aspects of the matter which are important. One of the chief seems to us to be the connexion which undoubtedly exists between the present outbreak of "submerged belief"—to use Dean Inge's phrase—and the so-called "new" psychology. At least one physician of repute has expostulated with even the more sympathetic groups in the Church on the ground of their too ready assumption that Freudian psycho-analysis means modern psychology and neurology. It remains to be seen whether the imposing verbiage now current under the description of Freudian psychology will yield up a single significant fact concerning the mental or physical behaviour of human beings. It spread widely and wildly in Great Britain in company with other "psychical" teachings like Jung's and those of the Nancy school during and after the War because those who very nobly rescued certain of our troops, in the teeth of a reluctant War Office, from the stigma of asylum treatment, had to invoke the authority of a "new" psychology to do so. The recognition of suggestion as a therapeutic agent amounts to little more than the conversion of its unconscious use into a conscious and premeditated use with possibly diminishing success. Technically no resource of the psychotherapist could surpass the "healing" mission in the creation of a favourable atmosphere. If, as the Bishop of Manchester says, the cures are few, we have at least some evidence of the scope for this treatment.

The discussion of "healing" missions brings home the wide interest in psychology albeit ill-informed and misdirected. May it not be, however, that many of the extravagances of the present time might be avoided if sound scientific knowledge were more accessible not to the public alone but also to the medical profession itself? Much has been done of late to bridge the gulf between the medicine of the body and the medicine of the mind; but much remains to be done. Surely it is now time that the science of behaviour should be taught by those who know what is known concerning the organism that behaves. Yet we believe there is not more than one school in London where that could be done soundly and thoroughly.

The interposition of a pseudo-science between biology and its practical application in medicine would, at this stage in the age-long and arduous fight for the liberation of medicine from magic, lead to disaster. It is such an interposition that we are witnessing in the practice of medicine by laymen whether under a religious or a "psychical" guise. The extrusion of such doctrines from scientific medicine and the elaboration of a sound medical psychology can be secured only by giving to psychology its rightful place in the hierarchy of the biological sciences.

Origin and Structure of the Earth.

The Earth: its Origin, History, and Physical Constitution. By Dr. Harold Jeffreys. Pp. x+278. (Cambridge: at the University Press, 1924.) 16*s.* net.

DR. JEFFREY'S book on the earth will be very welcome to the many who are interested in the larger dynamical aspects of our planet, in its present and past states. The book may be divided roughly into three nearly equal parts, dealing respectively with the origin and past history of the earth (considered as a basis for conclusions about its present condition), the theory of isostasy and of the surface features, and, finally, various miscellaneous subjects—seismology, the figures of the earth and moon, tidal friction, and the variation of latitude. Despite the generality of the title given to the book, many branches of geophysics are not touched on at all—terrestrial magnetism and electricity, general tidal theory, and meteorology. This was almost inevitable in a book of comparatively small size, particularly since its aim is not to be merely descriptive, but rather to give in some detail the mathematical reasons for the hypotheses adopted.

The first part of the book, on the origin of the earth, overlaps to some extent with Dr. Jeans's recent "Problems of Cosmogony and Stellar Dynamics." The two writers are not in accord on all points, but the degree of agreement is more important than the differences, considering that their work has been independent. The earth and other planets are supposed to have been formed by condensation from a gaseous fragment of the primitive sun, torn off from the nearer of the two tidal protuberances raised on the sun during the close passage of a much more massive star. The reasons for rejecting the theory of break-up under the influence of rotation alone are given in a chapter on Laplace's nebular hypothesis.

Jeans has shown that, in order to explain the relatively small mass of the planets compared with that of the sun, the disrupted body must have been highly condensed towards its centre. This seemed to necessitate that the primitive sun must, at the time of the break-up, have been in the giant stage, and on this basis the author sets, as a lower limit to the radius of the sun at that epoch, a distance equal to one-seventh the radius of the present orbit of the earth. He supposes, in fact, that the sun, though far larger than now, was well within the present orbit of Mercury; Jeans, on the other hand, supposed that it extended beyond the present orbit of Neptune; the author gives his reasons for preferring the smaller size. Since the book was written, however, Eddington has cast serious doubt on the view, hitherto tacitly accepted, that the substance of dwarf stars is not in the state of a perfect

gas; if it is, then a dwarf star is as highly condensed towards its centre as a giant star, and the above method of fixing a lower limit of size for the sun at the time of break-up seems to fail.

The further history of the earth is described as follows: it probably became solid near the surface within 15,000 years, but remained too hot for the condensation of water vapour until much later, when the sun had cooled through the giant stage and become a dwarf, probably of type Fo. Geological time starts at about this point, when the oceans were formed: and it extends over the period of cooling of the sun from type Fo to its present type Go. Astrophysical reasons are given for supposing that this second period is perhaps ten times as long as the pre-geological period, so that the duration of geological time is nearly equal to the whole age of the earth. Various methods of estimating this age are given, which roughly agree in indicating a period of a few thousand million years. The most trustworthy method is that based on the uranium-lead ratio in the earth's crust.

The thermal history of the earth is worked out on the assumption that the conductivity and other thermal properties of the rocks affected are independent of depth, that is, of changes of pressure and temperature. Experimental evidence is inconclusive on this point. The result thus arrived at is that below a depth of 700 km. no appreciable cooling has yet occurred, while at about 300 km. it amounts to between 200° and 300° C. These figures refer to the part covered by land, the cooling under the oceans being somewhat greater. The physical state of the matter at great depths has therefore probably remained unaltered since the earth first condensed, that is, it is liquid, unable to transmit distortional waves, and indefinitely deformable by long-maintained shearing stresses. At intermediate depths, such as 300 km., the rocks will be rigid but probably not "strong," that is, they may be capable both of vibration and flow, like shoemaker's wax. At 100 km. depth the rocks are likely to be very rigid in the ordinary sense of the term. The bearing of these conclusions on the theory of isostasy is considered in detail.

In his discussion of the very controversial question of the method of formation of mountains, the author definitely concludes that the thermal contraction of the earth's crust is a sufficient cause. He estimates the probable reduction of the crust surface by contraction at four thousand million square kilometres, and the reduction necessary to account for the known mountains at half this area. The contraction is supposed to have proceeded gradually until the compressive stresses reached the yield point, mountains then being formed by surface fracture and crumpling. The fractures got sealed up and a period of quiet ensued until further contraction again raised the stresses to the breaking point. Periods of mountain formation thus alternated with quiet periods, and the author estimates, on the basis of his theory, that about six such alternations have occurred hitherto.

Owing to the greater cooling beneath the oceans (which is estimated as being 300° more, at 100 km. depth, than at the same depth under the land, while the sub-oceanic surface of the crust is maintained at a uniform temperature), it is suggested that the crust must have buckled beneath the oceans, the edges being bent downwards. In this way the ocean deeps are explained: in almost all cases they occur near the edges of the great oceans. The rise of extensive areas of sedimentation is also connected with the same phenomenon: the sediments will be deposited round the edges of the land masses, accentuating the tendency of the edges of the sub-oceanic crust to sink, and thereby also increasing the strain at the boundary between the ocean bed and the continental part of the crust. If fracture occurs, the oceanward side of the crust will be more free to bend downward further, but on the landward side of the fault the weight of the sediment may be insufficient to hold down the crust, which may therefore rise and bring the sediments above sea-level.

In the chapter on seismology the theory of earthquake waves is developed directly from the theory of elastic waves in a solid, assuming that the rigidity of the material of the crust increases considerably at a moderate depth (the discussion of the cooling of the crust had already suggested such a change, by indicating that at 10 to 20 km. depth the outer layer of acidic granitic rocks gives place to heavier basic rocks of greater rigidity); and that the underlying strata are sufficiently heterogeneous to cause a good deal of internal reflexion. But the velocities and paths of earthquake waves are still very uncertain, largely because the depth at which earthquakes originate is unknown.

The influence of tidal friction on the rate of rotation and orbital motion of the earth, moon, and other planets and satellites affords one of the most interesting and successful chapters in the theory of planetary dynamics. In the case of the earth, the subject has been put on a really satisfactory footing by Prof. G. I. Taylor's discovery of the paramount importance of tidal friction in shallow seas, supplemented by the author's discussion of the dissipation of energy in the various shallow seas of the globe. The relative unimportance of bodily tidal friction is shown by the persistence of the Eulerian nutation (modified by elastic yielding), as evidenced by the 14-monthly component of the variation of latitude. But the

variability of the amplitude of this component suggests that some damping exists, and also, consequently, some yet unexplained source of regeneration. The variation of latitude also has an annual component which is not adequately accounted for.

The book ranges over so wide a field of knowledge that probably no one critic can be competent to assess the probability of the many hypotheses adopted by the author as a result of his discussions; the process of sifting or confirmation must be left to the efforts of many workers over a long interval. The book might have been improved if Dr. Jeffreys, by means of references to further literature at the end of each chapter, had made it easier for his readers to examine for themselves the sources of observational evidences and the opinions of other writers. Again, some discussion might have been given of the probability of differences of internal motion in the earth, either as set up in the fragments initially torn off from the sun, or induced afterwards through unequal yielding of the earth to tidal retardation, as recently suggested by Eddington; such internal motions would, it is known, be very slowly dissipated by viscosity, and they might have important geophysical effects. But a desire for more information on the subjects discussed in the book must be regarded as a compliment rather than a criticism of the author, whose able and interesting exposition is likely to stimulate further investigation into the problems upon which his own work enables him to write with so much authority and insight.

The Protection of Timber in the Sea.

Marine Structures: their Deterioration and Preservation. Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council. By William G. Atwood and A. A. Johnson; with the Collaboration of William F. Clapp, of Robert C. Miller, and of H. W. Walker, H. S. McQuaid and Marjorie S. Allen. Pp. vi + 534 + 14 plates. (Washington, D.C.; National Research Council, 1924.) 10 dollars.

THE deterioration of engineering structures exposed to the action of the sea is at present being investigated by two important research organisations. In Great Britain, a committee of the Institution of Civil Engineers, acting under the Department of Scientific and Industrial Research, was established in 1916 and has issued three interim reports which have already been noticed in NATURE (October 21, 1920, p. 235; December 30, 1922, p. 878; and November 17, 1923, p. 741). In the United States a committee was appointed in 1922 by the National Research Council, following an inquiry by a local committee on a devastating outbreak of shipworm in timber structures in San Francisco Bay in the years following 1914. The report of this American Committee, now published, records a great mass of observations and experiments, ably digested and summarised by Col. Atwood, Mr. A. A. Johnson, and their collaborators. While the general scope of the inquiry is the same in both cases, the American investigators have given less attention than have their British colleagues to the corrosion of metal structures and have devoted themselves more particularly to the problem of protecting timber from the attacks of marine boring animals.

The Committee has realised the need for precise systematic determination of the animals causing damage, and considerable space is devoted in the report to the description and illustration of the numerous species of wood-boring Mollusca and Crustacea found in American waters. Of the molluscan shipworms, about two dozen species are named and a number of other forms are recorded which may prove to be distinct species. It is of interest to note that the European *Teredo navalis* is recognised as "one of the most widely distributed as well as one of the most destructive," occurring both on the Atlantic and on the Pacific coasts of the United States. This is not in agreement with the views of Dr. Bartsch, of the United States National Museum, who has stated that no shipworm found on the coast of the United States can be identified with any species occurring in other parts of the world. The zoologists of the Committee appear less inclined to apply the Monroe doctrine to systematic zoology, and they acknowledge a number of immigrants among the Teredinidæ.

The point is not without some practical as well as theoretical interest. It is a characteristic feature in the biology of the shipworms that from time to time they make their appearance in numbers in places where they had not previously been noticed; and it is no less characteristic that, when this happens, "practical men" always begin by attributing their appearance to importation from abroad. Thus Linnæus, when he called the shipworm "Calamitas navium, ex Indiis in Europam propagata," was expressing the common opinion of the eighteenth century, and, quite lately, the destructiveness of *Teredo navalis* in the United States has been attributed to its recent importation from Europe. Perhaps, in some cases, the practical men were right, especially in the old days when wooden ships came home from long voyages with timbers "almost spongy with decay." It is very likely, however, that, more often, excessive multiplication has merely directed attention to a pest that had lurked in odd corners unnoticed because harmless. Sometimes

it is possible to trace the cause of this multiplication in some change of the physical conditions, as the San Francisco outbreaks were found to follow years of deficient rainfall leading to increased salinity of the harbour waters. For many outbreaks, however, no obvious cause can be assigned. Perhaps, as in many other cases, it has been too readily assumed that the increasing or decreasing abundance of a species must be due to man's interference with Nature or to the mutability of weather. It is easy to forget that a fauna is not a fixed unchanging thing but a swaying balance of opposing forces in which now one and now another species may have the higher hand.

The business of the engineer, however, is to find some means of defending his handiwork against possible disaster, and a great part of the report is occupied by an exhaustive discussion of methods that have been used or suggested for warding off the attacks of marine timber-borers. Some kinds of wood are much more resistant than others, but the numerous records here collected and tabulated do not encourage hope that any will be found permanently immune. Methods of protecting timber by means of paints and other surface applications have been investigated, as well as more elaborate and expensive processes of casing the piles with metal or concrete, some of which have given good results. Many processes of impregnating wood with various substances have been tested, and much study has been devoted to creosote impregnation, the most efficient of the methods actually in use. It is pointed out that " after the shipworms have become established and their development has proceeded beyond the larval stage, they seem to work only little less freely in creosoted than in uncreosoted timber," so that the protective value of creosote is due to its action on the larvæ.

In the United States, as in England, the investigators have turned the experiences of warfare to account in their search for poisons that may be used to impregnate wood, and a long and interesting section of the report is contributed by the Chemical Warfare Service. The toxicity of some 45 compounds was tested on larval and adult shipworms and on the crustacean Limnoria. It may be recalled that the British investigators obtained the best results with a substance which they termed phenarsazine, the " D.M." of poison gas warfare. If this be the same as diphenylaminechlorarsine, which the American report identifies with " D.M.," it is remarkable to find that it is here rated very low on the scale of toxicity. It is not included in the list of eleven compounds of which it is stated that " between these solutions and all the others there is a decided decrease in effectiveness." Experiments are in progress to test the degree of protection given by these and other substances when used for impregnating wood, but these experiments have not yet gone far enough to give conclusive results.

The Committee records two authentic instances of concrete being seriously damaged by rock-boring mollusca. One of these was in the Panama Canal zone, and the damage was mainly due to Lithophaga, a borer which appears to disintegrate the concrete by chemical action. At Los Angeles, on the other hand, the chief agent was a species of Pholadidea, belonging to a family of mechanical borers, which rasp away the rock with their shells. In this case it is not surprising to learn that " a sample of the best mortar in which the borers were found could be readily cut with the thumb-nail."

The report concludes with a bibliography extending to 61 pages closely printed in double columns. It is admirably done and will be of great assistance to future workers. It appears to approach completeness as nearly as any bibliography can ; the industry of the compilers has even extended to quotations from the Septuagint and the Vulgate, but the relevance of the passages quoted is not apparent, at least in the Authorised Version. W. T. C.

Laws and Customs in Central Africa.

(1) *The Laws and Customs of the Yoruba People.* By A. K. Ajisafe. Pp. vi+97. (London: G. Routledge and Sons, Ltd.; Lagos: C.M.S. Bookshop, 1924.) 3*s*. 6*d*. net.

(2) *The Bagesu and Other Tribes of the Uganda Protectorate: the Third Part of the Report of the Mackie Ethnological Expedition to Central Africa.* By the Rev. Canon John Roscoe. Pp. xiv+205+32 plates. (Cambridge: At the University Press, 1924.) 20*s*. net.

(3) *White and Black in East Africa: a Record of Travel and Observation in two African Crown Colonies.* By Hermann Norden. Pp. 304+18 plates. (London: H. F. and G. Witherby, 1924.) 15*s*. net.

THE authors of the three books under notice approach their subjects from three entirely different points of view. Mr. Ajisafe is a Yoruba native who puts forward a treatise upon the laws and customs of his own people : Canon Roscoe and Mr. Norden write as foreigners visiting Africa, but, again, their points of view differ. Canon Roscoe is a trained ethnologist ; his expedition was organised for the purpose of obtaining information useful to anthropological science. Mr. Norden writes as a tourist, relating the experiences of a pleasure trip in Kenya and Uganda.

(1) The work of Mr. Ajisafe is an extremely useful compendium of the legal and social system of his countrymen ; the ordinances of the Yoruba, based upon

age-long tradition, appear to be both just and merciful. Take as an example the following :

" A child's mother being a slave or captive, the child inherits in greater proportion than those children whose mothers are free-born, for the children of the free-born have maternal sides to inherit from while the child of a captive or slave wife has none."

The Yoruba king was, apparently, by no means absolute, and his ministers were responsible to the people for his conduct. In certain cases they could depose him, requesting him to " sleep," that is, to die. The king had " power to declare war, and even send and commission any of his military subjects to wage war against a certain town or tribe." If, however, his subjects were defeated, it seems that it was necessary for him to " sleep " before the unsuccessful expedition returned home. Some of the laws seem strange to us; for example, the wearing of socks except by " Egungun " was forbidden by native law ; an offender was liable to a heavy fine, imprisonment, or even death.

No less strange was the ordinance " Should a cock in transit crow at the town gate, it is seized and confiscated by the toll collector, the owner in addition to this paying 1*s.* 1*d.* Both the cock and the fee belong solely to the collector."

The book is useful as a record of native customs in a country where European influence is fast increasing. The scientific reader will regret that there is no index, and no adequate vocabulary of native terms.

(2) Canon Roscoe's book is a collection of notes on various tribes, chiefly in the neighbourhood of Mount Elgon, about which, even now, little is known. The first seven chapters deal with the Bagesu, one of the most primitive tribes in Africa. Chapters viii.-xiii. deal with the semi-pastoral Basabei. A chapter is next devoted to the Nilotic Bateso, concerning whom Canon Roscoe has already given us some information in his book " The Northern Bantu." The following four chapters are concerned with the Basoga, with whom the above-mentioned work also deals in part. Further chapters treat of the Bakonjo, the Bambwa, the Bakuntu, and Batuse.

Perhaps the most interesting section of the book is constituted by the chapters on the little-known semi-pastoral Basabei, living upon the north and north-east slopes of Mount Elgon. This tribe observes a system of compensation for murder which is highly unusual. In the case of a fight between two members of the same clan resulting in the death of one, no compensation could be claimed by the parents of the dead man ; but if the deceased were married, his wife's parents were entitled to a cow and a sheep.

" Should the murderer and his victim be of different clans, the clan of the murdered man would demand compensation. The murderer brought to an appointed place ten cows, and two bulls, and members of both clans met there. One bull and one sheep were killed for the men, and the same for the women, and the clans ate a meal together and were smeared with the contents of the stomach and some of the blood of the animals. The spear, shield, and knife of the murdered man were brought and given to his brother, who also took the skin of one bull and one sheep, while the brother of the murdered man's wife took the rest."

As the tribe practised clan exogamy, the clan of the murdered man obtained next to nothing, and the clan of the victim's wife were the chief gainers. This seems inexplicable, unless a husband worked for his wife's family, and on his death the latter required an indemnity. Further study of this tribe may afford an explanation.

It would be of interest to have a medical account of the very drastic form of circumcision performed during the initiation ceremonies of the youths of this tribe. It seems incredible that, immediately after so severe an operation as Canon Roscoe describes, the boys should be able to engage in a dance.

It is much to be regretted that folklore relating to domestic animals amongst primitive people has been rarely collected. Although in Europe much has been recorded concerning bees and bee-keeping, little has been written by ethnologists on the subject of bee-culture, and the taboos connected therewith amongst primitive tribes. Therefore, the information recorded on pages 171-2, concerning the taboos observed before the collecting and eating of honey amongst the Bakyiga, is very welcome. Canon Roscoe is to be congratulated upon the completion of a series of extremely useful reports.

(3) Mr. Hermann Norden's book is readable and illustrated with good photos. It covers his journey through Kenya and Uganda on the way to the Congo, and we hope to hear of his further adventures, after leaving British territory, in a later volume. The author had perused the records of hunters, missionaries, and explorers and determined upon obtaining first-hand impressions of this part of Africa. Accompanied by his friend Lewis, he entered by way of Zanzibar and Nairobi, and, striking inland, visited the famous troglodyte natives of Mount Elgon for one hour, finding this survey sufficient. Many tribes were afterwards visited, and the travellers record their presence at many dances, in most of which the transatlantic eyes of Mr. Norden beheld indecency. A fuller account of the Ja-Luo people, the Nilotic branch of the Kavirondo, is given than of any other tribe, and it is evident that a special study of these folk is needed.

Mr. Norden was appreciative of the work of the British white officials, and seems to have enjoyed himself thoroughly. LOUIS C. G. CLARKE.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Ed. Prof. Dr. Emil Abderhalden. Abt. XI.: *Methoden zur Erforschung der Leistungen des Pflanzenorganismus.* Teil 1, Heft 7 (Schluss), Lieferung 134. *Experimentelle Physiologie der Pflanzenzelle.* Von Ernst Küster. *Serum-Reaktionen zur Feststellung von Verwandtschaftsverhältnissen im Pflanzenreich.* Von Carl Mez. Pp. 961-1123 + xxiv. (Berlin: Urban and Schwarzenberg, 1924.) 6·75 gold marks.

AN almost uncanny ingenuity seems to have been shown by the distinguished editor of this series in devising the subjects for monographic treatment, and in attempting the discussion of the experimental physiology of the plant cell, the author has almost inevitably taken refuge in banalities. There is a brief section upon material, which may be summarised as saying that unicellular organisms are more convenient for use and that tissue culture experiments with plants have so far been singularly unsuccessful.

Under the section upon testing material there is a brief discussion of the use of plasmolysis, staining, etc., to determine the vitality of the material under examination. The main part of this monograph may be useful as bringing together data upon a number of different technical methods scattered widely through the literature and including the isolation of microscopic organisms for examination, measurements of growth on single hyphæ, plasmolysis, following the internal movements of certain cell constituents or chloroplasts, the influence of light, centrifugal force, narcotics, etc., upon the cell and its component parts. Micro-dissection methods are briefly referred to, but more space is given to a number of out-of-the-way experimental methods which would certainly be buried in the literature but for this monograph.

The brief monograph upon serum diagnosis is confined strictly to a practical account of the method as employed by Mez, who has injected plant extracts into dogs and afterwards, by the use of precipitin and agglutinin reactions with serum from the animal, investigated extracts of other plants as to their biochemical similarity, relying upon the specific nature of the protein chemistry of these reactions as shown by the experience of animal physiology. This biochemical method is thus employed as a test of relationship as embodied in the current classification of the plants. Work of this nature has filled many pages of German and Japanese botanical journals in recent years, but so far has been left alone by British workers.

Pighude (*Echinodermer*). Af Th. Mortensen. (Danmarks Fauna: Illustrerede Haandbøger over den Danske Dyreverden med Statsunderstøttelse udgivne af Dansk Naturhistorisk Forening.) Pp. 274. (København: G. E. C. Gads Forlag, 1924.) 7·50 Kr.

THIS little book on the echinoderms of Denmark, by a well-known investigator of the group, is part of a Danish series comparable with the "Faune de France." Considerable progress has been made since the Trustees of the British Museum published the late Jeffrey Bell's "Catalogue of British Echinoderms," but British naturalists will now find their needs almost completely supplied by Dr. R. Koehler's "Echinodermes" and Dr. Mortensen's "Pighude." Between them they cover the English Channel and the greater part of the North Sea. One would have liked some general discussion of the echinoderm fauna as a whole, with its relations to Arctic, Atlantic, and southern faunas, but this book, like Dr. Koehler's, is almost purely descriptive. Two points in which it differs from any previous work of the kind are the description of the larval forms of the species wherever known, and the inclusion of the chief Danish fossil echinoderms. The latter course is practicable for Denmark, because examples are virtually confined to the Chalk. Another useful and unusual feature is the indication of the tonic accent in systematic names, thus: *Soláster éndeca.*

In view of the author's recognised competence it were superfluous to praise the exactitude and clarity of his descriptions, though British readers may get more use from the clear diagrams and photographs with which the book is liberally provided. One does not, perhaps, look in a work of this kind for its author's views on classification; one assumes that a somewhat conservative attitude is adopted for the sake of a wide public. This no doubt explains the retention of Phanerozonia and Cryptozonia as the two orders of starfish, and of Ophiuræ and Euryalæ as the two orders of brittle-stars. Under the sea-urchins we are glad to see the old ordinal name Diadematoidea. In this, as in other features, the book is thoroughly well suited to the working naturalist. F. A. B.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1915. Part 5: *Réseau Mondial,* 1915. *Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude.* M.O. No. 222g (Tables). Pp. xviii+115. (London: H.M. Stationery Office, 1924.) 24*s.* net.

THE outstanding feature of this work, gathered from a rough examination, after realising the immense labour in its production, is the valuable step made by the publication of the several annual results towards interpreting aright the causes which influence the weather and its changes in different parts of the globe. The monthly and annual means afford much material for study, especially now that results are available for six years, 1910–1915, and year by year the data are accumulating. For the present volume, observations are utilised for 434 stations. It is to be regretted that so far data from the sea have not been included; over the Atlantic, and somewhat in other oceans, where daily synchronous charts are or can be prepared, observations could be fairly easily obtained. Monthly charts for the several elements would facilitate immensely the study of the material.

The following are typical of some facts to be gathered from the work: the mean pressure results for the year show that the highest mean pressure is 30·22 in. at Tanana in 65° N. and 152° W., the lowest 29·28 in. on the *Endurance* in 73° S. and 44° W. The highest mean temperature for the year is 86° F. at Khartoum in 16° N. and 33° E., the lowest 13° F. at Markovo-sur-Anadyr in 65° N. and 171° E. The greatest annual precipitation is 12,875 mm. (507 in.) at Cherrapunji in 25° N. and 92° E., the bulk of which falls in the four

months May to August. This is more than 20 times greater than the normal for London. A summary is given of the winds at selected stations in the tropics, and notes are inserted on the state of the ice in the Arctic seas and in the North Atlantic Ocean.

Agrikulturchemie. Bearbeitet von Prof. Dr. F. Honcamp; in Gemeinschaft mit Dr. O. Nolte. (Wissenschaftliche Forschungsberichte: Naturwissenschaftliche Reihe, Band 10.) Pp. viii + 160. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 0·95 dollar.

THIS small paper-covered volume is a review of the more important investigations in agricultural chemistry published during the years 1914–1920. It is specially intended to help workers who were, perforce, unable to keep in touch with their subject during those years and have not time to go through back numbers of journals. It seems a little late to bring out a summary down to 1920 only; but, in explanation, the editor states that much foreign literature has reached him quite recently.

There are four sections—soils; plant nutrition and manuring; animal nutrition and feeding stuffs; and agricultural chemical methods. Dr. O. Nolte is responsible for the first and last sections. Individual papers are for the most part dealt with very briefly, and the book is written somewhat after the manner of the annual reports to the Chemical Society and the Society of Chemical Industry. Full references are included. The authors show a patriotic bias in their selection of material for mention; but the decision as to what to include in a brief survey of this sort, dealing with a very large amount of literature, must in any case involve a strong personal factor and it is perhaps unreasonable to complain of omissions.

So far as the writer has tested them, the references are accurate and the discussions in the text adequate for the purpose. The book is a painstaking compilation which will prove useful to research workers and teachers of agricultural chemistry.

Manual of Cultivated Plants: a Flora for the Identification of the most Common or Significant Species of Plants grown in the Continental United States and Canada for Food, Ornament, Utility, and General Interest, both in the Open and under Glass. By L. H. Bailey. Pp. 851. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 31*s.* 6*d.* net.

PROF. L. H. BAILEY has again placed horticulturists in his debt by the publication of his "Manual of Cultivated Plants," in which he has set down the plants commonly grown in N. America, both for use and for their horticultural interest. The book is furnished with keys by which the various species can readily be identified, which are of very great value. The descriptive portion is prefaced by a very useful general account of herbarium methods, terms and names used in botanical science, and a valuable list of the botanists who have given to the plants their specific names. This is followed by a key to the families of the plants referred to in the manual.

The various families are then treated in detail, and concise but adequate descriptions are given of the genera and species. The more important genera or families are illustrated with very useful text figures, which are of considerable value to the plant lover who may not be a professional botanist.

Though the book is written for N. American and Canadian readers, it is not without value to students in Great Britain, where most of the plants recorded can be cultivated. It is a model of what such a book should be to enable plant lovers easily to determine the plants under cultivation in gardens or for economic purposes.

Kant und Einstein: Untersuchungen über das Verhältnis der modernen Erkenntnistheorie zur Relativitätstheorie. Von Dr. Alfred C. Elsbach. Pp. viii + 374. (Berlin und Leipzig: Walter de Gruyter und Co., 1924.) 8*s.*

THIS book is a study of the important problem of the relation between the space-time theory of Kant's "Critique of Pure Reason" and the relativist theory of Einstein. The author, who is of Dutch nationality, has already written essays on the subject in his native language. The present extensive study in German is based on the works of the late Hermann Cohen and Paul Natorp, and more especially on the recent work of Prof. Ernst Cassirer, to whom the book is dedicated. Cassirer's "Substance and Function" was reviewed in NATURE of August 9, p. 187. The transcendental æsthetic theory of Kant was founded on the classical mechanics of Newton, and intended to give the philosophical basis of Newton's concepts of absolute space, time, and velocity. There is no more important problem in contemporary philosophy than to determine whether and how far Kant's doctrine can be adapted to the new physics.

(1) *Immanuel Kant*, 1724–1924: *Gedächtnisrede zur Einweihung des Grabmals im Auftrag der Albertus-Universität und der Stadt Königsberg in Preussen am* 21 *April* 1924 *im Dom zu Königsberg gehalten.* Von Adolf von Harnack. Pp. 14. (Berlin: Julius Springer, 1924.) 0·25 dollar.

(2) *Immanuel Kant und seine Bedeutung für die Naturforschung der Gegenwart.* Von Prof. Johannes von Kries. Pp. iv + 127. (Berlin: Julius Springer, 1924.) 0·95 dollar.

THESE two works are issued in connexion with the bicentenary of Kant's birth, recently celebrated in his native city of Königsberg. They were both referred to in our note concerning that event (NATURE, May 17, p. 723). They are now issued separately and in convenient form.

Descriptive Labels for Botanic Gardens. By Humphrey Gilbert-Carter. Pp. 80. (Cambridge: At the University Press, 1924.) 1*s.* 6*d.* net.

THE booklet of descriptive labels drawn up by the Director of the Cambridge University Botanic Garden is a very useful publication, and it is interesting to see that the practice started at Kew many years ago for trees has been extended by Mr. Carter to other plants of economic or botanical importance. It may be thought that the labels are rather on the "learned" side, but the inclusion of Arabic and Hindustani words will no doubt be appreciated at Cambridge. Mr. Carter gives some very useful suggestions as to methods of preparation of these labels in a cheap and lasting manner.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Earth Tides, Ocean Tides, and Local Geology.

I HAVE read with interest Dr. Lambert's letter in NATURE of October 18 with reference to the earth tides observed by means of Hecker's horizontal pendulums at Potsdam. These indicated a greater rigidity on the earth in a direction a little north of west and south of east. I connected this with the prevailing west-north-west and east-south-east strike of the folds of the rocks to the south, and probably also of those underlying the point of observation.

Dr. Lambert, however, points out that the earth tides are the result of the summation of the effects of the attraction of the moon and sun on the different concentric zones of which the earth may be conceived to be made up, and contends that as the influence of geological structure does not extend to any great depth, it would not seriously affect the result. It is, on the other hand, possible to show that a higher zone has a greater effect on the tidal movement at the surface than one of the same thickness at a lower level. It is easily seen that the direct distortional stress, f, of lunar or solar attraction on a zone of the earth's crust is proportional to the distance, r, of the zone from the centre. It is also proportional to the density, ρ, of the zone and inversely proportional to its rigidity, μ. We can therefore write $f = Cr\rho/\mu$ . . . (1), where C is a constant. But the resulting effect at the surface, F, will be diminished in the ratio of the area of the zone to that of the surface, namely, in the ratio of r^2 to R^2 where R is the radius of the earth. Accordingly $F = Cr^3\rho/\mu R^2$. Let C/R^2, which is a constant, be equal to D; then $F = Dr^3\rho/\mu$ . . . (2). But if v is the velocity of the propagation of distortional waves in the zone, we know that $v = \sqrt{(\mu/\rho)}$. Hence $\mu = v^2\rho$. Substituting in (2) we have $F = Dr^3/v^2$ . . . (3). Hence the total effect of all the zones at the surface $= D\Sigma r^3/v^2$.

Mallet found the velocity in sand to be 0·25 km. per second, and Fouqué and Lévy, that in the Fontainebleau sandstone to be 0·3 km. Dr. Jeffreys and Dr. Wrinch, calculating from the records of the Oppau explosion, concluded that the velocity of distortional vibrations in typical sedimentary rocks was 0·8 km. and for the underlying crystalline acid rocks 3·1 km. Below these is a basic magma which extends, it is believed, down to a depth of nearly 1500 km., and the velocities at different depths have been worked out by Zoeppritz and Geiger in Germany, and more recently and accurately by Knott at Edinburgh, from the times of transit of distant earthquake shocks. Knott gives a fairly uniform increase from 3·98 km. per second at the surface to 6·88 at a depth of 1449 km. It is probable, however, that these figures do not apply to sedimentary and acid crystalline rocks near the surface.

Below 1449 km. the velocity varies but little down to 4449 km. This is probably not because the rigidity is constant but because the density increases. The distortional waves cannot be traced to greater depths, but the effect at the surface of tidal action in this region must be comparatively unimportant.

We do not know the composition of the rocks at different depths at Potsdam, but to form a general idea of the probable effect at the surface of tidal action in different zones, we may make a reasonable assumption of their thickness.

The surface formation at Potsdam consists of unconsolidated sand, and this and similar materials probably extend down to a considerable depth. The velocity near the surface would be about 0·25 km. per second. Let us assume that in the first 2 km. it averages 0·3 km. and that in the next 3 km. of more consolidated sedimentaries 0·8 km. per second, and then for 15 km. in acid crystalline rocks, 3·1 km. per second. Below 20 km. the velocities are taken to be those given by Knott.

The following table shows the velocities at different depths on the above basis and the values of r^3/v^2 indicating the relative tidal effects, at the surface of the earth, of the lunar (or solar) attraction on zones of equal thickness at each depth.

EFFECT ON SURFACE OF TIDAL ACTION IN CONCENTRIC ZONES.

Depth in km.	Radius in km.	Velocity of Distortional Waves, in km. per sec.	r^3/v^2 divided by 10^9.
0* to 2*	6,378 to 6,376	0·3	2,883 to 2,880
2* to 5*	6,376 to 6,373	0·8	405·0 to 404·4
5* to 20*	6,373 to 6,358	3·1	26·94 to 26·74
20	6,358	4·08	15·44
30	6,348	4·10	15·22
80	6,298	4·22	14·03
127	6,251	4·37	12·79
195	6,183	4·50	11·67
256	6,122	4·65	10·86
333	6,045	4·79	9·626
408	5,970	4·97	8·864
491	5,887	5·14	7·722
577	5,801	5·32	6·897
673	5,705	5·53	6·072
760	5,618	5·77	5·326
890	5,488	5·98	4·622
1,017	5,361	6·24	3·957
1,162	5,216	6·50	3·359
1,336	5,042	6·77	2·797
1,449	4,929	6·88	2·530
1,662	4,716	6·85	2·235
2,072	4,306	6·84	1·707
2,458	3,920	6·84	1·288
2,842	3,536	6·85	0·942
3,239	3,139	6·85	0·658
3,675	2,703	6·74	0·435
4,026	2,352	6·84	0·278
4,449	1,929	6·72	0·159
6,378	0,000	unknown	0·000

* Depths down to 20 km. are assumed.

If we assume that the influence of the folds extends down to a depth of 80 km., that from a depth of 20 km. to one of 1449 km., dv/dr is constant and equal to $-0{\cdot}00196$, and that from this depth to the centre of the earth v is constant and equal to 6·83, the ratio of the effect at the surface of the earth of the tidal action on the zones influenced by the folding to the effect of such action on the lower zones down to the centre will be about 55 to 78. If, as is usually supposed, the sedimentary and acid rocks as well as the folding extend to greater depths, the former figure will be increased and the latter diminished. In any case, these figures are sufficient to show that tidal action on the upper zones of the earth must exercise a very considerable influence on the movements of the surface, and that differences of direction of structures in the earth's crust cannot be disregarded in explaining the apparent difference of rigidity which has been observed.

As a matter of fact, we have not at present the materials for a definite conclusion. What is urgently needed is a systematic series of observations in a number of localities differently situated with reference to the more important features of the surface of the earth.

JOHN W. EVANS.

The Electrodeless Discharge.

IN the electrodeless ring discharge, the type of spectrum produced depends largely upon the voltage drop per mean free path. This is in general only a few volts, under ordinary operating conditions. A comprehensive survey of the entire subject has been given recently by Mierdel (*Phys. Zeit.* 25, pp. 241-55, 1924). As discussed in this article, spark spectra may be excited by increasing the voltage or by reducing the pressure. Both methods have been employed effectively; the former especially by L. and E. Bloch. We have used the latter method with potassium. At high vapour pressure the arc spectrum alone is observed. When the pressure is reduced, the spark lines appear. Observations on the stages in the excitation of known spectra furnish a trustworthy means for estimating the potential gradient in the electrodeless discharge.

The presence of several differently coloured, concentric rings of discharge has been often noted. The voltage gradient is a maximum at the circumference of the bulb and approaches zero at the centre. This effect is beautifully marked with bulbs 25 cm. or more in diameter, especially with the vapour HCl.

We have operated the electrodeless discharge at extremely low pressures. Mercury at 0·002 mm. and iodine cooled to $-50°$ C. are sufficient for a brilliant and uniform luminosity throughout the bulb. In the spectrum of the latter the line at 2063 A is strongly developed.

On disconnecting one terminal of the ring, a "capacity discharge" fills the entire vacuum system and a uniform glow appears in the bulb. The spectrum of this glow from a molecular vapour is usually almost free from atomic lines.

Because of the low pressures under which the electrodeless discharge may be operated with high intensity, it should rival the low voltage arc for the production of sharp, unreversed lines, and by proper adjustment for low field strength, might be desirable as a source in fine structure analysis. It does not appear, however, to be satisfactory for exciting resonance radiation in mercury.

It was thought that this type of discharge should be especially suitable for the production of the hydrogen Balmer lines. At a pressure of a few thousandths of a millimetre, the probability of two dissociated atoms colliding and recombining is small, so that, once the gas is dissociated, further excitation should give the atomic lines. To our surprise only five or six members of the Balmer series were observed. This is probably due to the fact that collisions of electrons having velocities comparable with the ionisation potential, with hydrogen molecules, usually result in excitation or ionisation without dissociation. Franck has recently given some attention to a theoretical discussion of this phenomenon (cf. "Ergebnisse der Exakten Naturwissenschaften," vol. 2, p. 120, 1923, Julius Springer).

If a liquid air trap is sealed directly to the large bulb, and moist hydrogen is streamed through the system, a rapid "clean up" is observed, so that a considerable amount of hydrogen disappears. On removing the liquid air, a momentary, brilliant red flash occurs. We did not determine whether this is due to condensed monatomic hydrogen or simply to water vapour.

When a bulb containing mercury vapour at room temperature is first operated, before the glass walls have warmed appreciably, a beautiful mercury mirror ring is deposited on the glass, concentric with the metal conducting ring. This is due to the tangential velocity impressed by the circular field upon the mercury ions formed. Under the conditions of our experiment magnetic forces upon the ions may be neglected. Such a large deposit of mercury occurs that possibly the method could be modified for the separation of isotopes.

The ring discharge with a large bulb is an effective means for producing the activated form of nitrogen observed by E. P. Lewis. There can be little doubt that active nitrogen consists of N_2 molecules in a metastable condition. First, evidence in favour of this view was the observation by Fowler and Strutt that the spectrum of active nitrogen consists of a selection of the positive bands, while L. and E. Bloch as well as Foote, Meggers, and Mohler (Cf. "Origin of Spectra," p. 190) found these bands to be excited well below the ionisation potential of the molecule. Further evidence may be drawn from Strutt's observation that no appreciable current flows between sounding electrodes (unless these are in actual contact with the luminous vapour), indicating that glowing active nitrogen is not ionised. The production of current when the active nitrogen is in contact with the electrodes, appears to be a confirmation of the Holst-Oosterhuis hypothesis (*Phil. Mag.* 46, p. 1117, 1923) that excited molecules upon encountering a metal surface may liberate electrons. This phenomenon might be useful in fixing superior limits for thermionic work functions or for critical potentials.

Saha and Sur (*Phil. Mag.* 48, p. 421, 1924) have discussed the data of Lewis, Strutt, and Fowler on the excitation of the spectra of gases and metal vapours in contact with active nitrogen, and assuming the observed effects to be due to collisions of the "second kind," have estimated the energy of active nitrogen to be slightly less than 8·8 volts (incorrectly computed as 9·4 volts).

We have found that mercury lines requiring 9·5 volts for their excitation are strongly developed. It does not appear that these may be attributed to molecules or atoms having abnormally high translational energy.

PAUL D. FOOTE.
ARTHUR E. RUARK.
Bureau of Standards, Washington, D.C.

Pyramid and Prophecy.

IN the notice in NATURE of October 25 of the work entitled "The Great Pyramid: its Divine Message," by the late Dr. H. Aldersmith and myself, the reviewer, by a careful selection of remotely secondary features of the book, convinces himself he has proved the work to be of the "assertionist class." He represents that I have obtained the length of the Pyramid base from the positions of the sockets, which is not the case. He also represents that I have obtained the Pyramid base side by adding ten inches to the longest existing socket base side, which is also not the case. Sir Flinders Petrie's survey has shown that the core masonry surfaces are hollowed in up the centre, and that the base casing stones still exist in the centre of each base side. With the casing surfaces hollowed in to the same extent as the core masonry surfaces are hollowed in to receive them, we obtain the Pyramid base circuit of the same dimension as the ancient Egyptian literature shows it to have been, namely,

36,524 units, the unit being of the value 1·0011 British inches.

The reviewer confuses our historical treatment with our treatment of the fictitious chronology of the Egyptians and our treatment of the Jewish chronological forgeries. These are dealt with as separate considerations in our book. The two latter have been proved successively in every stage of evolution, together with the reasons prompting the various stages. They are not, therefore, brought into operation to show the fiction and forgery at a stage in our historical treatment when, as the reviewer alleges, we find "the records are not convenient." The real fact is that the proofs of the said fictions and forgeries are found to be inconvenient for the historical theory your reviewer has adopted.

It is also alleged that our proof of the fixed calendar year in early Egypt is a matter of assertion. An attempt is made to justify this by a misrepresentation. The reviewer selects what he deems to be an exception to a general rule established in the first chapter of the book, and advances this alleged exception as typical of the application of the general rule. Other authorities have already recognised the importance of the data establishing this general rule—as graphically collected on our Plate IX., as proving the fixed year in Egypt. This element is the real disturbing feature of the book to your reviewer, and while it is a remotely secondary feature of the book itself, it is made almost the entire point of criticism.

The whole range of the reviewer's criticism is entirely covered and satisfied by the graphical analyses of our Plates IX., XVI., and XVII. An unbiassed critic, whether an Egyptologist or not, can really satisfy himself, by the examination of these three plates, as to which statements, the reviewer's or our own, "belong to the assertionist class." I am content to let the whole construction of our work rest upon these three plates as a definite basis, if for no other reason than that your reviewer has summarily dismissed all the other really essential features of the work in the last six lines of his criticism.

I would emphasise, in conclusion, that our work throughout has been based on the very trustworthy archæological and metrological *facts* of Sir Flinders Petrie, but that our co-ordination of these and other related *facts* has compelled us to reject his elaborate Egyptological *theories*. Unfortunately, your reviewer evidently considers a thesis to be "devoted to confusing the public mind" if it fails to accord with the *theories* of the Petrie school of Egyptology.

D. DAVIDSON.

47 Park Square, Leeds,
November 5.

THE review referred to the physical statements, which were suitable because they could be dealt with on ground familiar to the readers of NATURE. They were not "remotely secondary," but are put in the forefront of the volume, in the first 64 pages, and are referred to as a basis for other assertions. The assumed curvature of the casing of the pyramid is contradicted by the mark of the edge of the casing, which is now exposed at the north-east corner; it was straight within an inch. The length of the sides is asserted to have been 9141 inches, and this involves disregarding the sockets, and adding 10 inches to the longest socket side. The intricate assertions about chronology could not be discussed in a year of NATURE; but it is a safe method in all treatment of complex matters to look at the product; if that is physically impossible it is of no effect to argue about the detail. Now the proposed contemporaneousness of the Dynasties XII. and XIII., and the blank left between 1477 and 1216 B.C., are impossibilities in any view held by any scholar familiar with the monuments. Such a sample, of fundamental importance, relieves us from discussing how such results are reached. All that a discussion could prove would be the untrustworthiness of its material or method. There are well-known equations proving that $a=2a$, but they do not convince.

THE REVIEWER.

Spectrum Observations on the Copper Arc.

DURING some work in this laboratory with the copper arc, certain pole effects were observed. The arc was formed by two rods of pure copper, 4 mm. in diameter. The length of the arc was 6 mm. and the current strength 3 amp. on a 220-volt circuit. An image of the arc was projected on to the slit of a Hilger quartz spectrograph (size E.1), the arc being in line with the slit.

Above λ2800, practically no effects were observed, but below this wave-length a number of lines showed a change of intensity between the centre of the arc and the two poles. Lines at the positive pole were more intense than at the negative pole, while a few lines were seen in the positive pole only. Table I. was drawn up according to the notification of Merrill (*Astro. Jour.*, v. 56, p. 475).

TABLE I.

λ.	Group.	λ.	Group.	λ.	Group.
2824·378	1	2276·244	3	2192·236	3
2544·85	5	2263·09	1	2189·599	4
2489·659	4	2246·984	3	2181·68	1
2442·625	1	2242·599	4	2179·37	3
2406·661	1	2230·071	1	2148·93	4
2403·327	5	2228·845	4	2135·92	4
2400·102	3	2227·74	1	2125·978	5
2369·877	3	2218·079	3	2122·916	5
2303·109	2	2210·240	4	2112·023	4
2294·353	4	2199·65	2		

Group (1) slight observable increase, (2) small increase, (3) considerable increase (about twice), (4) great increase, (5) very great increase.

The following lines showed a greater reversal towards the negative pole: 2293·832, 2263·09, 2230·071, 2227·74, 2225·665, 2215·65, 2214·56, 2199·65, 2181·68, 2178·91.

Among the lines found by Shenstone (NATURE, v. 114, p. 501 (No. 2866)) in an 8-volt copper arc, 2293·832 was the only line showing an appreciable change of intensity. The wave-lengths given above are Hasbach's as given in "Handbuch der Spectroscopie" (Kayser and Konen), vol. 7. Basing a Hartmann formula on the lines 2148·93, 2112·023, and 2054·88 (Hasbach's Values), the wave-lengths of the following four lines were interpolated: 2138·49 (Hasbach, 2138·44; Huppers ("Handbuch der Spectroscopie," Kayser and Konen, vol. 7), 2138·54); 2105·03; 2104·70 (Hasbach gives one line at 2104·717); 2079·53 (Pina, *loc. cit.*, 2079·47). The line given by Hasbach at 2085·22 was not found. The dispersion of the instrument in this region is 0·7 mm. per angstrom.

F. SIMEON.
E. S. DREBLOW.

Research Laboratory,
Adam Hilger, Ltd.,
75A Camden Road, London, N.W.1.

The Molecular Weight of Glycogen.

RECENTLY Mr. W. K. Slater has prepared glycogen in a high degree of purity, and has commented on the difficulty of obtaining the polysaccharide in an anhydrous form (*J. Physiol.* 58, 163, 1923; *Biochem. J.*, 18, 621, 1924). This observation may be of significance in connexion with the molecular weight of the higher polysaccharides for a reason which I have not hitherto seen discussed, although it is probably familiar to some of your readers.

When the general formula for the complete hydrolysis of a lower polysaccharide, such as *raffinose* or *stachyose*, is considered, it will be seen that the saccharide on being converted into n molecules of hexose requires only $(n-1)$ molecules of water:

$$\underset{\text{Raffinose.}}{C_{18}H_{32}O_{16}} + 2H_2O = 3C_6H_{12}O_6,$$

$$\underset{\text{Stachyose.}}{C_{24}H_{42}O_{21}} + 3H_2O = 4C_6H_{12}O_6.$$

Applying this equation to the hydrolysis of a higher polysaccharide, such as *glycogen*, it would appear either that (1) the higher polysaccharide exists in some stage of the hydrolysis as a cyclic compound requiring the addition of two molecules of water in order to produce two derivative molecules; or that (2) the simple equation for the hydrolysis of a polysaccharide is not quantitatively correct, and instead of being:

$$(C_6H_{10}O_5)_n + nH_2O = nC_6H_{12}O_6$$

it should be:

$$(C_6H_{10}O_5)_n + (n-1)H_2O \rightarrow nC_6H_{12}O_6.$$

Now, if n molecules of hexose be formed from the hydrolysis of one molecule of a polysaccharide by the addition of $(n-1)$ molecules of water, the formula for a polysaccharide must be:

$$(C_6H_{10+2/n}O_{5+1/n})_n$$

and the equation becomes:

$$(C_6H_{10+2/n}O_{5+1/n})_n + (n-1)H_2O = nC_6H_{12}O_6.$$

Consequently, from a percentage analysis of a pure polysaccharide the value of n may be obtained by calculating the difference between the observed value for the hydrogen $(H_{10+2/n})_n$ and the theoretical value $(H_{10})_n$ found from the $(C_6H_{10}O_5)_n$ formula.

WILLIAM FEARON.

Physiological Laboratory,
Trinity College, Dublin.

The Uniform Development of Photographic Plates.

IN the issue of NATURE for April 5 we directed attention to the limit of accuracy which is imposed on all methods of photographic photometry, by lack of uniformity in the manufacture, or development of photographic plates. In most cases these errors are much larger than any other errors, and, as the photographic method of photometry is so much used at present, it is very desirable that these errors should be removed.

From various considerations it appears that by no ordinary method of development can fresh developer be supplied to the surface of the plate as fast as the plate can use it, (or, alternatively, the products of development cannot be removed so quickly that they do not remain in appreciable concentration). The result is that any local increase in eddy motion in the developer gives rise to a darker image. If, however, the eddy motion close to the plate could be made so great that fresh developer could be supplied more quickly than it could be used, any small change in turbulence should cause no change in the development.

With this in view, we have tried a developing tank in which the plates are held against the vertical walls, and a piston nearly fitting the tank is moved up and down past the plates. Thus the developer is caused to flow at a high velocity through the narrow opening between the piston and the plates. The violent eddies produced effect very thorough mixing.

Developing ordinary commercial plates in this way, we have obtained much greater uniformity of density than we can get by any other method, and the results are better than any others published which are known to us, including those obtained with specially prepared plates on flat glass.

G. M. B. DOBSON.
D. N. HARRISON.

Clarendon Laboratory,
Oxford, October 27.

Aquarium Technique.

MAY I claim the hospitality of your columns to publish a method of getting rid of blue-green algæ from aquarium cultures for biological teaching? In procuring inoculation material for starting Amœba, Actinosphærium, Rotifer, etc., cultures (see NATURE, vol. 102, p. 166; vol. 105, p. 232), blue-green algal spores are frequently included in the "catch." These latter develop quickly, the resulting filaments becoming troublesome inhabitants of the cultures, binding down the other contents and interfering generally with the well-being of the micro-organisms.

I have been experimenting for some time with various chemicals, and have found that ferrous sulphate is an excellent poison for the blue-green algæ, while at the same time it appears to be a "tonic" for the amœba, actinosphærium, and rotifer. In a bad case of infection it was necessary to add 1 gram to a bulk of 2 litres of liquid (June 5). At the time of writing this note, November 1, the rotifer culture so treated is in a flourishing condition.

While awaiting the publication of a paper on *Amœba proteus* (where the subject of hydrogen ion concentration and amœba cultures is dealt with more fully) it may be of interest to the many people who have applied to me for assistance in starting cultures to know that ferrous sulphate has also been used with success for restoring the optimum P_H of the water of an amœba culture that had departed too far from that value for the well-being of the amœbæ.

MONICA TAYLOR.

Notre Dame, Dowanhill,
Glasgow.

British Actiniaria.

I AM preparing a monograph on British Actiniaria which the Council of the Ray Society has undertaken to publish shortly. Certain little-known species of vague systematic position have never reappeared since their first discovery, this usually dating prior to 1860. In such a case it is very desirable that all described forms should be procured before the appearance of a new monograph, so that an accurate species-list and correct details of distribution may be included. If any one who would care to collect living material during 1925 will communicate with me, I shall be glad to supply a list of desiderata and localities, to defray cost of postage, etc.

T. A. STEPHENSON.

Zoology Department,
University College,
Gower Street,
London, W.C.1.

Some Recent Researches on X-Rays: the J-Phenomenon.[1]

By Prof. C. G. BARKLA, F.R.S.

A FEW years ago there appeared to be two, and only two, X-ray phenomena—scattering and fluorescence. One was due to the tremor, the forced vibration, set up in electrons when matter was traversed by X-rays; the other was due to the ejection of electrons from certain atoms and the subsequent free vibration of electrons within those atoms. One was governed by classical laws, the other by quantum laws.

For some years now, what is apparently a third phenomenon has been coming to light. This phenomenon has many of the characteristics of fluorescence (with the emission of characteristic X-rays). As it was found to occur at frequencies higher than those associated with the K-radiations, it was called the J-phenomenon. It has also frequently a close association with scattering, an association which led to what has been called a quantum theory of scattering. The phenomenon is, however, neither X-ray scattering nor X-ray fluorescence, as these terms have been understood; and it seems undesirable to use either term to denote what is quite distinct from both. It is almost certainly governed by quantum laws, and it is possible that its investigation will lead to some solution of the whole problem of the quantum relationships.

THE J-PHENOMENON.

The effects described as the J-phenomenon are briefly these:

As the frequency of an X-radiation gradually increases, though there is in general an increase in the penetrating power of the radiation, under certain conditions the absorption in a given substance exhibits a discontinuity, rising abruptly to a higher level, and afterwards diminishing as previously with increasing frequency of the radiation. This is very similar to the rise in the absorption in a substance accompanying the emission by that substance of a characteristic radiation.

This absorption discontinuity occurs at higher frequencies (higher penetrating powers) the higher the atomic number of the absorbing element. The discontinuities have been observed in carbon, nitrogen, oxygen, aluminium, sulphur, copper, gold, and platinum.

The sudden increase in the absorption of the rays is accompanied, when the absorbing substance is in the gaseous state, by a sudden increase in ionisation in that substance. When in the solid state, the absorbing substance emits an additional corpuscular radiation. The ejected electrons are apparently slowly moving electrons.

All these phenomena are suggestive of the emission of characteristic radiations of another series, the J series.

There are, however, a number of characteristics which distinguish the J-phenomenon very clearly from the phenomena associated with the emission of characteristic radiation of the now well-known K, L, M series. These may be briefly summarised:

1. The phenomenon is conditional on some unidentified factor or factors (possibly of intensity or superposition), whereas the only condition essential to X-ray fluorescence as previously known is that expressed by Stokes's fluorescence law.

2. The sudden changes in absorption and in ionisation appear to be absolutely abrupt, even when a *heterogeneous* primary beam is used.

3. The point at which the discontinuity occurs appears to be more closely connected with the rate of absorption of energy than with a critical wave-length (though the former, of course, depends upon wave-length).

4. The series of critical wave-lengths in the various elements cuts right across the well-known K series.

5. The change of critical frequency with atomic number is very small.

EXPERIMENTAL EVIDENCE.

The experimental facts illustrating 3 (above) are so remarkable and so entirely new, that they are worthy of description even in a short summary.

(*a*) Two beams proceeding from the same X-ray tube at the same time in different directions may have different penetrating powers. (There are various possible reasons for this; though it may be suggested that the obvious ones are not necessarily correct.) As the tube hardens up, the discontinuity in the absorption of each beam occurs, not when a particular state of the tube is reached, but when each beam, independently of the other, reaches the critical penetrating power for the substance used as the absorber.

(*b*) A heterogeneous beam direct from an X-ray tube in some cases shows no absorption discontinuity as the tube becomes harder, whereas when the same radiation is filtered and so brought to a higher average penetrating power, the discontinuity in absorption occurs at the correct critical penetrating power for the absorbing substance used. Thus the absorption of a complex beam is not the sum of the absorption of its constituents.

(*c*) Again, in some experiments, if the radiation is passed through a thin filter, as the tube hardens the absorption discontinuity does not appear; whereas when a thicker filter is used, the absorption of the transmitted radiation shows a well-marked discontinuity, and at the correct critical penetrating power.

(*d*) Further, and confirming the above, in some experiments the absorption discontinuity does not appear when *thin* absorbing sheets (absorbing only a small fraction of the radiation) are used; whereas the discontinuity appears when the absorption is measured by means of *thick* absorbing sheets.

(*e*) Transmission of a given heterogeneous radiation through successive very thin sheets of absorbing material, shows (as might be expected from the above results) that at a certain critical thickness there is an abrupt drop in the intensity of the transmitted beam; that is, the exponential law of absorption evidently breaks down and there is a sudden extinction of the primary beam. After this the absorption differs little, if at all, from what is normally expected. Whether or not the transmitted beam is truly transformed is not shown by these experiments; in experiments of another kind, however, when the sudden extinction occurs, the transmitted beam is definitely of a more absorbable type than previous to the abrupt change.

These results naturally suggest such inquiries as the

[1] A summary of the Silvanus Thompson lecture delivered before the Röntgen Society on April 1.

following: Are we really measuring the intensity of the radiation? Is a certain portion of the ionisation (used as a measure of intensity) produced by a method distinct from the remainder, and are all the phenomena above described due to this special ionisation? Is a fraction of the observed effect of the X-rays due to the combined action of a number of radiations differing in wave-length? Is a certain portion of the ionisation due to short-range electrons as distinct from the bulk of the ionisation taken as a measure of intensity?

An answer to these and many other questions is given by the results of experiments in which various methods of measuring intensity were adopted. Ionisation in air, in sulphur dioxide, and in hydrogen produced by the emission of high-speed electrons from an aluminium plate in the path of the X-rays, and ionisation produced by the high-speed electrons ejected from copper, were all used as measures of intensity. The discontinuity was observed by each method, and at the same critical penetrating power. The phenomenon thus appears to be independent of the particular method of measuring the X-radiation. We must therefore assume that the phenomenon is one in the X-rays themselves, for our only measure of X-rays is obtained from such effects.

These phenomena have been observed with radiations from many different tubes and with different anticathodes; with strong and with very feeble radiations; with narrow pencils and with wide beams; with polarised and with unpolarised radiations; with heterogeneous and approximately homogeneous radiations; with primary radiations, scattered radiations, and characteristic radiations.

Applications to the Scattering of X-Rays.

The results recorded above have many important applications, notably to the phenomenon of scattering of X-rays.

Röntgen radiation which is scattered from light elements is exactly like the primary radiation in its penetrating power (and hence its wave-length) over a long range of wave-lengths. The polarisation, distribution, and intensity of this radiation are all accounted for by the classical theory of radiation. There is no shadow of the quantum in the phenomenon. The appearance under certain conditions of a secondary radiation differing from the primary indicated the probability of the emission of a fluorescent radiation of the J series by these light elements. Compton has recently called this transformed radiation "scattered radiation." It appears that this transformed radiation is neither a fluorescent radiation nor a scattered radiation, as these terms have been understood.

The transformation observed by us is the transformation associated with what is described above as the J-phenomenon. For some reason (possibly connected with intensity), the scattered radiation appears more susceptible to the J-phenomenon than the primary radiation. The following brief statement of results obtained from experiments on scattering show that the true phenomenon of scattering may be completely masked by the J-phenomenon as described above; the results are precisely those to be expected from the application to the scattered radiation of the laws governing the J-phenomenon. They are all contrary to Compton's hypothesis. (Most of the following results were obtained in collaboration with Dr. S. R. Khastgir.)

1. As the wave-length of a primary radiation diminishes, the scattered radiation remains exactly like the primary (measured by its absorbability) over a long range of wave-lengths. There is nothing even approaching the difference between primary and scattered required by Compton's hypothesis.

2. An apparent change—a difference between scattered and primary radiation—appears quite abruptly as the frequency of the radiation is increased. It is a change of the order of five or more times the error of experiment. There is no mistaking it. This well-marked difference in penetrating powers of scattered and primary radiations persists for all shorter wave-lengths. (This phenomenon seemed at first to confirm the indications of an emission of characteristic rays of the J series.)

3. Further sudden changes in the scattered radiation appear as the wave-length of the primary radiation is diminished, the difference between the secondary and primary radiations becoming greater at certain critical, though not accurately definable, wave-lengths. There are several well-marked discontinuities.

4. Using various substances to measure the absorbability of the primary and secondary radiations, the above-mentioned discontinuities occur not at the same but at slightly different wave-lengths.

5. When *thick* absorbing sheets are substituted for *thin* ones to test the character of the radiations, the discontinuity—the sudden appearance of or increase in the difference between the primary and the secondary radiations—appears earlier; that is, when the primary is of greater wave-length than is the case when thin absorbing sheets are used.

6. The wave-length at which the difference appears (the discontinuity) depends to a certain extent both upon the *material* and upon the *thickness* of the radiating substance.

7.[2] In certain selected cases, we can identify the thin layer of absorbing material in which the change occurs. Thus as primary and secondary radiations are transmitted through an increasing thickness of absorbing material, the absorptions up to a certain thickness are exactly alike (unmodified scattering). A further thin layer makes all the difference between the two. Afterwards the scattered radiation is the more absorbable. Thus we have curves showing quite definitely that an unmodified scattered radiation becomes suddenly modified by transmission through material quite outside the scattering substance. It is, of course, only by proper selection of the radiation experimented upon that this transformation can be located in this way. But this fact alone shows that the transformation is not necessarily or essentially in the process of scattering.

The importance of this result is little affected by the fact that in numbers of experiments in the Laboratory at Edinburgh as elsewhere, long series of observations show a persistent difference between primary and secondary radiations without a suggestion of equality of wave-length or of the abrupt changes referred to above.

[2] Results under section 7 were obtained in April 1924, shortly after the lecture before the Röntgen Society.

The experiments only *appear* to indicate a change of wave-length produced by scattering. It is possible that, of these cases, the J transformation occurs at the birth in the scattered radiation. But facts of much greater significance are these :

As the frequency of the X-radiation increases we can, in many cases, observe the quite abrupt transition from an unmodified scattered radiation to the modified scattered radiation. There is a gulf between the two which makes the identification unmistakable and shows that some special condition is essential to the production of the modified scattered radiation. We can, in selected cases, take the unmodified scattered radiation and transform it into the modified scattered radiation, even identifying the thin sheet of absorbing material which affects the transformation—quite outside the scattering substance.

These are not isolated results, nor are they of the hazy, indefinite kind which some seem to suspect. The changes are of a magnitude several times the magnitude of the possible error. The phenomenon has all the characteristics of the J-phenomenon as observed originally in primary radiations, and as briefly indicated above.

It is not intended here to discuss either the process or even the nature of the transformation involved, for though many experiments have been made, many more are necessary before we can get a secure foundation for any theory. The phenomenon is not scattering nor is it fluorescence with the emission of characteristic radiation as generally understood ; it is a new—a third X-ray phenomenon. Without committing oneself to an opinion, it may be stated that there is the appearance of a sudden absorption of the beam followed by a re-emission of radiation of somewhat greater wave-length proceeding in the original direction of propagation. Absorption laws break down ; methods of comparing intensities of radiation are no longer applicable. This needs to be borne in mind in experiments upon penetrating radiations. It seems highly probable, for example, that in experiments on the absorption of penetrating X-rays and γ-rays, the transmitted beams produce far too much ionisation for their energy, and thus appear not to be absorbed so strongly as they really are. For we have observed sudden increases of ionisation of so much as 100 per cent. due to a very slight diminution in wave-length. Thus there seems little doubt that when penetrating X- and γ-rays are transmitted through thick layers of absorbing material, the ionisation coefficient is suddenly increased at certain points (under certain conditions the change may be gradual), and the transmitted radiation then produces a greater effect than is accounted for by intensity alone. It appears more penetrating than it really is.

CONCLUSIONS.

The broad conclusions are that under certain conditions not yet identified, but apparently depending on the rate of energy absorption, discontinuities occur in the absorption of X-radiation accompanied by corpuscular emission from the absorbing substance and ionisation when that substance is in the gaseous state. The transmitted primary radiation behaves as a transformed radiation.

No direct evidence of the emission by the absorbing substance of a characteristic X-radiation (of J series) has been obtained. If it exists it must be very feeble. What originally appeared to be a fluorescent radiation (and to others a modified scattered radiation) has been found in some cases to be merely the scattered radiation transformed by transmission through matter after its production. The radiation when observed is neither characteristic nor scattered, but is the scattered radiation after having been transformed by the J process (a process similar in many ways to fluorescence with the emission of characteristic X-rays). The necessity for critical conditions suggests obedience to the quantum laws in some form. The well-known laws of X-ray absorption break down when the critical conditions are reached.

Though it is realised that some of the results here recorded will possibly need re-statement or modification when they are tested by experiments extending over a wider range of conditions, the results already obtained are so absolutely new, so remarkable, that they seem to justify publication before a solution of the whole problem has been found. Further investigation of the subject promises to lead to some of the most interesting and important generalisations.

Historical Tradition and Oriental Research.[1]

By Prof. J. H. BREASTED, University of Chicago.

IT has often been remarked that the outstanding trait of the untrained mind is credulity. The rationalisation of man's views of the world has been a very slow process and it is still very far from a completed process. It has commonly been thought to have begun with the Greeks, but its origin must be sought in the Orient in a period long before Greek civilisation had arisen. The Edwin Smith Medical Papyrus, acquired in 1906 by the New York Historical Society, discloses the inductive process of scientific investigation already in operation in the seventeenth century before Christ. For example, this document contains the earliest occurrence of the word " brain " anywhere appearing in surviving records of the past. The word is unknown in Old Testament Hebrew, in Babylonian, Assyrian, or any of the ancient languages of Western Asia. The organ itself therefore was evidently discovered, and the recognition of its various functions was begun, for the first time by these physicians of early Egypt in the thousand years preceding the seventeenth century B.C. The observations recorded in the Edwin Smith Medical Papyrus show that its author had already observed that control of the members and limbs of the body was localised in different sides of the brain ; and the recognition of localisation of functions in the brain, mostly the work of modern surgeons and others within the past generation or two, had already begun in the seventeenth century B.C., at a time when all Europe still lay in savagery or barbarism.

There is in existence part of an original transit

[1] From a paper communicated to the National Academy of Sciences, Washington, on April 29, and published in the Proceedings of the Academy for July, vol. x. No. 7, 1924.

instrument, made, as stated by the inscription upon it, by no less a king than Tutenkhamon, in the fourteenth century B.C. It did not come from the tomb of Tutenkhamon, but was apparently made by him for the tomb of his (or his wife's) great-grandfather, Thutmose IV. (fifteenth century B.C.). This and another such piece at Berlin are the oldest scientific instruments of any kind now known to us. It was used for determining meridian time, especially at night, in order that the observer might then set his water-clock, with its 24-hour divisions, a division of the day which thence passed over into Europe in Hellenistic times, whence it was transmitted to us.

Now Herodotus reports a tradition current in his day (fifth century B.C.), that the Greeks were greatly indebted to Egyptian knowledge. This tradition has in recent times been universally rejected ; but it would seem that there was much truth in the tradition transmitted to us by Herodotus, and that its complete rejection by classical prejudice is unjustifiable.

The fact that the early Egyptian scientific worker employed an inductive method so far back as the seventeenth century B.C. does not, however, mean that he had completely banished from his mind all belief in magic or in supernatural forces. This truth has been well demonstrated for later ages by Prof. Lynn Thorndyke in his monumental volumes on "The History of Magic and Experimental Science." Undoubtedly the Greek took the longest step in freeing his mind from inherited religious and traditional prepossessions. Using astronomical observations undoubtedly drawn from Babylonia, Thales predicted a solar eclipse in 585 B.C. Astonishing as it seemed to the Greeks, there is little probability that this feat was an unprecedented achievement. What *was* unprecedented, however, was the revolutionary generalisation which Thales based upon his ability to make such a prediction. For he banished the erratic whims of the gods from the skies and discerned the sway of natural law throughout the celestial world. To tear away and fearlessly to trample under foot beliefs and superstitions which had been sanctified by age-long religious veneration demanded dauntless loyalty to his own intelligence. This first supreme enthronement of the human mind was probably the greatest achievement in the career of man.

We can pay no greater tribute to such Greek thinkers than to recognise, that although they put credulity to rout, they could not banish it altogether. It has survived with extraordinary persistence even to the present day. In modern times it was of course the tremendous significance of the discoveries of Galileo which most impressively reproclaimed the supremacy of natural law and the sovereignty of the human mind in discerning that law.

From Galileo's struggle with the church to Huxley's debate with Gladstone, the heavy guns of natural science have dealt tradition one destructive blow after another. It has been under this destructive attack at the hands of natural science that historical criticism has grown up in modern times since Niebuhr. Indeed it has been no accident that in the United States the first serious discussion of the Old Testament narratives in Genesis and Exodus was written by Thomas Cooper, who was the associate of Priestley in the discovery of oxygen. Cooper was Thomas Jefferson's appointee as first president of the new University of Virginia ; but in the Virginia of that period the social feeling against Cooper for having assailed the literalistic interpretation of the Old Testament was so strong that Jefferson was unable to secure his induction into office. Jefferson's influence, however, secured Cooper's appointment as president of the University of South Carolina, where public opinion was at first not so strong against him as in Virginia. It is interesting to note that before the end of the 'twenties, that is, less than a century ago, conservative sentiment was strong enough to bring about Cooper's dismissal from the University, although his personal popularity was such that he was promptly appointed to codify the laws of the State, and the first legal code of the State of South Carolina was edited by this gifted representative of natural science and historical criticism.

The merciless critical scalpel which had not spared Hebrew tradition was equally unsparing in its treatment of the cherished classical heritage from Greece and Rome. The tales of Romulus and Remus, the Trojan war, and the entire cycle of legends which were linked with it, were shorn away. A critical attitude of universal negation arose. It included the whole Mediterranean and Oriental world : Rome, Greece, Hebrews, Babylonians, Assyrians, and Egyptians. Historical criticism would not allow that early man at the beginning of the age of writing had ever heard and transmitted an echo from earlier ages, which, because they possessed no writing, could only send on their story in the form of oral traditions. This attitude of the historical critic may be compared with that of an observer who stands on a mountain peak, and, looking off across a distant landscape to a dim horizon shrouded in mists and cloud, insists that the intermittent glimpses of mountain profiles which vaguely emerge on the far-away skyline cannot correspond to any reality. In short, without ever having been himself on the ground to investigate, he denies the existence of the phantom mountains on the horizon.

The orientalist, if he be something more than a philologist, may be compared with the explorer who pushes out to that distant horizon, and is able to determine on the ground whether the phantom mountains really exist. Such investigation is, however, relatively recent, and the historical critic could scarcely anticipate that it was coming. He seemed to be quite safe in sweeping away all early human tradition. It dealt with a world of gods, demi-gods, and heroes ; it was dominated by the whims and caprices of angry or jealous divinities, and it was filled with impossible wonders and prodigies. How could a soundly critical historian accept narratives which seemed so manifestly impossible ? We must grant that in the circumstances rejection complete and unqualified seemed the only safe course.

Such critical negation was supreme when, fifty years ago, archæology began to reveal with startling vividness the facts and the daily equipment of human life in the very ages with which the rejected traditions dealt. In the seventies of last century the excavations of an untrained observer from the outside disclosed an astonishing vision of pre-Greek civilisation at Tiryns, Mycenæ, and Troy. The incredulity with which these

discoveries of Heinrich Schliemann were greeted by the classicists was highly characteristic. His excavations recovered and exhibited to the incredulous eyes of the destructive critics the whole material equipment of daily life from the very age of the Trojan war (or wars), and from the very city in and around which it was waged.

Similar revelations, involving far earlier periods of time, rapidly disclosed the successive stages of the human career from a remote antiquity, reaching well back of the beginnings of the world as dated by an alleged "Biblical" chronology. In dealing with the traditions of these earlier ages the orientalists soon developed a similar school of negative criticism. Such traditional accounts were promptly thrown into the discard. Maspero's bulky history of the oriental peoples, still a standard work on most modern library shelves, tells us that Menes, the first king of the First Dynasty of Egypt, was a purely mythical or legendary figure. Nevertheless we now possess his tomb, and in our collections at the University of Chicago we have a piece of his personal ornaments, a gold bar bearing his name in hieroglyphic — the oldest piece of inscribed jewelry in existence. Since 1894, thousands of prehistoric graves have been excavated along the margin of the Nile Valley, revealing to us the successive stages of human advance for many centuries before the once legendary Menes.

Much the same process is going on in the investigation of Babylonian history. Even the mythical hero Gilgamesh, the original of the European Hercules, bids fair to emerge at last as a remote city king of early Babylonia, who gained a reputation for his prowess in war, until he became the typical and proverbial strong man of all ages.

The crowning disclosure in this unprecedented series of unexpected revelations has recently come from Asia Minor. Nearly twenty years ago the German Assyriologist, Hugo Winckler, visited the mounds of Boghaz (or Boghaz Köi—"Boghaz village") in central Asia Minor. As he walked over the ruins he kicked up with his boot heel several cuneiform tablets, lying practically on the surface. Below were piled the clay tablet archives of the Hittite "Foreign Office," the earliest of which had been lying there at the capital of the Hittite Empire since the middle of the second thousand years before Christ. The result has been the decipherment of ancient Hittite, or rather a whole group of Hittite, dialects. The War has intervened, and since Winckler's death the progress of examining this enormous body of archives has unavoidably been very slow. We owe a great debt, especially to Hrozny and Forrer, for the invaluable disclosures which they have wrung from these documents.

One of these tablets reports a war of Atreus, king of Achaia, against the king of Caria at about the middle of the thirteenth century, that is, about 1250 B.C. There can be no doubt that in this tablet we have a contemporary reference to the cycle of Trojan wars—a reference which must be regarded as an irreproachable historical source, as old as the events which it records. Thus out of the lost oriental background of Greek history in Asia Minor comes a *written* document confirming a Greek tradition, born in an age when the Greeks themselves still lacked writing. Because writing reaches further back in the Orient by nearly three thousand years than it does in Greece, we are able to confirm Greek tradition out of contemporary written sources.

It has long been recognised that in the early development of Greek civilisation the cities of Asia Minor took the lead. Thales, who lived in one of these cities, was an example of this early stage of Greek culture in Asia Minor. It is also evident that the inland background of oriental culture contributed much to this early development of Greek civilisation on the western fringes of Asia. It is out of this newly recovered oriental background that we are slowly regaining the earlier forerunners of Greek civilisation.

This contemporary reference to the Trojan war is an epoch-making revelation, which must react powerfully upon our treatment of early human traditions. It at once demonstrates that such traditions must not be thrown to the scrap-heap, but rather carefully divested of gods and goddesses, prodigies and wonders, and then examined for the nucleus of sober fact upon which the legendary tale has been built up.

As we look back upon our earliest historical horizon, we now know that the men who stood there in the grey dawn of the age of writing were able to hear echoes of a remoter past, transmitted in the form of oral tradition, of which some portion was then committed to writing and thus survived. In our modern effort to recover and reconstruct the story of man's past career, we have thus rehabilitated a new body of sources, however cautious it behoves us to be in making use of them. Not credulity alone, but also historical method, demands that we recognise these traditions, or the nucleus of fact to be drawn from them, as a body of sources to be restored to their proper chronological position in the succession of surviving evidences which reveal to us the past career of man on earth.

We are the first generation of men able to survey that career without a serious break. As we marshal the evidence for its successive stages, the humanists stand shoulder to shoulder with the workers in natural science, for as we look backward it is the materials and the methods of the geologist which confront us first. The geologist is succeeded by the palæontologist, the anthropologist, the anthropogeographer, and the archæologist. It is at this point, on the border land between the investigations of the worker in natural science and those of the humanist, that we must insert these long-discarded echoes from an age able to transmit only oral tradition, the true value of which oriental research has now interpreted to us. The Homeric songs of the Trojan war can no longer be regarded as exclusively noble literature, of purely legendary content; and, in the presence of these earliest surviving monuments of science, the Greek tradition of substantial Egyptian contributions to knowledge must not be rejected as baseless. There is every possibility that the tombs of Egypt may yield us further scientific treatises like this great Edwin Smith Medical Papyrus, and we cherish the hope that the thirty-five or forty chests, boxes, and caskets still lying in the innermost chamber of the tomb of Tutenkhamon with their seals unbroken may contain written documents.

Rotor Ships.

DURING the last few days, accounts of a new departure in ship propulsion have reached Great Britain. One vessel has been modified to illustrate the working of the new method and has operated in Kiel Harbour. The new invention represents an application of scientific principles known for many years; an early English paper entitled "The irregular flight of a tennis ball" was published in 1878 by Lord Rayleigh, using the same principle in explanation. The practical deduction from the general physical and mathematical idea is that a body like a circular cylinder, spinning about its axis and moving at right angles to it experiences a force which is at right angles both to the axis of the cylinder and to the direction of translation. The force is proportional to the product of the speeds of rotation and translation.

Herr Anton Flettner, the inventor of the "Rotor ship," uses two masts, one forward and the other aft, as pivots for two rotating drums. The drums are about 60 ft. high and 10 ft. in diameter, and are driven at 100 r.p.m. by electric motors of 9 h.p. The direction of rotation may be reversed and with it the resulting force. To see the method of application to steering, imagine the ship to be moving forward under power from auxiliary machinery with the two towers rotating in opposite directions. The forces will be athwart the ship in opposite directions and will together give a couple turning the ship. The only effect of rotation in the same direction would be to produce drift.

The most important of the claims made for the invention appears to be its capacity for extracting energy from the wind. Clearly, from what has been said above, the maximum propulsive effect from the circulation will be obtained with the wind across the ship, and it will fall off as the wind comes into the direction of motion. By changing the direction of rotation of the towers and tacking, advantage can be taken of any wind, and, in a general way, the problems are of the same character as those connected with sailing.

There are points of difference, however, which can only be dealt with adequately on the basis of efficiency, and the data so far received are insufficient for a discussion. Circular cylinders produce vigorous eddies in their wake, and such experiments as have been made show that the circulation produced by rotation is imperfect; the result is a very much smaller force across the direction of translation than is calculated, and in addition there is a drag.

It is probably not generally realised that the wing of an aeroplane, without rotating, is an efficient means of producing circulation, and that the support of an aeroplane is an example of the law enunciated at the beginning of this note. The sail of a ship belongs to the same category, and from the fact that the experimental work on circulation was executed at the Aerodynamical Laboratory at Göttingen, where this is very well known, and that no aeronautical applications have been made, it appears that scepticism as to the claims for high efficiency of the "rotors" is justified. The accounts received are such that it is difficult to disentangle achievements and hopes, but the claims for handiness and seaworthiness, etc., may merit closer attention when fuller details are to hand. L. B.

Obituary.

Sir Archibald Geikie, O.M., K.C.B., F.R.S.

THE "Long Life's Work" reviewed in NATURE of July 26 has been brought to a close. Sir Archibald Geikie passed away in his eighty-ninth year on November 10. For several years gradually failing health had confined him to the home he had made at Haslemere, but his pen was busy almost to the last, for the autobiography referred to bears the date 1924. The details of his upbringing and career, his extensive travels, the innumerable functions in which he was a leading figure, and the many friendships he made, are set out in the review in NATURE and need not be repeated, but his relation of personal experiences may now be supplemented by an account of geological achievements, which he passes over lightly. The comparative share which he and his contemporaries took in the elucidation of some of the great problems of the day requires a fuller consideration than could be given in a volume which was designed as a record of reminiscences rather than as a geological treatise.

Geikie was for many years the leading figure in British geology. His numerous original contributions to scientific journals, the charm and lucidity of his style, and not least the lasting value of his "Text-book of Geology," placed him in the forefront of living geologists. His work, unlike that of Lyell, was largely founded on the observations which he himself had made in the field, either original work for which he was alone responsible, or the work of colleagues which he had inspected in his official capacity on the Geological Survey. In either case his eye for scenery, his rapid grasp of essentials, and his facile and ever-industrious pen enabled him to record some of the greatest advances made in geology during the present era in papers which are unsurpassed for interest, elegance of diction, and lucidity.

When the Murchison Medal of the Geological Society was presented to Geikie forty-three years ago, special mention was made, in an already long list of valuable papers, to his work on the Chronology of the Trap Rocks of Scotland. He had been struck by the remarkable abundance of traces of volcanic action in past geological times as an outstanding feature in the geology of Midlothian and West Lothian. He recognised distinct vents from which lava had flowed on to the surface, or from which dust had been shot into the air, all to be buried and intercalated later on in the sediments of the Old Red Sandstone or Carboniferous formations. From this time on he tells us "the wide subject of volcanism . . . grew to hold the dominant place in my geological enquiries, leading me ultimately to pursue it far and wide over the whole of Scotland, and into every tract in England, Wales and Ireland where relics of volcanic history have been preserved. The study further impelled me in later years to visit the volcanic regions of Auvergne, the Eiffel and Italy,

and eventually to explore the great lava-fields of Western America" ("A Long Life's Work," p. 62). His exhaustive study of the subject found issue in a paper communicated to the Royal Society and afterwards in "The Ancient Volcanoes in Great Britain," one of those books in which he fascinates non-geological readers as well as experts by descriptions of some of the past episodes of the earth's history, written in his own inimitable style.

The controversy on the North-West Highlands is briefly referred to in the autobiography mentioned above, but cannot be passed over so lightly in estimating Geikie's share in the advance of geology. He accompanied Murchison in 1860 on a tour through the Highlands. Cambrian[1] fossils had been recognised by Charles Peach in 1854 in the limestones of north-western Sutherland, and Murchison wished to extend his conclusions drawn from that discovery to the central and southern Highlands. "I have to admit," Geikie writes in 1924, "that this expedition . . . was a premature attempt to solve problems which have not yet been all solved . . . the true structure of the Highlands was far too complicated to be unravelled by desultory and hasty traverses of the ground. It required to be patiently worked out by detailed mapping, such as has revealed the complicated grouping of the rocks in Sutherland" ("A Long Life's Work," pp. 84, 85).

The Sutherland complications here referred to had deceived Murchison. The one infallible test of the relative age of geological formations is that of superposition, provided always, and this is a big proviso, that the superposition is original and not the result of the reshuffling of the formations by subsequent earth-movements. Here lay the trap in Sutherland, for strata containing Cambrian fossils were seen, not once but repeatedly, to be directly overlain by crystalline schists, the "Upper Gneiss," as it was called in contradistinction to the Laurentian gneiss which forms the foundation of the whole region. No one making mere traverses of the area could doubt the evidence of his eyes, and it was only seventy or eighty years after the first account by Macculloch and after repeated visits by many eminent geologists that the truth was learnt. Nicol, who had accompanied Murchison in one of his visits, strongly opposed his views in 1856. He established the pre-Cambrian age of the Torridon Sandstone, which was regarded by Murchison as Old Red Sandstone by reason of a remarkably close lithological resemblance, and in 1858, at a meeting of the British Association, he stated his conclusion that the "Upper Gneiss" owed its position to faults. Heddle, while accepting much of Murchison's sequence, thought that the Cambrian strata had been dropped in by faults, and Callaway also declined to accept the natural superposition of the "Upper Gneiss" upon them. Much depended upon the correctness of these views. The "Upper Gneiss" extends over large areas in the central Highlands, and if Murchison had been right, all the rocks must have been regarded as of post-Cambrian age. Moreover, it would have been necessary to suppose that a great series of rocks had been highly metamorphosed, while the strata below them remained unaltered, with their fossils not obliterated. Space does not permit of an account of all the contributions to the controversy,[2] and I must come at once to the solution. Lapworth, in speaking of the apparent superposition, used the words "it would appear, at first sight, that his [Murchison's] theory of the sequence, so far as the Durness area is concerned, is "absolutely impregnable," but in the Erriboll region he obtained definite proof that the Cambrian beds are newer than the "Upper Gneiss." By exhaustive, systematic examination of the whole Durness-Erriboll region he determined the true sequence, and established the fact that the superposition of the "Upper Gneiss" is actually due to subsequent earth-movement on a great scale.

Geikie, who had adopted the views of his chief, when once it was brought home to him that they were erroneous, was largely instrumental in their correction. He put in hand the detailed six-inch surveying of the debated areas, and selected Peach and Horne for the work, instructing them, perhaps needlessly, "to get at the truth, regardless of anything that had been published on the subject" ("A Long Life's Work," p. 214). He himself inspected their work, under stress of mist, rain, and gale, in order to convince himself of the correctness of their interpretation. The maps of the Durness-Erriboll region confirmed Lapworth's work. They were completed in 1884, and thereupon the North-West Highlands became classic ground to geologists all the world over, not only as exhibiting overthrusting on a scale hitherto unknown in the British Isles, but also for the skill and detail of the mapping by which these structures had been recorded.

Previously to this, Lapworth had, by brilliant palæontological work, thrown a flood of light on the sequence of Lower Palæozoic rocks in the southern uplands. The sequence at Moffat, as accepted by Geikie and others, involved the assigning of abnormal thicknesses and characters to certain formations. By intensive study of the fossils, Lapworth showed that the abnormalities were due to frequent repetitions of the same strata by excessive plication. In the Girvan region also profound dislocations, folds, and inversions had obscured the original order. The succession, as Lapworth found it at the hands of his predecessors, consisted of an enigmatical group of great thickness, varying extraordinarily in petrological character and containing an admixture of fossils elsewhere characteristic of distinct formations. He left it an orderly sequence, each member of which was distinct and constant in petrological character and fossil contents over the whole area.

The share taken by each of the protagonists in this controversy now lies open to posterity for judgment. That Geikie added much to the solution of these great Scottish problems can be affirmed with confidence, but he had not been able, either himself or through others, to make those exhaustive examinations in the field of the structures and the fossils that were essential for the unravelling of the tangles. Possibly the fascination of exercising his power with the pen led him to expressions of opinion earlier than his better judgment might have counselled. He was influenced also, without doubt, by a feeling of loyalty to his chief, as well as by

[1] I use the name Cambrian here to avoid confusion. The rocks were not then so called.

[2] A full history of the investigation will be found in "The Geological Structure of the North-West Highlands of Scotland" (Memoir of the Geological Survey), 1907, chap. ii.

a natural disinclination to abandon views to which he had committed himself in print. Our sympathies may well go out to a man who puts up a good fight for his own work, for it means that he has had his heart in it and believes in it. I am reminded of an anecdote about Ramsay (Geikie's predecessor in office), who by a rare mistake had shown upon his map of North Wales as a lava a rock that was obviously a volcanic ash. Years after, brought face to face with the rock in the field, he opened a discussion with the remark, "Whatever else is wrong, my map cannot be." True it is that in the memoir already mentioned (*v.* footnote 2), which was edited by Geikie, full justice has been done to all who took part in the controversy. It is true also that, in a preface to the original report by Peach and Horne, Geikie confessed that he had been wrong. Yet one could have wished that in his last book, in which, near the close of his life, he relates his own personal experiences, and from which posterity will judge what manner of man he was, he had taken the opportunity of expressing some more generous appreciation of the labours of his fellow-workers.

I have spoken plainly, I hope not too plainly, of the part taken by Geikie in controversies, but there remains the great mass of his original unchallenged work, which for many years to come will keep his memory fresh as one of the greatest of geologists. Outstanding among his original researches are those upon volcanic phenomena, to which reference has already been made, but his papers on the Old Red Sandstone and on the glacial phenomena of Scotland are also classics. He was the first to give a connected account of the glacial deposits of his native country, and to advocate, in advance of the general opinion of his time, the agency of land-ice as a distributor of drift. In South Wales he utilised his experience of Lower Palæozoic and Archean rocks in correcting some generalisations by Dr. Hicks, himself a pioneer in that branch of geology, but prone to impetuous solution of difficulties by calling in many a *Deus ex machina* in the shape of faults. But I venture to think that he derived almost more pleasure from the writing of biographies of men he had known and worked with, and whose characters he could portray in his own kindly way. These books not only appeal to the non-geological reader, but also provoke the expert to explore literature he might have overlooked. Geikie himself was indefatigable in delving into the earliest records of geology. The "Founders of Geology" and "The Love of Nature among the Romans," to mention but two, could only have been written by a man who had read deeply in modern and ancient literature and had remembered wisely. In his "Reminiscences," his "Sketches," and his "A Long Life's Work" his pen was not fettered by the constant endeavour to avoid the use of technical expressions, and his easy, graceful language testifies to the value of his early training in the humanities and of his appreciative reading of good authors. With his keen sense of humour he could never be dull.

As a companion he was interesting and delightful, full of experiences, and charged with racy anecdotes which could be readily drawn from him, but were never forced on an unwilling listener. During his travels he made friends everywhere and he never lost their affection. In all parts of the world where geology is known, his loss will be felt as a personal bereavement.

The career now ended has indeed been a remarkable one. Adopting geology as his life's work, without interest and rather to the consternation of his father, he rose by his own exertions to the highest scientific posts Great Britain can offer, and received honours innumerable at home and abroad. Untiring industry directed by great sagacity was the keynote of his success.

A. STRAHAN.

MR. HARRY INNES PERKINS, I.S.O., died at Sydney on October 24, at sixty-three years of age, having retired in 1919 after a long and useful career in the Colonial Service. The son of Major-General E. N. Perkins, he was born at Simla, and educated at the King's School, Rochester. He held for a short time a post as Clerk to the Director of Public Works in Trinidad, and at the age of twenty obtained an appointment on the survey staff in British Guiana, where he ultimately became Acting Crown Surveyor. In 1884–1885 he took part in an expedition to Mount Roraima, and prepared a map of the mountain for the Royal Geographical Society. In 1895 he was appointed Acting Commissioner of Mines. Early in that year his "Notes on British Guiana and its Gold Industry" was published. In these notes, Perkins prophesied that valuable diamond deposits would one day be discovered in the Mazaruni, which has since become an important diamond-producing area. While Acting Commissioner of Mines, he served as one of the British Commissioners appointed for the demarcation of the British boundary between British Guiana and Venezuela, and in 1901 wrote a report on the geological features of the district traversed by the Commission. In some of his geological work he was associated with Sir J. B. Harrison, whose "Geology of the Goldfields of British Guiana," published in 1908, included contributions by Perkins. He received the I.S.O. in 1904, and in the following year was appointed Surveyor General of British Honduras, where he later became a member of the Executive and of the Legislative Council.

WE regret to announce that Gerard Kalshoven Gude, the authority on tropical land mollusca, died on November 8. Born in 1858, he was of Dutch parentage. Acting as secretary to Messrs. Veitch of Chelsea in earlier years, he had for several decades devoted himself to the study of land mollusca, contributing a volume on that subject to the "Fauna of British India." Mr. Gude also studied and arranged the important series of Tertiary land and freshwater shells of Europe for the Geological Department of the British Museum. A constant visitor to the Museum, his information was freely at the service of his colleagues, by whom he was greatly esteemed. He had been secretary and president of the Malacological Society of London.

WE regret to announce the following deaths:

Sir Maurice Fitzmaurice, C.M.G., F.R.S., president in 1916–17 of the Institution of Civil Engineers, and formerly a member of the advisory council of the Science Museum, on November 17, aged sixty-three.

Dr. Gustav Jaumann, professor of physics in the German Technical High-School in Brunn, and a foreign associate of the Vienna Academy of Sciences.

Current Topics and Events.

A REPORT on the "White" Indians discovered by Mr. R. O. Marsh on the Chucunaque River, to whom Mr. Julian Huxley referred recently in our columns (September 27, p. 464), appears in *Man* for November. It is the result of an examination made by Dr. F. C. Shrubsall, Dr. A. C. Haddon, and Mr. L. H. Dudley Buxton at Prescott, Ont., during the recent visit of the British Association to Canada. The party brought by Mr. Marsh from Panama consisted of two "white" boys and a girl, the parents of the girl, who are brown, and two San Blas Indians from an adjacent area. The "white" subjects, except in pigmentation, are identical with the brown in physical characters. They are very sensitive to light, and their vision is subnormal. All show rapid lateral nystagmus, and the younger boy occasional rotary nystagmus. The irides are greyish violet, with increased pigmentation at the papillary margin, and in one case a certain amount of brownish coloration. Choroidal pigmentation is markedly deficient. The hair is light golden and straight, the eyelashes nearly white. The skin is white with a rosy tint. Yellow brown freckles and blotches appear on the exposed parts. The parents of the girl are normal, but the maternal grandmother is said to have been white. The conclusion of the report is that the "white" characters are due to albinism and are of no racial significance.

THE report of the administrative council of the Empire Cotton Growing Corporation for the first full year since the passing of the Cotton Industry Act on July 18, 1923, has just appeared, and is a record of much valuable work. The Corporation is now firmly established, and at the moment its funds show an excess of income over expenditure, though if the cultivation of cotton in the British Empire should succeed as is hoped, there will soon be need for every penny. Signs of success are already visible in the rise of the exports from such colonies as the Sudan or Uganda; in the latter the crop is expected to reach 120,000 bales this season, a handsome figure, though as yet small compared to the 12½ million bales of the United States, or even to the 750,000 bales of Brazil, another country of recent appearance upon the market. It must never be forgotten in this connexion that the pioneer work in the British colonies was chiefly done by the British Cotton Growing Association, founded for the purpose more than twenty years ago. This Association is now attending more to the marketing work, leaving the propaganda, cultivation, and so on, to the larger organisation of the Empire Cotton Growing Corporation.

AMONG the most important activities of the Empire Cotton Growing Corporation at the present early stage are those recorded upon the first two pages of the annual report. By representation, protest, and otherwise, it has been largely instrumental in promoting the great Gezira irrigation scheme, which will render a very large area in the Sudan available for cotton, as well as in promoting the extension of railways in Uganda, Tanganyika, and South Africa, and in other ways. The most promising portion of the Empire is undoubtedly Africa, but cotton is much hampered there at present by lack of transport facilities. In this connexion attention may be directed to the interesting experiment described in the report; two lorries of "caterpillar" type have been sent out to Nigeria for trial upon unmade roads. It seems possible that such vehicles may prove to be available for the transport of cotton over untouched country, while at the same time consolidating the tracks upon which they move. Great enthusiasm is being shown in taking up cotton in Queensland, New South Wales, and South Africa, and fairly rapid progress is also being made in parts of tropical Africa. A considerable number of men (passed students, as well as senior men) has been sent out during the year to Uganda and elsewhere to aid in cotton work. The number of students has been increased, and a large sum has been provided for the keeping up of scientific work in various universities and other institutions. We wish all success to the efforts of the Corporation in its great Imperial task.

IN the *Times* of November 10, reference is made to a recent discovery of oil at Gabian, between Béziers and Paulhan, Dept. of Hérault, France. Within the last few years there have been several reports of the location of petroliferous deposits, mainly in central and south-eastern France, but save for the actual records of such discoveries, little seems to have been heard of any subsequent industrial developments on a large scale. From geological considerations, this is largely what was to be expected, though in the present oil-find at Gabian, if initial output is anything to judge by, prospects are better than might otherwise be anticipated. The search for petroleum throughout likely areas in France has been carried on arduously under the guidance of the Ministries of Commerce and Public Works, and in this connexion more than 12,300 acres of potential oil-bearing territory in the Gabian district have been acquired for the State. On behalf of the Ministry of Commerce, the Pechelbronn Company conducted drilling operations, which resulted in the bringing in of a well with a production of 250 gallons per hour of a fairly light oil (specific gravity 0·84). This well came in as a gusher, and it is because of its performance that considerable optimism prevails as to the future of this region of France as a productive oilfield. It is early days yet to form any definite ideas as to the possibility of this area from a commercial point of view; geologically there is much to be said against the likelihood of commercial pools being located, though the actual presence of petroleum is by no means contrary to expectation. But in this, as in other cases of petroleum occurrences in Western Europe, it is not the location of the oil which is surprising but rather the undaunted energy shown in the persistent search for economically valuable oil pools in the face of so many past negative results. Nevertheless, this discovery at Gabian is regarded as being the most important of its kind yet made within French territory.

VOLUME 68 of the Memoirs of the Manchester Literary and Philosophical Society contains an interesting account of the early domestic history of the Society, by Mr. Francis Nicholson. The Society was founded in February 1781 with 25 members, four of whom were fellows of the Royal Society and five are noticed in the "Dictionary of National Biography." Within a year of its foundation, it elected Joseph Priestley as an honorary member, and in November 1785 remitted to him 50*l.* as a tribute of respect and for "promoting and extending his philosophical pursuits." John Dalton removed from Kendall to Manchester in 1793 to take up the post of tutor in mathematics and natural philosophy at the Manchester Academy, founded in 1786 as a place of education of university standard without religious tests. On the removal of the Academy to York in 1799, he remained in Manchester as a teacher of mathematics and chemistry. He was secretary of the Literary and Philosophical Society from 1800 until 1809, when he was elected a vice-president and in 1817 president, an office he held until his death in 1844. One of the most interesting documents Mr. Nicholson brings to light in his history is a letter of Dalton's dated February 1794, in which he describes how he discovered the previous summer that colours appeared different to him from their appearance to other persons and how he was investigating the peculiarity. He never married, but this letter appears to indicate that if his head had not been, to quote his own words, "too full of triangles, chymical processes and electrical experiments, etc., to think much of marriage," he might have been.

THE Physical Society of Frankfurt-am-Main is preparing to celebrate its centenary.

PROF. M. DOELLO-JURADO, of the University of Buenos Aires, has been appointed as from January last to be director of the National Museum of Natural History at Buenos Aires.

PROF. A. S. EDDINGTON, Plumian professor of astronomy in the University of Cambridge, has been awarded the Bruce Medal of the Astronomical Society of the Pacific, "for distinguished service to astronomy."

APPLICATIONS are invited by the British Boot, Shoe, and Allied Trades Research Association, 50 City Road, E.C.1, for the posts of applied mathematician and assistant physicist. The applications should be sent to the secretary of the association.

THE Council of the Röntgen Society has decided to present the Röntgen Award for the session 1923–1924 to Mr. L. H. Clark, of the Physics Department, Middlesex Hospital, for his papers (1) "A Clinical X-Ray Balance Radiometer," and (2) "On the Measurement of X-Ray Intensity."

UNDER the Peter Le Neve Foster Trust, the Council of the Royal Society of Arts is offering a prize of 25*l.* for an essay on "The Effect of Trade Union Regulations on Industrial Output." Competitors must send in their essays not later than March 31, 1925, to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

THE Stockholm correspondent of the *Times* states that after a long discussion the Swedish Academy of Sciences has decided not to award the Nobel Prizes for chemistry and physics for 1924, but to reserve them another year. It was announced recently that the Nobel Prize for medicine for 1924 had been awarded to Prof. W. Einthoven, professor of physiology in the University of Leyden.

THE October issue of *The Fight against Disease*, the official organ of the Research Defence Society, contains among other matter an interesting historical account of the discovery of the lacteals by Asellius in 1622, of Sir Charles Bell's differentiation of the different functions of the anterior and posterior spinal nerve roots, and of Claude Bernard's observations on vaso-motor nerves—all of them epoch-making discoveries in the annals of physiology.

IN many investigations concerned with the nature, transmission, and prevention of human diseases, experiments on monkeys afford the best hope of a solution. In temperate climates these animals are difficult to keep for any long periods, and to overcome this difficulty the Pasteur Institute of Paris has established a laboratory at Kindia, French Guinea, particularly for research in which the higher and lower apes are employed. A detailed and illustrated account of the Kindia laboratories is given by Dr. Calmette in *La Nature* of October 25.

THE National Union of Scientific Workers, 25 Victoria Street, Westminster, S.W.1, has recently published a suggestive pamphlet "On the Encouragement of Fundamental Research," being a report of the Research Committee of the Union. Several important aspects of research training and application are surveyed in the report, and a progressive policy is outlined. We hope to deal in a later issue with some of the points raised, but meanwhile we are glad to direct attention to the pamphlet, copies of which can be obtained at the offices of the Union, price sixpence each.

THE following officers for the session 1924–25 have been elected by the London Mathematical Society:—*President*, Prof. A. L. Dixon; *Vice-Presidents*, Prof. L. N. G. Filon, Prof. H. Hilton, and Prof. W. H. Young; *Treasurer*, Dr. A. E. Western; *Secretaries*, Prof. G. H. Hardy and Prof. G. N. Watson; *Other Members of Council*, Prof. S. Chapman, Miss H. P. Hudson, Prof. G. B. Jeffery, Prof. A. E. Jolliffe, Mr. J. E. Littlewood, Prof. A. E. H. Love, Prof. L. J. Mordell, Mr. H. W. Richmond, and Mr. F. P. White.

THE Institution Medal of the Institution of Automobile Engineers has been awarded as follows: to Dr. R. Ormandy, in connexion with the editing, checking, and preparation of the matter for the report of the Empire Motor Fuels Committee, recently published as a volume of Proceedings of the Institution; to Mr. Geo. W. Watson, for his paper on "Standardisation," which formed the subject of his presidential address before the Institution; and to Mr. H. G. Burford, for his services in connexion with the co-ordination of the relations between the Institution,

the S.M.M.T., and the B.E.S.A. This Medal, which was recently established, is awarded for any paper or similar service which may be considered likely to have a special influence on the advancement of automobile engineering.

RECENT visitors to the Museum of the Brooklyn Institute of Arts and Sciences will have noticed its congested state and will be glad to learn from Mr. W. H. Fox's Report for the year 1923, lately received, that the city has appropriated 1,050,000 dollars for the completion of two new sections of the building. It is hoped that these will be available in a few months' time. We are informed that the city has also recently completed the purchase of a house adjoining the present Children's Museum; so that institution will likewise have more space for the admirable educational work that it conducts under the inspiring leadership of Miss Anna Gallup.

ABOUT two years ago the Trustees of the British Museum (Natural History) decided to catalogue and label all type specimens of Rhopalocera (butterflies) in the collections. Until recently many undoubted type specimens stood in the collections without any indications of their unique character. As a consequence some were discarded and replaced by "better" examples. It is, therefore, gratifying to know that proper measures are now being taken to ensure against the recurrence of such treatment. The first instalment, Part I., Satyridæ, has recently come to hand, and in it are listed some 3900 type specimens. The work was commenced by Mr. N. D. Riley, but the greater part of it has been done, under his supervision, by Mr. A. G. Gabriel. The catalogue gives the Museum number, name, genus under which originally described, original reference, sex, date, etc., of each type, and it will prove valuable to the systematist.

THE second annual report of the director of the Institute of Science and Industry of the Commonwealth of Australia covers the period from July 1922 to December 1923. It appears from it that the Institute, although established in 1920, has not yet been provided with the funds necessary to enable it to carry out the whole of its functions. The total sum available for its work in 1922-3 was only 13,900*l.*, and the grant for the following year 12,900*l.* It is carrying out researches on pottery, paper pulp making, the supply of tannin, seed improvement, agricultural pests, and stock diseases. No funds have, up to the present, been devoted to the study of the refrigeration problems which are in urgent need of solution, nor have any steps been taken to organise the information available as to ore deposits and the best methods of treatment of the ores. There is no lack of problems awaiting solution which cannot be touched until more financial aid is available.

WE learn from *Science* that at the stated meeting of the Franklin Institute held on October 15, the following medals were presented: The Louis Edward Levy Medal to Dr. Harvey Fletcher, of the Western Electric Company, New York City, for his paper on "Physical measurements of audition and their bearing on the theory of hearing," printed in the issue of the Journal of the Franklin Institute for September 1923 (this is the first award of the Levy Medal, which is to be given annually to the author of a paper of especial merit, published in the Journal of the Institute, preference being given to one describing the author's theoretical and experimental researches in a subject of fundamental importance); the Edward Longstreth Medal to Thomas C. McBride, of Philadelphia, for his invention of a locomotive feed water heater, and to Milton Roy Sheen, of Philadelphia, for his invention of the expansion machine for tunnel construction.

THE autumn conversazione of the Natural History Museum Staff Association, which took place on November 12, attracted an unusually large gathering. Sir S. F. Harmer, the Director of the Museum, gave a short talk, illustrated by lantern slides, on the British Museum Australia Expedition. The exhibits shown included some of the more important specimens collected by the Expedition, among them being new and rare reptiles and batrachians, freshwater crustacea, mammals and birds, mainly from northern Queensland. Besides these, the general exhibits included a large number of interesting specimens recently added to the Museum collections. A selection was shown of the large consignment of mineral specimens which Dr. L. J. Spencer, while in Canada in connexion with the meeting of the British Association for the Advancement of Science, was instrumental in acquiring for the Museum. A selection of the Philip Roscoe bequest of Lower Carboniferous fossils, and also Ammonites from East Devon and West Dorset, were shown. A fruiting branch of the "Creeping Fig" was interesting for two reasons: because the plant possesses dimorphic foliage, and because the specimen illustrates a method of plant preservation by the use of copper acetate. Among the insect exhibits were insect remains found in oil-sand from Trinidad, and *Chrysops discalis*, a recent addition to the known disease-carrying Diptera. Other exhibits that may be mentioned were arachnids from Mt. Everest, from an altitude of 14,000 to 22,000 ft.; a new species of shrew from the Scilly Islands; a rare deep-water genus of Alcyonaria; skeletons of two very rare flightless birds from Madagascar; and series of specimens to illustrate the reduction of limbs and digits in lizards, and the evolution of planorbid shells in the Steinheim Basin.

METEOROLOGICAL information of considerable interest to seamen is given in the *Marine Observer* for November. Observations of various degrees of minuteness are made and supplied to the Meteorological Office by commanders of vessels in the mercantile marine and by some of His Majesty's ships; the logs of the latter are, however, always available for use through the Admiralty. In addition to the ordinary meteorological log and other means of registration, special reports are made by observers on matters and experiences of note, likely to be of interest to seamen generally, and many of these are included in the publication, together with a list of all who take any part in supplying regular information. "Wireless and Weather" data are regularly given, each monthly number containing usually some new feature, and

what is given will aid commanders materially in drawing for themselves special weather charts from wireless information, enabling them to know the weather conditions in which they are situated. An article is given on South Pacific hurricanes, prepared by Mr. H. Keeton of the Marine Division. The frequency and season of the hurricanes are dealt with, together with the tracks, rate of travel, and useful information with respect to neighbouring "hurricane warning stations." An illustration appears of the memorable escape of H.M.S. *Calliope* from Apia Harbour, Samoa, during a severe hurricane on March 16, 1889.

A BOOK of topical interest is announced for publication early in the new year by Messrs. Ernest Benn, Ltd., namely, "Radio: Beam and Broadcast, its story and patents." It is by A. H. Morse, late of the Marconi Wireless Telegraphy Co. of Canada, and purports to be the first published critical and constructive history of the development of wireless telegraphy and telephony. A feature of the work is the attention given to British and American patents.

MESSRS. Henry Sotheran and Co., 140 Strand, W.C.2, have just issued a new part of their "Catalogue of Science and Technology," namely, Part V., including VI., Physics, covering the letters S to Z, and containing a Supplement. This special catalogue of Messrs. Sotheran needs no recommendation, being well known for its valuable bibliographic notes, and the number of choice and rare books offered for sale. The new section is no exception. Copies of the catalogue are obtainable upon application.

MESSRS. Baird and Tatlock (London) Ltd., 14-15 Cross Street, Hatton Garden, London, E.C.1, have issued volume 4 of their Standard Catalogue. It is a quarto volume of 640 pages, well printed and illustrated, and covers the subjects of mechanics from hydraulics to aeronautics, heat including steam and internal combustion engines, light including radiology, sound and magnetism and electricity with their applications in industry. In order to give the users of the catalogue more liberty of choice, apparatus has been included which, although not made by Messrs. Baird and Tatlock, is guaranteed by the firm. The prices quoted represent present-day costs, and it is hoped that reductions in the cost of materials and labour will admit of their reduction in the near future; if this should be so, clients will reap the benefit. Amongst the newer apparatus catalogued we notice a universal bosshead clamp, a Langmuir condensation pump, a Duddell oscillograph, and a considerable range of wireless and X-ray apparatus.

Our Astronomical Column.

FIREBALLS.—Mr. W. F. Denning writes that a very brilliant fireball was observed from many places in Cornwall and Devonshire on Sunday, November 2, at about 10.55 P.M. A loud detonation was heard by various persons at about the same time, and the inference is that the noise was connected with the meteor. Observations are coming to hand which will enable a suitable investigation to be made and the real path of the meteor to be determined. It lit up the countryside with dazzling effect, and must have been one of the finest objects of its class.

Another object of similar kind was witnessed from the north-east region of Ireland on Tuesday, November 11, at 5.40 P.M. This fireball was remarkable for the length of its flight and its long duration. It traversed a path of about 124°, from the southern limits of Aries to near the star Cor Caroli, in about 20 or 25 seconds. The apparent size of the fireball was estimated to be about half that of the moon.

Mr. E. G. Fenton writes to say that he observed this meteor at Corbally, Limerick. It appeared in the eastern sky and moved slowly in a horizontal course from south to north. It was about four times as bright as Venus when at its brightest and of a bluish colour.

THE EFFECT OF SECULAR DIMINUTION OF MASS.—Dr. J. H. Jeans read a paper on this subject at the November meeting of the Royal Astronomical Society. It was based on Prof. Eddington's paper of last March, in which the conclusion was drawn that the luminosity of a star is simply a function of its mass, so that as the luminosity declines the mass does so likewise, through the conversion of part of it into radiant energy. Applying this to the sun, it was shown that its mass must be diminishing by millions of tons every second. This has an effect on the orbits of planets, the major axis of an orbit being inversely proportional to the mass of the central body. Dr. Jeans applied this principle to the development of the double-star systems, and found on certain hypotheses that the indicated age of the sidereal universe is of the order of 10^{14} years. This much exceeds previous estimates, and on the assumption that planetary systems arise from the close appulse of two suns, it is no longer necessary to assume that such systems are extremely rare. On the greater time-scale they might be expected in a large percentage of cases, especially as the stars were presumably closer to each other in early days.

Dr. Jeans further showed that motion in equiangular spirals would arise if the central body were losing mass very rapidly. This would, however, imply much higher brilliance in the central regions than that found in the spiral nebulæ.

THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.—The output of work from this observatory has been of such interest and importance that many will welcome the detailed description of the 72-inch reflector that appears in the *Observatory* for November. There was great good fortune in the safe arrival of the disc from the St. Gobain factory, as it left Antwerp only a week before the outbreak of War. It has a central aperture 10 inches in diameter for use with the Cassegrain mirror. The principal focal length is 30 feet, that with the Cassegrain mirror 108 feet.

The arrangements for mounting and supporting the mirror, for keeping the temperature constant, and for giving the telescope large and small motions (which are effected by electric motors) are fully described and appear to be admirably efficient. There is a special car for removing the mirror for resilvering, which is done about three times a year.

The spectroscope is attached below the mirror, being used with the Cassegrain mirror. One, two, or three prisms can be used. When three are in use, the star spectrum is about 4 inches long.

Some important results on radial velocities, spectroscopic parallaxes, and the O type stars have already been obtained and published.

Research Items.

THE AMORITES.—In the current issue of *Ancient Egypt*, Prof. Sayce adduces further arguments for identifying the Amorites with the Mitanni rather than with the Western Semites as usually assumed. The geographical evidence is that the early Babylonians called the inhabitants of the plateau on both sides of the Tigris Subaru—"The Highlander," and that a portion of this territory came to be called the land of the Murrû after the Mitannian occupation. The historical evidence is that the earliest known king of the Amorites, Aqwaruwas, bears a Mitannian name. In the Tel el-Amarna age, Mitannian names are still used mixed with Semitic. The philological argument is based upon the identity of Murrû as used by Sumerians for "Amorite" on one hand, and by the Mitannians and Hittites on the other, as the name of the Mitanni country, Amurru with the prothetic *a* appearing only in the Semitic languages. The argument from ethnology is that the Mitannians, speaking an Asianic language, originated in Asia Minor and belonged to the white races of Asia Minor and Europe. Hence they appear in the Egyptian monuments as blond, tall, long-skulled, with blue eyes and black or red-brown hair; they may be connected with the Libyans, the Berbers of to-day. They were the precursors of the Hittites in Palestine and Syria, and possibly represent the dolichocephalic neolithic population of Palestine. Their penetration to Babylonia in the semi-mythical age may explain why the Sumerians distinguish themselves from the earlier inhabitants as "the black-headed" race.

AGRICULTURAL RITES AND THE KINGSHIP.—Sir William Ridgeway, in a communication to the Cambridge Philological Society, (Proceedings CXXIV.-CXXVI.) criticises the methods of Manhardt and Frazer as applied by Miss Philpotts, Miss Jessie Weston, and Dr. B. Malinowski. In the case of Miss Philpotts, he shows that the evidence relating to kings in early Scandinavia points to their being, not god-kings, but war-kings. The absence of weapons in the burials is the practice of the later Iron Age, and no warrant for the assumption that they were the graves of temple kings. There is no evidence for a fertility drama. The performances interpreted in this sense are part of the rites of Frey, the king to whom the Scandinavians believed they owed good harvests. They thus fall into line with dramatic performances in other parts of the world in honour of ancient kings and chieftains. Miss Weston maintained that Tummuz could not be regarded as ever having been a man; yet it had been shown that in the first two dynasties of Kish and Erech "gods mingled with men on earth" and Sargon of Agade began his career as a cup-bearer of a deified king of Kish. Dr. Malinowski, while asking how magical influence can grow into political power, thinks that he has found in Eastern New Guinea a situation such as that postulated by the "Golden Bough." In each community is a garden magician, the head man, who performs his ritual for public benefit. But he gives no account of the machinery by which the chief promotes fertility. In the ancestor-worship of China, Japan, India, and elsewhere, and in New Guinea itself, we have the machinery. It is clear that ancestral spirits are held to control the crops. Further, in the account of the Trobriand chief, it is not shown what is the basis upon which the position rests. It is not magic, as the chief "has the best sorcerers at his command"; but it is apparent from Dr. Malinowski's statements that he is a military potentate. He and his ancestors owe their high rank to personal prowess.

FAUNA OF THE PEAT MOOR.—Complementary studies to those of the botanist upon the characteristic vegetation of peat are now in progress by the zoologist, and a preliminary descriptive account with lists of species is published by O. Harnisch in the *Biologisches Zentralblatt* (vol. 44, pp. 110-127, 1924). The author points out that his results are in agreement with the generalisation that an extreme habitat tends to be occupied by relatively few species represented by very large numbers of individuals, but he has also a number of interesting species to record which, though perhaps localised to this habitat, occur relatively rarely. He directs attention specially to the characteristic Rhizopod fauna associated with sphagnum, which he regards as the oldest element of the characteristic moor fauna.

VARIEGATION IN LEAVES.—As a result of the study of chlorotically variegated leaves, Seigo Funaoka proposes the following classification of the various forms (*Biologisches Zentralblatt*, 44, pp. 343–384, July 1924), based upon anatomical investigations. I. Variegation without modification of structure, including (1) periclinal chimæras, (*a*) white over green, and (*b*) green over white; (2) mosaic (aclinal) variegation, (3) variegation with gradual transition zones. II. Variegation associated with structural modification, of which two types are distinguished, (*a*) *Richardia Elliotiana*, neither palisade nor spongy parenchyma of the green leaf takes part in the formation of the white areas; (*b*) *Euphorbia marginata*, spongy parenchyma forms the white variegated region, the green spongy tissue of normal area passing over into white tissue in a brief transition zone. In an earlier number of the same journal (pp. 309–336, June 1924) Otto Renner studied the variegated mottling of Œnotheras of hybrid origin. He concludes that the differences in chromatophore structure must arise through mutation, and that we have to reckon with plastids and cytoplasm in problems of heredity, as well as with the cell nuclei.

THE SEDGE *CLADIUM MARISCUS* IN NORWAY.—One of the rarest plants in Norway is this sedge, which has so wide a distribution in South, West, and Middle Europe. Though it has occasionally been mentioned from the time of Bishop Gunnerus, great doubt attaches to all the determinations, and the only certain record is that by R. E. Fridtz, who, in 1871, found it near Kristianssand. In 1922, Dr. Jens Holmboe was so fortunate as to chance on it in a little tarn called Tveitavatnet, near Lervik. Here it grew at the end of a small promontory of sphagnum and other bog plants, and was itself associated with *Menyanthes trifoliata* and *Lysimachia thyrsiflora*. The underlying rock is a micaceous shale, but limestone crops out not far away. In "Bergens Museums Aarbok" for 1922–23, Dr. Holmboe seeks to trace the origin of these occurrences by a consideration of the fossil evidence. He concludes that, like *Hedera Helix*, Cladium entered Norway from Southern Sweden, where it already existed in late Glacial times, as the climate grew warmer. It then attained in the south and south-west coast districts of Norway a wider distribution than at present. Whereas the ivy is still stretching northwards along the west coast and cannot be said to have reached its possible limits, Cladium long ago reached its climatic boundary, and has since then shrunk to the couple of relict-occurrences herein noted. These conclusions may be commended to students of the "Age and Area" hypothesis.

STRUCTURE AND METAMORPHOSIS IN THE HIGHER DIPTERA.—In the case of the Cyclorrhapha, or higher Diptera, the characters separating most of the families represent but comparatively trivial departures from a uniform type of structure. The thorough elucidation of the morphology and development of a single well-chosen example will largely explain the features common to an enormous assemblage of species. The economically important apple maggot (the larva of *Rhagoletis pomonella*) is selected by Mr. R. E. Snodgrass with this object, and he has recently published (*Journal of Agricultural Research*, vol. xxviii., No. 1, April 1924, 36 pp., 6 pls.) an account of his conclusions which is worthy of consideration by students of insect morphology. The apple maggot lives a concealed existence within the fruit of the apple, safe from enemies and surrounded by the abundant pulp which serves as its food. Mr. Snodgrass suggests that the ancestral larvæ took to living in mud or stagnant water and, in adaptation to this environment, they developed a pair of secondary dorsal spiracles at one or both extremities of the body in connexion with the dorsal longitudinal tracheal trunks. The primitive spiracles associated with the lateral tracheal trunks became closed: their former presence is indicated by the functionless stigmatic cords which have been noted in several diverse types of dipterous larvæ. With further study it is likely that these vestiges will be found to be universally present. This adaptive change outlined by Mr. Snodgrass is found in all larvæ of Cyclorrhapha, and it is evidently advantageous since it has fitted them for varied modes of life. The larvæ of the higher flies therefore discard the primitively lateral spiracles and develop breathing-organs in relation with the dorsal tracheal trunks. The pupa retains the anterior spiracles of the larval system while the imago discards the larval spiracles and returns to the primitive or peripneustic tracheal system. Attention may also be directed to the interpretations given of the development of the larval pharynx and mouth-hooks, the pupal envelopes and the rôle of phagocytes in histolysis.

GEOLOGY AND GEOGRAPHY OF ARCTIC CANADA.—Some important geographical and geological work along the Arctic coast of Canada is published in volume xi. of the Report of the Canadian Arctic Expedition, 1913–18. The first part is a report by Mr. J. J. O'Neill on the geology of the coast west of Kent peninsula, including the Mackenzie delta and the valley of the Rae and Coppermine rivers. From his study of the deposits of the Mackenzie delta, Mr. O'Neill is inclined to believe that they are derived from material furnished by the Keewatin ice-sheet. The river brought these deposits to the coast and built them up at a rate greater than land was being lost by submergence. The growing delta was thus a barrier to the encroachment of the sea into the Mackenzie valley during the undoubted post-glacial submergence of the coast. A section of the report deals fully with native copper deposits in Arctic Canada. Vague reports of these occurrences have been circulated for many years, and it is now definitely known that deposits of native copper occur in the Coppermine valley and Bathurst Inlet. It probably is to be found also in central Victoria Island, and in Prince of Wales Island, and quite possibly in other places. It appears chiefly as amygdaloidal copper near the surface of lava flows. Mr. O'Neill goes on to discuss the commercial value of the deposits. The second part of the volume is devoted to geographical notes on the Arctic coast with a history of previous work by Messrs. K. G. Chipman and J. R. Cox. The volume contains a geological map of the coast between Darnley Bay and Bathurst Inlet.

METEOROLOGY AT SAMOA.—Reports of the weather at Apia Observatory, Samoa, for the years 1921 and 1922, together with a Summary of the Meteorological Observations for 1890 to 1920, by Dr. G. Angenheister, have recently been received. The annual reports give hourly observations of magnetic declination and of horizontal and vertical intensity with the monthly means for each hour. The seismological reports give a catalogue of earthquakes registered at the Observatory during the year. The annual report for 1921 gives only two pages to meteorology, the summary being of a very general character. In the report for 1922 daily meteorological observations are given. The summary of meteorological observations for the years 1890–1920 is very complete, and monthly means for each year are regularly given, together with the number of rainy days and the number of days with thunderstorms. In describing the climate of Samoa, it is mentioned that Samoa is exposed to the south-east trade wind, interrupted by westerly and northerly winds from December to March during the rainy season. The annual amount of rain increases very considerably with altitude, the mean increase being 18 per cent. per 100 m. The daily variation in the amount and duration of rain is, on the whole, semi-diurnal, with maxima in the morning and evening. In the trade-wind season there is only one maximum, at about 4 P.M. Observations are reported to show the 3-year period and the 11-year period. The instruments are supplied by the Seewarte, Hamburg. Numerous references are made to previous meteorological discussions of observations at Samoa, but no mention is made of observations in the years 1862–5 from instruments supplied by the Meteorological Department of the Board of Trade in 1861. These observations were taken by Mr. J. C. Williams, British Consul at Samoa, at the Consulate at Apia, a discussion of which was published in the Quarterly Journal of the Meteorological Society for July 1879.

SLOW AIR VIBRATIONS FROM LARGE EXPLOSIONS.—In the *Comptes rendus* of the Paris Acad. Sci., Oct. 6, M. P. Villard describes the register of air vibrations obtained at Paris by Dufour when the La Courtine explosions took place. Very considerable amplitudes were recorded with a frequency of about a second, the approximately sinusoidal motion lasting for about three seconds. This is about four octaves below the lowest audible note; there was no trace of audible frequency. It appears that, in all cases when large quantities of explosive are involved, the low-frequency waves, even at small distances, are much more important than the sound waves, which can be regarded as an accessory phenomenon. The author on one occasion was 1800 metres distant from a very violent explosion in an explosives factory; the sound heard was loud, but by no means deafening, being comparable with a short, loud thunder-clap. At the same time, although there was a calm, a breath of air was felt on the face, similar to that produced by the motion of a fan. This was the compression half wave of a movement with very low frequency, the amplitude being apparently several centimetres, of course enormous compared with that of a deafening sound. On another occasion a French window, which was unfastened, was opened about 10 cm. by the wave of compression of a similar explosion. On both these occasions windows were broken in the immediate neighbourhood by the pressure difference between the air outside and inside the buildings.

THE PLASTICITY OF ROCK SALT IN WATER.—This subject is discussed by Messrs. W. Ewald and M. Polanyi in the *Zeitschrift für Physik* of September 20. Various observations have recently been made on the

plasticity of wet rock salt; but the theories proposed to account for it do not agree. The authors have made additional measurements of the plastic bending of strips of rock salt in water, and conclude that the effect is due to a lowering of the elastic limit, which commences immediately in contact with water, and ceases when the surface is dried, or when the water is saturated with salt. The effect is observed, though not quite so strongly, when the upper compressed side of the bent prism is wetted. If only the lower side is wetted, the plasticity is scarcely observable (the prism or rod is supported at the ends and weighted in the middle). Apparently, at ordinary temperatures, the essential part of the resistance to change of form resides in the surface, and during the solution of the surface layers this resistance is removed. There is slip along the rhomb dodecahedron surfaces, and thus the layers of slip come to the surface, and fine steps or slip lines are formed. In the normal surface, the slip layers are locked in place. The breaking load was increased tenfold under water; this increase in strength is brought about by the lowering of the elastic limit. It seems to be possible to approach the molecular strength of rock salt, as given by Born's lattice theory. The subject is also discussed in a communication by Prof. A. Joffé, M. Kirpichewa, and M. Levitzky, which appeared in NATURE of March 22, p. 424.

SEASON-CRACKING OF BRASS.—The issue for October 10 of *Die Naturwissenschaften* contains an article by G. Masing on this subject. It has been shown by Moore and Beckinsale that the internal stresses due to severe cold-working, which are the cause of season-cracking, may be removed by annealing at a temperature much below that at which the brass is appreciably softened, and this has now become a usual practice. Thus annealing a 70 : 30 brass at 275° C. will remove internal stresses so that cracking no longer takes place on immersion in a solution of mercurous nitrate. The new experiments show that as the degree of cold-working increases, the liability to crack increases up to a maximum and then diminishes. This is explained by the fact that the action of the mercurous salt, as well as the failure in use, always proceeds along the intercrystalline boundaries. In a very severely cold-worked metal the structure becomes more confused, and it is suggested that chemical action along boundaries is thereby hindered. A different kind of cold-working, however, may again cause cracking. For example, a brass which has been reduced 40 per cent. in section by cold-rolling no longer cracks under the test, but if bent or pressed into a dished form, the liability to cracking reappears. This may be explained on the basis of present views as to the fibrous structure imparted to metals by rolling, and revealed by X-ray analysis. Masing also endeavours to distinguish between gross internal stresses of this kind and microscopic distributions of stress, which he regards as responsible for increase of hardness, the latter only disappearing at a much higher annealing temperature.

FORMATION OF CRYSTALS.—In order to prove that the study of crystals is not only of academic interest, but has also important practical applications, it is sufficient to note that the Chemical Engineering Group of the Society of Chemical Industry has thought it worth while to persuade Mr. T. V. Barker of Oxford to present to it a paper on "The Development and Formation of Crystals" as a companion to a more directly utilitarian paper by Mr. H. Griffiths on "Mechanical Crystallisation" read on October 23. The latter paper is of interest because it shows that the general public has realised that a well-crystallised product is generally chemically pure (although it might contain isomorphous impurities), whereas a powder may be impure or even deliberately adulterated to any extent. It is, therefore, possible to secure much higher prices for a "pea crystal" quality, in which each crystal is a separate entity, than for a crushed aggregate such as is generally supplied when the traditional processes of "uncontrolled" crystallisation are used. In order to obtain individual crystals of uniform size, it is necessary to make use of "controlled" crystallisation, and special plant (usually a trough which can be rocked) has been devised, in which the rate of cooling and velocity of flow can be varied in such a way as to produce the desired effect. From the point of view of the consumer, it is eminently desirable that these methods should be developed as fully as possible, since there is no other method by which the uniformity and purity of a crystalline product can be so readily established.

THE POSSIBILITY OF THERMAL DISTURBANCE IN MICHELSON'S EXPERIMENT.—M. E. Brylinski has shown that, if a source of heat were situated in a definite position in the laboratory, such that differences of temperature of from 0·01° to 0·001° C. were produced between different parts of the apparatus, periodic phenomena similar to those observed by Miller in 1921 would be observed when the apparatus was slowly turned about its axis (*C. R. Paris Acad. Sci.*, Sept. 22). Such differences might easily result if one wall were warmer than that opposite, or might be due to the presence of the observers. It appears that the only way to obtain more precise results in the experiment would be to use a revolving table of invar. This would reduce the disturbances observed with Miller's cast-iron table to about one-tenth. It would be necessary to shield the apparatus from the earth's magnetic field, or to allow for its effect upon the invar table.

ACIDS, BASES, AND SALTS.—Prof. E. C. Franklin, in the October number of the Journal of the American Chemical Society, has an interesting paper on acids, bases, and salts, in which the old theory of types is revived and extended. Oxygen, sulphur, nitrogen, the halogens, and even carbon are acid, base, and salt-forming elements in the sense of Lavoisier's theory. Aquo-acids, etc., have analogies in the H_2S and NH_3 types; hydrazoic acid, formulated as $H-N=N\equiv N$, is related to ammonia as nitric acid, $H-O-NO_2$, is related to water, and the two acids have many properties in common. Many reactions in liquid ammonia are explained on this scheme. Hydrocyanic acid is formally ammonocarbonous acid, namely, NH_3, in which two atoms of hydrogen are replaced by the negative divalent carbon atom. Although zincates and plumbates are hydrolysed, the corresponding ammono-salts are readily obtained crystallised from liquid ammonia, by the interaction of metallic amides with potassium amide. The paper is full of interesting and ingenious suggestions.

FORMS OF MERCURIC OXIDE.—Although the red and yellow forms of mercuric oxide are generally supposed to differ only in fineness of division, the experiments of E. Cohen on the electromotive force of a cell composed of mercury in contact with the two forms in an alkaline solution led to the result that they are allotropic forms. The X-ray spectra of the two varieties have now been determined by G. R. Levi, who in the *Gazetta Chimica Italiana* for September shows that the crystalline forms of the red and yellow oxides are identical. Two photographs of the spectra are reproduced, which leave no doubt that the forms are not different modifications, and the usual theory appears to be completely confirmed.

The Trans-Canadian Excursion of the British Association and the International Mathematical Congress.

THE Toronto meetings of the British Association and the International Mathematical Congress in August were followed by an excursion from that city to Vancouver and Victoria and back. About 360 persons took part in it, mainly members of the Association from Great Britain, but including about two dozen members of the International Mathematical Congress from European countries, and a few Canadians and Americans. The excursion was generally voted a wonderful success and a most enjoyable and memorable experience. From a collection of notes and impressions from various sources, it is now possible to visualise something of its wide scientific interest.

The outward journey passed through the mining and agricultural districts of northern Ontario, and proceeded, by way of Winnipeg, Saskatoon, and Edmonton, to Vancouver, following the route of the Canadian National Railway, with the exception of a stage in northern Ontario on that of the Timiskaming and Northern Ontario Railway. The return journey from Vancouver was made over the Canadian Pacific Railway through the famous mountain scenery of British Columbia, and by Calgary, Regina, Fort William and Port Arthur, and Sudbury, to Toronto. The whole excursion represented 5396 miles of travel by rail; it lasted from August 17 until September 4, for almost the whole of which period the two special trains were the dwelling-places of the travellers, and the comfort of the provision made for them by the two great railways is attested by the absence of expressions of distaste for this mode of life, the habit of which was soon acquired. Moreover, the time-table of the excursion was arranged with extraordinary skill in regard to viewing points of interest, passing quickly over stages of least scenic attraction, and affording reasonable periods for rest. The generosity of provincial governments and the local committee in Toronto rendered it possible to make the journey at exceptionally cheap rates.

The excursion offered a measure of scientific interest in every department, though perhaps geologists, botanists, zoologists, and agriculturists found the widest scope. Quite apart from formal arrangements, botanists and entomologists were most conspicuous in their activities whenever the trains stopped at station or crossing, and it was possible, for however brief a period, to get out of them; the freedom of the Canadian railways in this respect was appreciated by all as a mere relaxation from travel, but it also afforded real opportunities for collecting. The economic and industrial activities of the provinces traversed; the inhabitants and conditions of life in town and country; the architectural and other developments in the greater cities, especially as realised by those who had previously visited them—these features, together with the natural beauties of the Dominion, afforded sufficiently varied interest for all the trains' company, and an enlargement of their scientific horizon. Nothing impressed the visitors more than the lavish ground-plans and beautiful buildings erected for such institutions as the Universities of Saskatchewan at Saskatoon and Alberta at Edmonton, and the Manitoba Agricultural College near Winnipeg, to which must be added the new site and designs for the University of British Columbia.

With these developments in view, it can scarcely be mere accident that the reception of the party in the visited cities differed materially from that encountered in 1909, when an excursion to the West was made after the Winnipeg meeting. Be it said at once, the high quality of Canadian hospitality does not vary. But the phase of speeches confined to words of welcome and imperial sentiment (things however admirable in themselves), the phase of frank confession that science and its aims were not understood, the phase of the triumphal arch and the town band—these seem to have passed away. Instead, the party on the present occasion was received with words which indicated a real appreciation of its mission; the scientific problems which are most closely allied with Canadian progress were clearly pointed out, and visiting scientific workers were invited to inspect and participate in the results of Canadian research. From every principal stopping-point came requests for some form of scientific communication from members of the party, and in two instances, as will be seen, there were actual sessions of some of the Sections of the Association.

Parties of geologists and botanists left Toronto in advance of the main body, to spend additional days in northern Ontario in investigation respectively of the mineralogy and the forest and plant phenomena of that region. The main body viewed the mines and process of extraction at Cobalt, Kirkland Lake, and Timmins, and the power plant and paper mills at Iroquois Falls, with its "garden city" separated by many miles of forest from any other considerable centre of population. Agriculturists left the trains at Cobalt for a short run by motor-car through a portion of the "clay belt," to view the recent extension of farming there and to visit the Dominion Experimental Farm. At Swastika, some of the members of the Anthropological Section called upon a family of Londoners, whose improved circumstances since emigration greatly impressed them.

At Winnipeg, Man., nearly the whole party was entertained at the Manitoba Agricultural College; economists and others visited the grain exchange; a geological party went to Stony Mountain to study the Upper Ordovician rocks of the district, and a party of engineers and others was taken to the municipal hydro-electric plant at Point du Bois, 78 miles from the city, incidentally viewing some interesting features of Galician and other settlement in the district.

At Saskatoon, Sask., proceedings began with the formal opening of the new chemistry building in the University of Saskatchewan. Sectional sessions then took place, in chemistry with a discussion on photosynthesis, in zoology and agriculture jointly on the subject of animal diseases, and in geology. Agricultural and experimental grounds and stock-yards, the clay deposits of the neighbourhood, and other features of scientific interest were seen, and members interested in overseas settlement saw something of the homes of the people. In the evening a public lecture was given by Dr. E. E. Slosson on photochemistry and modern civilisation.

At Edmonton, Alta., there were sessions of the Sections of Physics, Geology, and Botany and Agriculture (jointly). Special geographical, geological, and agricultural parties were formed to see things of particular interest to them. In the evening a public meeting was held in the convocation hall of the University, when addresses were delivered by Sir John Russell, Sir William Beveridge, and Dr. J. S. Flett. Some of the botanists left the main excursion at Edmonton for a journey by motor-car through central Alberta and thence into the mountains, rejoining the rest at Banff.

The main excursion, after leaving Edmonton, called at the mountain resort established by the Canadian National Railway in Jasper Park, where the members were guests of Sir Henry Thornton, general manager of the railway. At Vancouver and Victoria, a most interesting and varied programme was arranged. Stanley Park, the Fraser lumber mills, the Capilano Canyon, a settlement of Squamish Indians on the north side of the harbour, the beautiful fiord of Howe Sound, with the Britannia copper mines above it, and the power plant at Lake Buntzen were among the points visited from Vancouver by members concerned with their several scientific interests; while at Victoria the astrophysical and meteorological observatories, the museum, some old Indian village sites, and the beauties of Butchart's Gardens and the gardens of Government House, with several localities of botanical interest, were inspected. A number of lectures were given in Vancouver at public meetings or to societies and clubs, the speakers including Prof. G. W. O. Howe on radio-telegraphy, Dr. A. W. Borthwick on forestry, Prof. W. T. Gordon on gem stones, Prof. W. W. Watts on buried landscape, Dr. and Mrs. Shrubsall on physical and mental welfare, and Dr. Ivy Mackenzie on physiological discoveries of importance to the man in the street. The president, Sir David Bruce, met members of the Vancouver Medical Association. Mr. O. H. T. Rishbeth gave a lecture on modern geography at New Westminster. Marine biologists visited the well-known station at Nanaimo.

Three beautiful days were spent on the mountain section of the Canadian Pacific Railway, with calls at Glacier, Lake Louise, and Banff, and ample opportunity, thanks to the provision of open observation cars, to view the scenery between these points. A small party paid a private visit to the ranch of H.R.H. the Prince of Wales, near High River, Alta. The main party called at Calgary, Alta., where the oil refineries and other industrial establishments were seen, and at Regina, Sask., where addresses were delivered by Prof. D'Arcy Thompson, Sir Thomas Holland, and Dr. Marion Newbigin. From Kenora, Ont., trips were made on the Lake of the Woods, the limnologists working tow-nets and the geologists examining some of the islands. At Fort William and Port Arthur, the twin ports at the head of Lake Superior, arrangements for handling the grain export from the west were shown, and a geological party viewed the interesting features of Mount M'Kay and the vicinity. Brief opportunities for further field work were afforded by halts on the fine northern coast of Lake Superior, and the scientific investigations of the journey ended with the inspection of nickel and copper mines at Sudbury, Ont.

In this short narrative, no specific reference has been made to the generous hospitality extended to the travellers at every point by public bodies and private individuals. Luncheons and dinners, always admirably arranged, afforded an opportunity for general intercourse which was impossible in the dining-cars; and fleets of private motor-cars were placed at the disposal of the visitors in every city. All who took part in the excursion owe unqualified gratitude to its organisers and to those who made them their guests.

Pigments, Varnishes, and Building Stones.[1]

Early Methods of Oil Painting.

THE evidence to be obtained from ancient manuscripts as to early methods of oil painting has been re-examined. From this it is clear both from the manuscript of Theophilus and the manuscript of Eraclius that the properties of such drying oils as linseed oil and walnut oil were thoroughly understood so early as the twelfth century, if not earlier, and their preparation in a suitable condition for a painting medium and their use for this purpose.

The methods used in their preparation differ very little from the best practice of to-day. The refining and bleaching of the oil and the use of driers was well understood, and there was no indication in passing from these earlier recipes to those of the fifteenth century that any new discovery of importance was made at the time of the brothers Van Eyck. Passing to later times, Vasari directs that pigments are to be ground in walnut oil or linseed oil, and this is all that is necessary, and he recommends the use of walnut oil as less liable to darken with time.

Many recipes for varnishes are given, and as neither spirits of turpentine nor alcohol were available in commercial quantities until the end of the fifteenth century, these varnishes are what we should now describe as oil varnishes, consisting of resins dissolved in hot oil. The natural balsams of the pine, resin, mastic, and sandarac, often all mixed together, were used in their preparation, the proportion of resinous material to oil being very high, and the varnishes consequently being very sticky and having to be heated and rubbed on with the hand. Spirit varnishes corresponding to the mastic varnishes of to-day are found in the sixteenth-century and later recipes.

The evidence of the accounts preserved at Ely and Westminster shows that both oil and varnish were used in painting on walls during the thirteenth and fourteenth centuries, this being the northern tradition, while the Italian tradition was the use of egg as a medium. There is no indication in these recipes of any special secret differing from what we know to-day; but it has been suggested by Prof. Berger and others that the early method of painting in the fifteenth century may have been with an emulsion of varnish or oil with yolk or white of egg, and two recipes, one in a Venetian manuscript of the fourteenth century and one in a Bolognese manuscript of the fifteenth century, are quoted in support of this theory.

It may be admitted that if these early painters wished to paint in varnish instead of in oil, they would have had to blend the varnish with white or yolk of egg to make it into a workable medium, and the question is worthy of further inquiry.

These early pictures were painted on a wood panel sometimes covered with strips of linen and coated with a gesso made of parchment size and whitening or plaster of Paris which had been soaked in water until it lost its binding properties. Recent experiments carried out by Mr. Thompson at the Heriot-Watt College, Edinburgh, on an old sixteenth-century panel, have revealed the fact that this panel was coated with a non-absorbent gesso upon which a very thin layer of absorbent gesso was laid, so as to ensure the binding of the oil to the surface of the gesso and, at the same time, preserve from staining the pure white surface of the gesso below. On this pure white gesso panel the picture was drawn in detail, and laid out either in monochrome or partly in colour with pigments probably mixed with size, and upon this the pigments ground in oil or, it may be, an emulsion of varnish and egg were laid, care being taken to paint the high lights very thinly as compared with the rest of the picture. In course of time the oil yellows and

[1] From lectures delivered on November 12, 13, and 19 in a course of six lectures to the students of the Royal Academy, London, by Prof. A. P. Laurie, professor of chemistry at the Academy.

the pigments, more especially the white lead, get more translucent. By painting the picture in this way, the artist ensures that the increased translucency of his white lead will correct the yellowing of the oil, owing to the white light reflecting from the gesso, and that his contrast of light and shade will be maintained owing to the laying out of his picture on the white gesso surface with pigments mixed with size, and owing to the fact that his high lights are thinly painted.

There is much more yet to be discovered as to these early methods, and the question as to whether varnish, emulsion, or oil was used has still to be finally cleared up; but we are, at any rate, increasing in our knowledge of their general methods of procedure.

Modern Pigments.

The pigments used by the artists of to-day can be classified into those that can be regarded as unchangeable, those that are moderately permanent, and those that are fugitive. This classification is based in the first place on the work done many years ago by the late Sir William Abney, but since then a good deal of additional information has been accumulated, and the leading artists' colourmen firms have themselves directed a considerable amount of attention to the subject, so that it is now possible to make a fairly sound classification of pigments suitable for oil painting, a more limited list for water-colour painting, and a still more limited list for fresco.

At the same time, there are a certain number of pigments which require further investigation, as their permanency seems to depend upon the method adopted in their manufacture, and they must at present be put on the doubtful list. These include the pale cadmiums, unless they have been specially manufactured for permanency. On the whole, the lists of permanent pigments drawn up by the various artists' colourmen will be found fairly trustworthy for practical purposes. It is also necessary not to use two pigments that act chemically upon each other, and it must also be remembered that the transparent blues and greens, when mixed with oil and laid pure on the canvas, unless in very thin glazings, tend to degrade, owing to the yellowing of the oil.

The oil painter to-day is faced with similar problems to those of the oil painter of the fifteenth century, namely, that a medium which yellows with age, and that certain pigments, such as flake white, grow more translucent with time, and therefore the permanent brilliancy of an oil painting, after having selected his pigments as advised by the chemist, depends on the technical skill of the artist.

Some English Cathedrals and Stone Decay.

The Cathedrals of Durham, Lincoln, Ely, and Norwich have been visited, and in addition the condition of the stone at Hampton Court and the Houses of Parliament has been re-examined.

The ruins of Elgin Cathedral were first discussed. In order to understand what is happening here and elsewhere it is necessary to classify the stones used for building into three main groups: the lime-stones, the sand-stones in which the quartz particles are united by calcite, and the sand-stones in which the particles are united by silica. This classification will be regarded by petrologists as wanting in detail and being somewhat diagrammatic in character, but it will be the most convenient for the present purpose, which is an inquiry into the injury caused to modern buildings by the presence of sulphur dioxide in the air produced by the burning of coal.

The ordinary causes of stone decay do not require special mention here as they are well known to architects and builders. The new and the main cause of the rapid decay taking place in modern buildings is the attack on the calcium carbonate of the lime-stone and of the calcite forming the binding material in sand-stones by sulphur dioxide in the presence of air and moisture, forming calcium sulphate. Calcium sulphate is slightly soluble in water, and therefore is being slowly dissolved in the rain and removed, but this is not the most serious cause of damage. Cases of rapid decay are found to be associated with the crystallisation of calcium sulphate inside the stone and the consequent breaking up of the stone.

In some cases where siliceous sand-stones have been used, the source of lime must be the mortar, the rain dissolving and washing the lime into the stone. Analyses at remote places like Ely and Tintern Abbey have shown that the destruction by the action of sulphur dioxide is not confined to the towns, but is spread over the remote country districts.

Probably the best thing that can be done is to treat such stone surfaces with a binding material depositing silica cement, and periodically to wash down the building with water during the summer with the view of removing the excess of sulphate of lime, and thus diminish the danger of crystallisation. While it is not possible in the state of our present knowledge to say whether such washing can be safely applied to every variety of lime-stone, experiments in this direction are well worthy of the serious consideration of architects.

British Institute of Radiology.

IN the issue of the *British Medical Journal* for November 8 an account is given of the new British Institute of Radiology. This is situated in Welbeck Street, W.1, the house of the old Russian Embassy. The Embassy consisted of a lofty, roomy house, and this has been altered and adapted to meet the needs of the new Institute.

The main objects of this—the first of its kind in Great Britain—are set out in full in the article in question, and are the outcome of joint deliberations between representatives of the British Association for the Advancement of Radiology and Physiotherapy (B.A.R.P.), the Royal Society of Medicine, and the Röntgen Society. Primarily, it may be said that the object of this Institute is to promote the advancement of radiology and physiotherapy on scientific lines under the direct control of the medical profession, protecting in every possible way the interests of those engaged in these subjects. Further, it is hoped to provide facilities for the delivery of lectures, the holding of classes and examinations, the establishment of scholarships, and the granting of prizes, diplomas, etc., in radiology and electrology. Arrangements are well in hand for the formation of a library and radiographic museum. These two features have been much helped by gifts of books from Lady Mackenzie Davidson and the presentation of radiographs from many interested in the Institute.

Membership of the Institute is, however, by no means restricted to the medical profession, for not only are physicists, engineers, and manufacturers of electrical apparatus eligible in this respect, but representatives of them have also from the first been invited to join in the discussions precedent to the formation of the Institute.

The present needs of the Institute are largely financial. It was helped at its formation by the action of the trustees of the Mackenzie Davidson Fund in

handing over a sum which had been publicly subscribed to perpetuate the name of Mackenzie Davidson. Even so, however, additional expenses have been incurred, and an appeal is now made for a sum of 6000*l.*, which will pay off arrears and allow for future developments.

Reference to this Institute would be incomplete without mentioning the name of Sir Archibald Reid. It was largely due to his untiring efforts that the Institute took shape when it did, and his memory is being perpetuated by the formation of a reference collection of radiographs, both normal and pathological.

The acceptance of the presidency of the Institute by Sir Humphry Rolleston, Bart., president of the Royal College of Physicians, is proof, if any were needed, of the interest of the medical profession in this venture and of their concern for its development. It is also one more instance of the many services which have been rendered by Sir Humphry Rolleston in the cause of medical radiology. S. RUSS.

University and Educational Intelligence.

CAMBRIDGE.—Mr. H. E. Tunnicliffe and Mr. N. J. T. M. Needham have been elected fellows of Gonville and Caius College. The John Bernard Seely Prize in aeronautics has been awarded to W. A. Johnson, Peterhouse, for an essay on "Dynamical Similarity and Scale Effects."

Dr. D. H. S. Cranage has been appointed secretary of the Board of Extra-mural Studies, and the Rev. J. W. Hunkin has been appointed secretary of the General Board of Studies.

The scheme for the creation of a class of extraordinary or visiting professors, to which reference has already been made in these columns, was rejected by one vote.

EDINBURGH.—The Prince of Wales has consented to open the new Chemistry Department of the University on December 3.

GLASGOW.—Mr. J. J. Lister has presented to the University the microscope used throughout his life by his uncle, Lord Lister, together with a number of auxiliary appliances and mounted preparations. The valuable and interesting relics will be placed, with the microscope of William Hunter, in the Hunterian Museum.

The microscope of Bentham, the botanist, has been presented to the Botany Department of the University by Mr. James Whitton, late superintendent of the city parks and gardens.

The Bellahouston Trustees have, in honour of the Kelvin Centenary, made a grant of 2000*l.* to the University for the purchase of modern electrical apparatus for the use of the Natural Philosophy Department, now under Prof. H. A. Wilson.

LEEDS.—We have already referred in these columns to the "Smithells Fund" which was being raised to commemorate the services of Prof. A. Smithells to the University. The Fund has now reached a total of nearly 2500*l.*, of which about one half represents contributions from the gas industry. A portrait of Prof. Smithells has been painted by Mr. Fiddes Watt for presentation to the University. The presentation ceremony will take place on November 25. The balance of the Fund will provide a scholarship, of approximately 100*l.* per annum, which is to be established in the University in the name and with the advice of Prof. Smithells.

THE Harper Adams Agricultural College, Newport, Salop, is requiring an analyst and demonstrator in its chemical department with, if possible, experience in agricultural-chemical analysis. Particulars are obtainable from the principal of the college.

THE following election results complete the list of Parliamentary representatives for the Universities of Great Britain and Northern Ireland:—OXFORD: Lord Hugh Cecil (U.) and Sir Charles Oman (U.); SCOTTISH UNIVERSITIES: Sir Henry Craik (U.), Mr. D. M. Cowan (L.), and Sir George Berry (U.).

MR. H. T. CRANFIELD, who has held the post of senior lecturer in agricultural chemistry and head of the Chemical Department at the Midland Agricultural and Dairy College for several years, has been appointed adviser in agricultural chemistry, under the Ministry of Agriculture scheme, for the Midland Counties served by that College.

THE council of the British Electrical and Allied Manufacturers' Association (Inc.) have recently granted the following scholarships and renewals of scholarship tenable for one year, each of the value of 100*l.*, together with the payment of college fees:—*In Electrical Engineering:* Mr. J. T. Birtwell, at the College of Technology, Manchester; Mr. G. E. G. Foden, at the College of Technology, Manchester; Mr. P. J. Maggs, at the City and Guilds (Eng.) College, South Kensington; Mr. H. G. Richards, at the University of Birmingham; Mr. R. Robinson, at the University of Durham. *In Mechanical Engineering:* Mr. J. C. Burke, at the College of Technology, Manchester. *Renewals of Scholarship:* Mr. A. B. Everest, at the University of Birmingham, for metallurgical research in relation to electrical engineering; Mr. I. H. Hedley, at the University of Durham, for electrical engineering; Mr. G. S. C. Lucas, at the City and Guilds (Eng.) College, South Kensington, for electrical engineering, to enable him to carry forward his studies in alternator design; Mr. B. S. Pelton, at the University of London, for mechanical engineering (steam turbines).

THE appointments to Ramsay Memorial Fellowships in chemical science for this session, British, Dominion, and foreign, are practically completed. At the present time sixteen fellowships are being held in the universities and colleges of the British Isles. The list of awards for the present session, together with the university or college which has been selected by the fellow for his research, is as follows: *British*—Dr. Samuel Coffey (University College, London), Dr. A. F. Titley (University of Oxford), Mr. Sidney W. Saunders (University College, London). *Glasgow*—Mr. T. S. Stevens (University of Oxford), Dr. Alex. Robertson (since resigned on appointment to an International Fellowship in New York). *Canadian*—Dr. Edward H. Boomer (University of Cambridge). *Danish*—Mr. Kai J. Pedersen (University of Bristol). *Dutch*—Dr. J. Kalff (University of Manchester). *French*—Dr. H. Weiss (Royal Institution, London). *Greek*—Dr. Nicolas Oeconomopoulos (University College, London). *Italian*—Dr. Antonio Nasini (University of Cambridge). *Japanese*—Dr. Kameyama (University College, London). *Norwegian*—Mr. Leif Lindemann (provisional). *Spanish*—Dr. Miguel Crespi (University College, London). *Swiss*—Dr. Walter Feitknecht (Royal School of Mines, London). The total value of the annual amount of the fellowships that is awarded is approximately 4800*l.*, of which approximately 3300*l.* is provided by grants from Dominion and foreign sources.

Early Science at the Royal Society.

November 23, 1664. Monsieur Le Febure presented his printed discourse, both in French and English, upon the preparation of Sir Walter Raleigh's cordial. He likewise read a Latin letter sent him from Paris, and signed for attestation by some of the principal physicians and chirurgeons of that city, concerning the art practised by one Monsieur Bienaise, of healing tendons and nerves transversely cut, so as to restore the patient to the full use of his limbs. He was desired to leave the letter with the society, which he promised to do, after he had shewn to some of the college of physicians.

November 25, 1663. The president acquainted the society, that he had received a letter sent to a minister in England from a suffragan bishop in Iceland; which letter being produced, the secretary was ordered to peruse it, and give an account of it to the society at their next meeting; against which time the amanuensis was ordered to make a copy of the inquiries formerly drawn up by Mr. Hooke and sent to Iceland, in order that they might be considered of, and fitted by the president to be sent and recommended to the said bishop, as a person conceived to be capable and curious enough to return a proper answer to them.

November 26, 1662. The lord viscount Brouncker acquainted the Society with the approach of St. Andrew's day; and that by reason of the necessity of making some alterations in their charter, there could not be conveniently made an election of new council this year: but it was offered to the Society, whether they would propose some other persons to be presented to the King, and, according to his majesty's pleasure, to be put into the council of the altered patent, instead of some of those, who were in the first. It was put to the question, whether any alteration should be made in the council, or not? and it was carried in the negative.—Dr. Wilkins showed his way-wiser, and the effects thereof upon a coach; and was desired to leave his first engine of this kind with the society.

November 28, 1666. Mr. Henry Howard [afterwards Duke of Norfolk] was elected and admitted, who also received the public thanks of the Society for his respects to them.—Dr. Wallis gave the society some account of what he had lately observed in Kent about tides, viz., that, according to his hypothesis, the tides had been very high about Romney-marsh, three days after the new moon; which though the seamen there ascribed to the high winds, as not thinking of any other cause, yet he thought it might be imputed to the cause assigned in his theory; especially if upon continued observations for several years together it should happen in the same manner.

1667. Mr. Coga, the first person in England, on whom the experiment of transfusion was made by order of the Society, and by the management of Dr. Lower and Dr. King, presented himself before the Society, and produced a Latin paper of his own, giving an account of what he had observed in himself since he underwent the said experiment. It was ordered likewise that Mr. Coga being willing to have the experiment repeated on him, it should be tried again accordingly, when the physicians of the Society should judge it seasonable. [Oldenburg in a letter to Boyle, takes notice that the experiment was performed at Arundel-house, in the presence of many spectators, including Mr. Henry Howard and both his sons. The morning after the lord viscount Brouncker and Mr. Oldenburg went to see Mr. Coga pretty early.]

Societies and Academies.

LONDON.

Royal Society, November 13.—Sir Arthur **Schuster**: On the total reflection of light. The light which enters the optically rarer medium at or beyond the critical angle is an effect of diffraction originating near the boundary of the refracting surface. It derives its energy from the incident beam and must diminish the intensity of the reflected light. Thus there can be no total reflection in the strict sense of the word. The ratio of the energy dissipated by diffraction to the total energy of the incident light is inversely proportional to the length of the refracting surface, and therefore tends towards zero as the size of the refracting surface increases. At the critical angle the light dissipated by diffraction amounts to about one per cent. of the incident light, when the length of the refracting surface is 5 cm. The numerical value is subject to correction depending on the approximate nature of the investigation.—N. K. **Adam** and J. W. W. **Dyer**: The molecular structure of thin films. Pt. VI. Five long-chain alcohols have been examined. The area of cross-section of the chain in the alcohols is the same as in the acids, within $2\frac{1}{2}$ per cent., and the CH_2OH group occupies 21·6 sq. A.U. of area. The acetates of these alcohols pack with the heads occupying 23 sq. A.U., and form expanded films of the same kind as other esters. The methyl ethers of the alcohols do not form stable films. Highly unsaturated acids, with three and five double bonds in the chains, behave much like oleic acid, which only has one double bond. Arachidic acid and its derivatives behave normally. Substituted acetamides show a solid film with chains close-packed at low temperatures, and this melts at a definite temperature, raised by compression, to a liquid film of area 24·2 sq. A.U. This melting seems to be due to the molecules acquiring sufficient kinetic energy other than translational to break up the solid structure. Hydrocarbon chains more than 27 carbons long tend to mask the typical phenomena in condensed films. Pentærythritol tetrapalmitate, which has four chains attached to a common centre through polar groups, and should normally have these four chains directed to the corners of a tetrahedron, orients all the chains vertically in the surface. These are not quite close-packed until a compression of about 20 dynes per centimetre is applied.—T. **Alty**: The cataphoresis of gas bubbles in water. The velocity of a gas bubble in water is independent of the gas used. It is proportional to the applied field throughout the whole range of diameters, the maximum velocity being $4{\cdot}1 \times 10^{-4}$ cm./sec./volt/cm. at a diameter of about 0·1 mm. The highest velocity is only attained in water of specific conductivity $8{\cdot}5 \times 10^{-6}$ ohms^{-1}. In water of specific conductivity $1{\cdot}8 \times 10^{-6}$ ohms^{-1}, the charge on the bubble is very small, and is occasionally reversed during the course of an experiment. Two bubbles appear to repel each other.—D. R. **Hartree**: Some relations between the optical spectra of different atoms of the same electron structure. I.—Lithium-like and sodium-like atoms. Relations between values of corresponding terms of the spectra of different atoms of the same electron structure are worked out for the Bohr atom model with a central field. The relations are different according as the series electron does or does not penetrate into the core. The theoretical relations agree fairly closely with such experimental data as are available.—P. A. M. **Dirac**: The conditions for statistical equilibrium between atoms, electrons and radiation. The principle that every process which

occurs in an assembly in thermodynamic equilibrium is exactly balanced by the reverse process occurring to the same extent is applied to the general case of n-body encounters, both radiative and non-radiative processes being considered. Van 't Hoff's isochore is of universal validity, even for radiative processes and with relativity mechanics. From Planck's law of radiation it is deduced that every process by which radiation is emitted is stimulated by external radiation of the same frequency, the ratio of stimulated to spontaneous emission being independent of the nature of the process, and inversely proportional to the cube of the frequency.—Ida **Doubleday**: Boundary lubrication—further consideration of the influence of the composition of the solid face.—Christina C. **Miller**: The Stokes-Einstein law for diffusion in solution. Dilute solutions of iodine in a large number of solvents of different viscosity were used. According to the Einstein-Stokes expression, which is based on the assumption of large particles moving amongst relatively small molecules, the product [diffusion-coefficient × velocity] should be constant for all solvents. The product in the case of organic solvents actually varied between 850 and 1544; for aqueous solutions of alkali halide of different concentrations the variation was between 826 and 1216. According to Sutherland, on the opposite assumption that small dissolved molecules move amongst relatively large molecules, the value of the product in the extreme case should be 1·5 times as great as the value given by the Einstein-Stokes expression. If acetylene tetrabromide be excepted, the ratio for any two products actually falls between 1 and 1·5.—Helen S. **French** and T. M. **Lowry**: Studies of co-ordination, Pt. I. Absorption spectra and co-ordination of some cupric compounds. The absorption-spectra of the cupric compounds, both organic and inorganic, are dominated by (i.) a red or infra-red band, which is characteristic of the cupric atom, and (ii.) an ultra-violet band or general absorption, which depends mainly on the anion or organic radical. The colour of the cupric compounds depends on the character of the narrow region of transmission between these two absorptions.—L. F. **Bates**: On the range of α-particles in rare gases. A scintillation method was used, and the value found for helium, after repeated purification of the gas used, is very different from that found by previous observers, due probably to the big effect of small quantities of impurities in reducing the range. Henderson's theory of the loss of energy of an α-ray in passing through matter, whilst accounting for approximately the same fractional loss of energy in all the rare gases, does not account for the whole loss. There is a rough linear relation between the logarithms of the observed stopping powers and the logarithms of the atomic weights of the rare gases, but it does not take the simple form given by Bragg and Kleeman. —D. H. **Black**: The β-ray spectrum of mesothorium 2. Thirty-one lines were detected and their energies calculated. The majority of these lines are considered to be due to the conversion of γ-rays in the absorption levels of the atom itself. In all, eight γ-rays have been classified, and it has been possible to account for seven of these quite satisfactorily by the system of transitions between levels in the nucleus. —J. Keith **Roberts**: The thermal expansion of crystals of metallic bismuth. The thermal expansion of crystals of metallic bismuth parallel and perpendicular to the vertical axis, by comparison with that of crystalline quartz, are practically constant from ordinary temperatures up to 240° C. Bismuth melts at about 270° C. The constant expansion coefficients over this range are:—Perpendicular to the axis, $12{\cdot}0 \times 10^{-6}$; parallel to the axis, $16{\cdot}2 \times 10^{-6}$; mean, $13{\cdot}4 \times 10^{-6}$. The bending over of the length-temperature curve as the melting-point is approached indicates dissociation of the atoms in the solid.—R. **Stoneley**: Elastic waves at the surface of separation of two solids. A wave, analogous to the Rayleigh wave, exists at the plane surface of separation of two elastic solids, which extend otherwise to infinity, if the velocities of distortional waves in the two media are nearly equal. A transverse wave of the type that Prof. Love has shown to exist in certain circumstances in a surface layer cannot exist at this surface of separation. A wave of this type may exist in a stratum of uniform thickness bounded by media extending to infinity if the stratum is sufficiently thick or the wave-length sufficiently small. Nodal planes may also exist. The geophysical bearing of these results is that some of the energy of deep-seated earthquakes may be "trapped" at surfaces of discontinuity, and eventually be dissipated in solid friction without appreciably affecting seismographs. —J. H. **Jones** and J. C. **Boyce**: The constants of the Rydberg-Ritz equation. The type of atomic field necessary to give observed terms in hydrogen-like spectra must be due to a virtual attracting charge which is additional to the net charge of the atomic kernel. The additional field, strong near the kernel, but rapidly diminishing at greater distances, resembles that of an electric doublet. The doublet seems to be induced in the kernel by the field of the valence electron itself, in its interaction with the screening electrons. This can be pictured as the charge induced on a conducting sphere, and for such a model a Ritz spectral formula may be derived. One of the correcting terms of the Ritz formula has been obtained for a number of spectra of the sodium type, and the values are of the same order of magnitude as those calculated from known spectral data.

Physical Society, October 24.—Mr. F. E. Smith in the chair.—D. **Gunnaiya** and G. **Subrahmaniam**: Underblown pipes. The phenomena of underblown pipes have been studied in the case of four wooden pipes ranging over an octave. They present many features of remarkable interest, and a new theory is proposed.—W. **Mandell** and J. **West**: On the temperature gradient in gases at various pressures. Sets of curves indicating these gradients at various pressures have been obtained; they show the existence in contact with the vessel walls—at low pressures—of very large "temperature jumps." The general character of the results may be explained on the assumption of the presence at the walls, of a gas film possessing certain properties due to the attracting forces existing amongst wall molecules and gas molecules. Several thermocouples of differing thicknesses—and therefore differing curvature—were employed under identical conditions. They showed systematic differences which may also be attributed to the presence round the various thermocouples of gas films the thickness and character of which vary with the thickness of the couple.—J. F. S. **Ross**: Vectorial dimensions: The paper directs attention to the deficiency of the present dimensional notation [M] [L] [T], and in particular to the anomalies (*a*) that it makes the dimensions of work and torque the same, and (*b*) that it allows the dimensions of angular velocity and acceleration to appear as functions of time alone. These defects are due to the neglect of the vectorial character of length, and it is accordingly proposed that the present notation be modified by using the symbols $[L_x]$, $[L_y]$, and $[L_z]$, where different directions are involved. The proposal by Bartorelli to treat angle as a fourth independent fundamental quantity is open to serious criticism.

Mineralogical Society, November 4.—Dr. H. H. Thomas and afterwards Prof. W. W. Watts in the chair.—M. S. **Krishnan**: Note on cordierite in a cordierite-gneiss from Madura District, Madras, India. Optically positive cordierite occurs in an Archæan gneiss produced by the metamorphism of biotite-gneiss by an intrusive tongue of charnockite. The associated rocks are crystalline limestones (with lime-silicate minerals), and gneisses containing felspars, garnet, sillimanite, biotite, and titanoferrite. Cordierite from two other localities in Peninsular India (Vizagapatam and Travancore) is also known to be optically positive. This positive character is suggested to be due to the isomorphous replacement of MgO by FeO, as in the rhombic pyroxenes, olivines, etc.—A. **Brammall**: Lime as a constituent of certain important rock-forming minerals: its behaviour relative to that of other bases of RO type. A review of the facts governing the extent to which RO-bases replace each other in rock-forming minerals, special reference being made to the antipathetic relationship between lime and magnesia as constituents of the same simple molecule.—L. J. **Spencer**: (1) An inclusion of magnetite in diamond. A minute black fragment (about 1 mg.) taken from a cavity in a diamond from Bultfontein mine, Kimberley, was definitely identified as magnetite. Black inclusions and spots are of common occurrence in diamond, but usually they are non-magnetic and therefore not magnetite. (2) Biographical notices of mineralogists recently deceased (second series). Notices of fifty-five English and foreign mineralogists. The average age of 303 lives (since 1876) is 64 years, and a curve shows a highest point at 74 years. The greatest age was attained by F. E. Neumann (1798–1895), the German crystallographer.—A. **Russell**: A notice of the occurrence of native arsenic in Cornwall (with analysis by H. F. Harwood); of bismuthinite at Shap, Westmorland; and of smaltite and niccolite at the Coniston Mine, Lancashire.

MANCHESTER.

Literary and Philosophical Society, November 4.—H. B. **Dixon** and W. F. **Higgins**: On the phosphorescent flame of carbon di-sulphide. In determining the ignition-point of mixtures of carbon disulphide vapour with other gases, *e.g.* hydrogen, nitrogen, carbon dioxide, methane, it was found that a mixture of 80 per cent. methane with 20 per cent. carbon disulphide immediately inflamed when brought into oxygen in a concentric-tube apparatus at a temperature of 191° C., but did not inflame in air until both gas and air were heated to above 410° and had been in contact 10 seconds. The mixture of methane and carbon disulphide was observed to give a phosphorescent glow when it met the air at temperatures between 200° and 400°, and by regulating the gas supply a steady flame could be maintained. This flame can be studied more easily in a glass tube, or by throwing a steady air current by means of a glass cone on to the gas jet. The phosphorescent flame is due to the partial burning of the carbon disulphide, to carbon mono-sulphide, and sulphur dioxide. The methane is not attacked. The flame does not come down to the jet: it lights some inches above it. When certain gases, such as ethylene, acetylene, coal-gas, nitrogen peroxide, mix with the gas and air near the orifice of the jet, the phosphorescent flame is immediately extinguished—but these "poison" gases have no effect when brought into the flame itself. The phosphorescent flame is accompanied by particles of the red-brown polymer of CS and appears to be due to the partial burning of CS_2 molecules condensed on these solid particles. The "poison" appears to prevent this condensation.

PARIS.

Academy of Sciences, October 27.—M. Guillaume Bigourdan in the chair.—The president announced the death of Louis Emile Bertin, the oldest member of the section of geography and navigation, past-president of the Academy.—Paul **Appell**: The nature of the movement of a fluid celestial body round its centre of gravity.—G. **Friedel**: An experiment demonstrating the symmetry between the increase and decrease of crystals.—Édouard **Imbeaux**: The great artesian basins of the United States.—Paul **Montel**: The exceptional involutions of the algebroid functions.—Maurice **Fréchet**: An intrinsic parametric representation of the most general continuous curve.—S. **Stoïlow**: The continued transformations of a variable.—Alfred **Rosenblatt**: Varieties of three dimensions the tangent spaces of which satisfy certain differential equations.—R. **Jacques**: Networks such that the congruences described by the tangents and the congruences derived by the Laplace method belong alternately to linear complexes.—Jean **Thibaud**: The absorption and diffusion of γ-rays of very great energy in the light elements.—A. **Dauvillier**: A method of distinguishing natural pearls from culture pearls. The means hitherto available for distinguishing between the pearls produced artificially in the oyster by the Japanese method and natural pearls, necessitate the destruction of the pearl. It is shown that the photographs of the Laue figures produced by X-rays are different for the two classes of pearl, and this examination does not require the mutilation of the pearl.—Jules **Stoklasa** and Jos. **Penkava**: The radioactivity of the eruptive gases of Vesuvius and of solfataras and their influence on the development of bacteria and the higher plants. Details of measurements of the electrical conductivity of the air near two craters of Vesuvius, at different altitudes on the Eiffel Tower in Paris, and at the potash mines at Mulhouse.—L. J. **Simon**: The neutralisation of chloric acid by the alkalis, followed by means of viscosimetry. The minimum viscosity corresponds to equimolecular proportions of alkali and acid.—E. **Audibert**: A necessary condition for safe mining in an inflammable atmosphere. Doubt is thrown on the efficacity of inert rock dust for preventing the propagation of explosion in mines.—A. **Lassieur**: The electrolytic separation of copper, antimony, lead and tin.—A. **Damiens**: The suboxide of tellurium. The experiments described do not confirm the production of tellurium suboxide under the conditions given by Divers and Shimozé. The reaction indicated by them is incomplete when working with pure tellurium, and the body described as the suboxide TeO is only a mixture of tellurium and the dioxide TeO_2.—J. A. **Muller** and Mlle. E. **Peytral**: The sudden pyrogenic decomposition of methyl formate and the principle of minimum molecular deformation. Methyl formate, passed rapidly through a hot tube at 1000° C., splits up into two molecules of formaldehyde; secondary decomposition of the aldehyde gives rise to carbon monoxide and hydrogen.—J. **Barthoux**: Contact metamorphism in the Djebilet ad Rehamna, Morocco.—Sabba **Stefanescu**: The apparent anomalies of the molars of elephants and the number of plates of their crowns.—A. **Maige**: The regeneration of the amylogen excitability of the plasts during hydrolysis.—L. **Leger**: The specific value of the three kinds of European lamprey and the young stages of *Petromyzon fluviatilis*. From a study of the young post-larval stages, the author concludes that the three kinds of European

lamprey, known under the names of *Petromyzon marinus*, *P. fluviatilis*, and *P. planeri*, must be considered as distinct species, since their differential characters, clearly marked in the adult, are already shown from the metamorphosis which follows their long larval life in fresh water.—M. **Parat** and J. **Painlevé**: The internal reticular apparatus of Golgi, Holmgren trophosponge and vacuome. The "reticular apparatus" of Golgi or the "trophosponge" of Holmgren results from the precipitation of metallic silver or osmium in the interior, at the periphery, or in the interspaces of the protoplasmic vacuoles. The author concludes that there is no cellular "apparatus."—A. **Bonnet**: The digestive and absorbing apparatus of some Echinideæ.—Eugène **Aubel** and René **Wurmser**: The utilisation of the energy liberated by oxidations.

BRUSSELS.

Royal Academy of Belgium, May 6.—M. Max Lohest in the chair.—Report on the work of the Committee on "Biographie Nationale" during the year 1923-1924.

June 7.—M. Max Lohest in the chair.—The P. J. and Ed. van Beneden Prize (2nd period, 1921-1923) is awarded to M. Daleg for his researches on the physiology of the egg during maturation: the decennial prize for applied mathematics (period 1913-1922) to M. De Donder for his works on the Einstein gravific and his treatises on thermodynamics and physical chemistry.

August 2.—M. Max Lohest in the chair.—The Edouard Mailly Prize is awarded to the Antwerp Astronomical Society.—Th. De **Donder**: The Weyl-Eddington-Einstein gravific.—Victor van **Straelen**: An amphipod from the oil-bearing strata of Pechelbronn (Alsace). Details of a new species to which the name of *Gammarus alsaticus* is given.—M. **Alliaume**: The best approximation in the determination of the instantaneous terrestrial pole and an attempt at the systemisation of researches on the deviation from the vertical.—M. **Alliaume**: The generalisation of Poisson's theorem relating to the probability of an event the cause of which has undergone an unknown modification.—R. **Lucion** and A. **Brichaux**: Experiments undertaken by Ernest Solvay, from 1877 to 1881, on the fundamental unity of matter and energy.—E. **Ectors**: Contribution to the study of the reaction of organo-magnesium compounds on the nitriles. Benzonitrile. An account of experiments made to elucidate the mechanism of the reaction between benzonitrile and benzyl-magnesium chloride.—Suzanne **Leclercq**: New observations on the anatomical structure of some fossil plants of the Belgian coal measures. Two new species are described, *Botryopteris Fraiponti* and *Sphenophyllum Gilkinetti*.—A. **Merten**: The calculation of barrage walls.—Victor van **Straelen**: The first remains of fossil Phacochoerus collected in the Belgian Congo.—J. de **Smedt**: The diffraction of the X-rays by polymerised liquids.

DUBLIN.

Royal Dublin Society, October 28.—Prof. E. A. Werner in the chair.—H. H. **Jeffcott**: The determination of the most economic size of pipe line for water-power installations. In choosing the size of pipe lines and tunnels leading from a reservoir to the turbines in a hydroelectric installation, the criterion of greatest economy is that the sum of all the charges in connexion with the pipe lines (including the value of the power lost in the pipes), when reckoned over a long period of years, shall be a minimum. Reducing the diameter of such pipe line lessens cost, but increases the loss of power due to frictional resistance, and, owing to loss of head at peak loads, it is necessary either to increase the size of the turbines, or to install additional turbine and generator sets to supply the deficiency at large discharge. From these considerations formulæ are obtained for the theoretically best sizes. As practical considerations require the thickness of wall of the pipe to be not less than a specified quantity, the low-pressure portion of the pipe line is of constant size. Thereafter the diameter diminishes, and the thickness of wall increases gradually as the pipe line descends towards the power-house. For the tunnel portion of the system the diameter is constant under the conditions hypothesised. As the output of the power-station varies considerably from time to time, the total frictional loss of energy in the pipe line in a year is proportional to the mean cube of the several discharge rates during equal periods in that year.—W. R. G. **Atkins** and G. T. **Harris**: Seasonal changes in the water and heleoplankton of fresh-water ponds. The plankton of two ponds was found to be very different, so the water was analysed and the plankton estimated at intervals for about two years. A new record was obtained for *Elakatothrix gelatinosa*. The electrical conductivity of the water was low when the P_H value was high; the seasonal changes differed in the two ponds. In spring the developing plankton used up all the phosphate, lack of which appeared to limit the increase in growth.—K. C. **Bailey**: The synthesis of urea from carbon dioxide and ammonia under atmospheric pressure. Urea can be synthesised from carbon dioxide and ammonia at atmospheric pressure by passing the mixed gases through the annular space between a quartz tube heated to a temperature higher than 500° C. and an inner water-cooled glass tube. It is advantageous to use the gases in the ratio of two volumes of ammonia to eight of carbon dioxide. The yield of urea increases with temperature to at least 700°.

Royal Irish Academy, November 10.—Prof. Sydney Young, president, in the chair.—K. C. **Bailey**: The reaction between ferric chloride and potassium thiocyanate. The reaction between ferric chloride and potassium thiocyanate in various proportions has been reinvestigated, and an explanation is offered of the seeming anomalies in the extraction of ferric thiocyanate by ether or amyl alcohol. No evidence has been found of the existence in the reaction mixture of a dithiocyanate.—K. C. **Bailey** and J. D. **Kidd**: Freezing-points of solutions containing ferric chloride and potassium thiocyanate. Freezing-point curves of solutions containing ferric chloride and potassium thiocyanate in varying proportions have been constructed, but no definite evidence was obtained of the formation of double compounds.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 50, Art. 5: Further Notes on Ptilosis. By W. de W. Miller. Pp. 305-331. (New York City.)

Department of Health, Canada. Publication No. 32: Small-Pox and Vaccination; a Popular Treatise. By Dr. J. J. Heagerty. Pp. 27. (Ottawa: Department of Health.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 32 (Division of Chemistry Series No. 33): The Composition of Ripe Wine Grapes from the Government Viticultural Station, Paarl. By G. Frater. Pp. 30. (Pretoria: Government Printing and Stationery Office.) 3*d*.

Canada. Department of Mines: Mines Branch. Bituminous Sands of Northern Alberta. By Sidney C. Ellis. Pp. 35+6 plates. (Ottawa: F. A. Acland.) 25 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 291: A Gravimetric Test of the "Roots of Mountains" Theory. By William Bowie. Pp. 8. (Washington: Government Printing Office.)

United States Department of Agriculture. Department Bulletin 1227: Damage to Range Grasses by the Zuni Prairie Dog. By Walter P. Taylor and J. V. G. Loftfield. Pp. 16+6 plates. 10 cents. Department Bulletin No. 1267: The Rough-headed Corn Stalk-beetle. By W. J. Phillips and Henry Fox. Pp. 34. 10 cents. Department Bulletin No. 1268: Returns from Banded Birds, 1920 to 1923. By Frederick C. Lincoln. Pp. 56+4 plates. 10 cents. Department Bulletin No. 1273: The Bud Moth. By B. A. Porter. Pp. 20. n.p. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 8: Visual Education Departments in Educational Institutions. By A. P. Hollis. Pp. iii+36. Bulletin, 1924, No. 15: The Daily Schedule in the High School. By J. B. Edmonson, Warren E. Bow, Irvin Van Tassell. Pp. ii+17. (Washington: Government Printing Office.) 5 cents each.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1923. Pp. iv+50. (Trinidad.) 6*d*.

Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 29, Part 1, Session 1923-24. Pp. viii+118+5 plates. (Edinburgh.) 7*s*. 6*d*.

República Argentina. Ministerio de Agricultura de la Nación: Oficina Meteorologica Nacional. Boletin Mensual. Año 5, 1920. Pp. 89+12 charts+51 maps. (Buenos Aires.)

New Zealand Department of Mines: Geological Survey Branch. Bulletin No. 26 (New Series): The Geology and Mines of the Waihi District, Hauraki Goldfield, New Zealand. By P. G. Morgan. Pp. ix +218+7 plates. (Wellington, N.Z.: W. A. G. Skinner). 10*s*.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 270: Geodetic Operations in the United States and Outlying Possessions, January 1, 1922, to December 31, 1923. By William Bowie. (Special Publication No. 104.) Pp. iv+28+18 plates. (Washington: Government Printing Office.)

Quarterly Journal of the Royal Meteorological Society. Edited by a Committee of the Council. Vol. 50, No. 212, October. Pp. 277-397+viii. (London: E. Stanford, Ltd.) 7*s*. 6*d*.

Tide Tables for the Pacific Coast of Canada for the Year 1925: including Fuca Strait, the Strait of Georgia, and the Northern Coast; with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents. Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada. (Twenty-fifth Year of Issue.) Pp. 72. (Ottawa: F. A. Acland.) Gratis.

Tide Tables for the Eastern Coasts of Canada for the Year 1925: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada. (Twenty-ninth Year of Issue.) Pp. 76. (Ottawa: F. A. Acland.) Gratis.

Development Commission. Fourteenth Report of the Development Commissioners for the Year ended the 31st March 1924. Pp. 156. (London: H.M. Stationery Office.) 4*s*. net.

Diary of Societies.

MONDAY, NOVEMBER 24.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—C. T. R. Wilson: Acceleration of β-Particles in Strong Electric Fields such as those of Thunderclouds.—Dr. G. F. C. Searle: The Determination of the Frequency of an Alternating Current Supply by the Vibrations of Rods.—Dr. F. W. Aston: Photographic Plates for the Detection of Mass Rays.—E. B. Moullin: The Current induced in a Wireless Telegraph Receiving Antenna.—R. R. S. Cox: Note on the Chemical Constant of Chlorine.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. T. J. Jehu and R. M. Craig: Geology of the Outer Hebrides, Part 2, South Uist and Eriskay.—J. A. Eldridge: Note on Professor Whittaker's Atomic Model.—W. Saddler: The Irreducible System of Concomitants of Two Double Binary (2,1) Forms.—A. C. Aitken: A Series Formula for the Roots of Algebraic and Transcendental Equations.—Prof. J. Tait and Dr. W. F. Emmons: Experiments and Observations on Crustacea. Part VI. The Mechanism of Massive Movement of the Operculum of *Balanus nubilis*.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—N. A. Allen and others: Discussion on The Electrostatic Wattmeter used for measuring Dielectric Losses in Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Modern Colour Problems (1) (Cantor Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—G. J. Goldie and Prof. Collingwood: Note on Protagulin in Hæmorrhage after Extraction.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Anthony Bowlby, Bart., and others: Discussion on The Treatment of Senile Gangrene.

TUESDAY, NOVEMBER 25.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—Miss S. D. King: Oogenesis in *Lithobius forficatus*.—Rev. H. C. Browne: The Influence of the FitzGerald Contraction on Space Measurements and Clock Times.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Lord Stevenson: British Empire Exhibition.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. L. Thornton: The Rôle of Technical Training in Marine Engineering.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Demonstration and Discussion on Car-cleaning Devices.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—G. Rogers: Automatic and Semi-automatic Rectifier Sub-stations.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. R. Newens: With Camera and Colour Plate.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Section) (at Broadgate Café, Coventry), at 7.15.—W. W. Small: Body Building.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—Prof. Réné Verneau: La Race de Néanderthal et la Race de Grimaldi: leur rôle dans l'humanité (Huxley Memorial Lecture).

WEDNESDAY, NOVEMBER 26.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Section) (at 244 Deansgate, Manchester), at 6.30.—Mr. Martin: Automobile Coach-building.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Ex-Bailie W. B. Smith: The Future Prospect of a Clean Atmosphere.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section) (jointly with Institution of Structural Engineers), at 7.30.—J. E. Barnard: The Elementary Principles of Microscopical Illumination (2). Self-Luminous Objects.—H. J. Deane: The Application of Microscopy to Cement Research.

ROYAL SOCIETY OF ARTS, at 8.—C. F. Elwell: Talking Motion Pictures.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. D. E. Core: The Clinical Value of Certain Emotions.

THURSDAY, NOVEMBER 27.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 4.30.—Dr. W. Edgecombe: The Principles of Spa Treatment in Great Britain (Presidential Address).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Dr. G. C. Simpson: Thunderstorms.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. J. J. Findlay: Education and Rhythm.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) (at Luton), at 7.30.—G. D. Ricketts: Production.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section, jointly with Society of Dyers and Colourists) (at University College, Nottingham).—G. H. Ellis: Acetate Silk.

FRIDAY, NOVEMBER 28.

PHYSICAL SOCIETY OF LONDON (jointly with Royal Meteorological Society) (at Imperial College of Science), at 5.—Discussion on The Ionisation of the Atmosphere, and its Influence on the Propagation of Wireless Signals.—Dr. W. H. Eccles: Opening Address.—Dr. C. Chree: Atmospheric Ionisation and its Variations.—Prof. E. V. Appleton: Experimental Observation of the Strength of Wireless Signals as affected by the Path of the Signals, Time of Day, and Season of Year.—R. A. Watson Watt: Atmospherics.—C. T. R. Wilson: The Electric Field of a Thundercloud and some of its Effects.—Prof. S. Chapman: The Evidence of Terrestrial Magnetism for the Existence of Highly Ionised Layers in the Upper Atmosphere.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Discussion and Demonstration on The After-treatment of Medical Diseases of Joints.

JUNIOR INSTITUTION OF ENGINEERS, at 6.30.—Exhibition of latest Scientific Instruments and Appliances for the use of Engineers.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. C. W. R. Knight: Bird Life from an Observation Post.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—J. Tutin: The Prediction of Critical Speeds in Ship Resistance.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—H. G. Clement: Ships' Life-Saving Appliances.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Section) (at Sheffield).—Prof. F. C. Lea: Effect of Repetition Stresses on Steels.

SATURDAY, NOVEMBER 29.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section, jointly with North of England Institute of Mining and Mining Engineers) (at Neville Hall, Newcastle-on-Tyne), at 3.

ROYAL IRISH ACADEMY, at 4.15.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Social Life amongst Insects. II. Butterflies and Moths.

TUESDAY, NOVEMBER 25.

WESTFIELD COLLEGE, HAMPSTEAD, at 5.15.—Rev. Dr. W. B. Selbie: Psychology and Religion.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: Bosanquet's Theory of the State and Society.

WEDNESDAY, NOVEMBER 26.

INSTITUTE OF HYGIENE, at 3.30.—Dr. H. G. Anderson: The Prevention of Physical Deformities.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. W. Cullis: The Practice of Health.

MEDICAL SOCIETY OF LONDON, at 5.15.—Dr. W. M. Feldman: Ante-Natal Child Physiology and Hygiene (Chadwick Lecture).

UNIVERSITY COLLEGE, at 5.30.—A. Esdaile: The British Museum Library. II. The Collections.

THURSDAY, NOVEMBER 27.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. Neilson Jones: Dual Personality in Plants.

KING'S COLLEGE, at 5.30.—O. V. Salomón: The Modern Civilisation of Peru.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. G. Gardner: The Personality of Mazzini.

FRIDAY, NOVEMBER 28.

KING'S COLLEGE, at 5.30.—Prof. E. W. MacBride: Scientific Method.

SATURDAY, NOVEMBER 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: Prehistoric Man and the "Land of Lyonesse."