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The Position of British Veterinary Education and Service.

THERE has just been issued the Report of a Committee appointed by the Secretary of State for the Colonies to inquire into the conditions of the Colonial Veterinary Service (H.M.S.O., Cmd. 3261. Price 9*d*. net). The Committee, which was presided over by Lord Lovat, was asked to frame proposals for obtaining the highest degree of efficiency in regard to veterinary research and administration in the non-self-governing dependencies that financial considerations permit. The questions considered and reported upon include the recruitment and training of veterinary officers, their conditions of service, the organisation of research and intelligence and the setting up and support of any institutions required. The entire field has apparently been very thoroughly explored and the report makes illuminating and very disquieting disclosures of the great difficulties under which veterinary education and training are carried out in Great Britain. Referring to the dilapidated condition of the Royal Veterinary College at Camden Town, the Committee says :

"It is nothing short of a national disgrace that such a condition of affairs should be allowed to continue. The blame does not lie with the teaching staff, labouring as they do under the great disadvantage of inadequate salaries in a school which is both inadequately staffed and equipped. On the contrary, they have made great personal sacrifices, and have themselves provided much of the existing equipment."

Indeed, it is within our knowledge that on more than one occasion in years of financial strain the teaching staff of the College have submitted to a considerable reduction of their already inadequate salaries, and that at times when most salaried officials, such as those of the Civil Service, were in receipt of a yearly bonus on account of the increased cost of living.

"Veterinary schools in this country receive but little help from the State and have to rely mainly on students' fees. When we compare the large veterinary institutions in other countries, supported principally by State funds, with those that exist in Great Britain, the contrast is somewhat depressing."

The Veterinary College of Berlin receives an annual grant from the State of £28,000, while, since the War, a new veterinary college has been built at Leipzig at a cost of more than £1,000,000. It is not to be wondered at, therefore, that the Committee is convinced that existing conditions

in Great Britain and overseas "should no longer be tolerated." A new policy, on comprehensive lines and with adequate financial support, is needed and should be carried out boldly.

Veterinary activities can no longer be limited to the mere treatment of specific diseases or even the prevention of epizoötic and enzoötic diseases. The advance of agriculture—the staple industry of almost all the dependencies of the British Empire—is closely associated with animal husbandry in its widest sense, and animal nutrition and animal genetics are of the highest economic importance, while the successful development of public health involves problems of improved milk and meat supply. Moreover, the advance of modern medical science—so largely the result of observations on animals—requires the continuous collaboration of veterinarians in the solution of such problems as insect-borne diseases like the trypanosomiases or the virus diseases.

The economic aspect of stock-rearing alone would justify the provision of adequate measures for combating animal diseases and improving the health and nutrition of the flocks and herds. Between 1914 and 1925 the cattle population of Nigeria was reduced by as much as 25 per cent, almost entirely through rinderpest. This same disease in two outbreaks destroyed 5,000,000 head of cattle in South Africa south of the Zambezi, representing a loss of £20,000,000.

The Lovat Committee is of opinion that the veterinary departments of the colonies are generally understaffed and that the conditions of service do not attract enough recruits of the type required, such as those combining technical proficiency with the personal qualities which are essential if the veterinary officer is to enforce his often disturbing regulations without undue friction. The colonies must make their veterinary services more attractive. The status and prestige and conditions of service of veterinary departments must be improved, and it will be necessary to offer higher salaries, particularly in the senior grades.

The present veterinary course of training in Great Britain, with the standard of preliminary general education identical with that demanded by the General Medical Council, consists of a four years' (membership diploma) or a five years' (university degree) course, with post-graduate courses for additional diplomas. There is no special training, however, in tropical veterinary science comparable with that provided for candidates for the colonial medical services at the schools of tropical medicine, and the Committee recommends that all newly appointed officers should undergo in Great Britain a course of instruction in tropical veterinary science before proceeding overseas.

If the recommendations of the Lovat Committee are adopted, the veterinary services will no longer be regarded as the Cinderella of the services, and opportunities will be afforded for utilisation of the best types of recruits for veterinary research. As Sir Arnold Theiler recently stated in referring to such matters, British veterinarians have brain and ability second to none in the whole world if they are only afforded the opportunity of applying them.

To remedy this condition of affairs, it is recommended that fundamental veterinary education in Great Britain must be supported in such a way that the stigma of a "national disgrace" shall be removed, and that a system of scholarships be instituted to attract more men with a scientific training and with an aptitude for research. There should also be a special post-graduate training, for which purpose there should be established a school of tropical veterinary science modelled on the lines of the London School of Tropical Medicine, and it should be closely linked with a veterinary college and affiliated to a university so as to be eligible for a grant from the University Grants Committee.

To complete its work, the Committee has made striking recommendations for the provision of headquarters organisations, the organisation of research with the establishment of a central research station adequately equipped and staffed, and the provision of a Colonial Veterinary Service available for service in any part of the Colonial Empire and not limited to any particular colony. In regard to this service the Committee says: "The veterinarian of the highest ability will enter the Colonial Services only if he is offered a career sufficiently attractive in pay and prospects to satisfy his ambitions as a scientific worker."

Much of this report cannot but be of considerable assistance to the departmental committee appointed by the Minister for Agriculture, sitting, at present, to inquire into the requirements for veterinary education in Great Britain, with particular reference to the Royal Veterinary College, Camden Town, and we earnestly hope that, as the result of recommendations of two such strong committees, the "national disgrace" at Camden Town will be reconstituted and endowed in such a manner as to become a credit as the senior and most important veterinary college of the British Empire.

Invertebrate Fauna of Rapid Waters.

Contribution à l'étude des invertébrés torrenticoles. Par Dr. Étienne Hubault. (Suppléments au *Bulletin biologique de France et de Belgique*, Supplément 9.) Pp. 388 + 10 planches. (Paris : Les Presses universitaires de France ; London : Dulau and Co., 1927.) 85 francs.

FRESH-WATER biology, much neglected in the past, is rapidly becoming the subject of intensive and valuable study. Until recently the majority of investigators into such problems as adaptation, evolution, migration, and geographical distribution have turned largely to the sea for material. But these phenomena are exemplified in almost, if not quite as marked a degree, by the more accessible inhabitants of fresh waters as by the denizens of the deep. Vast lake and tiny pool, clear spring and stagnant pond, rushing stream and trickling rivulet—each has its own characteristic inhabitants specially adapted for life under the particular set of environmental conditions found therein. Moreover, as in the sea, each of these principal types of habitat, such as hill streams, contains within itself numerous subsidiary types of habitat differing fundamentally one from another, and each harbouring its own particular group of organisms.

Specially welcome, therefore, is Dr. Hubault's contribution to the study of the invertebrate fauna of rapid waters. This most exhaustive work of superlative value is at once systematic, physiological, and biological. The systematic portion of the work consists of an enumeration of the organisms actually studied and collected by the author in the course of his researches, with a table showing the general distributions of all the species determined with certainty. The physiological portion includes in its scope detailed observations on the temperature, salinity, and oxygen content of the waters of hill streams, and the parts played by these factors in determining the distribution of a hill stream fauna.

The last-named factor Dr. Hubault has made the subject of detailed investigation, especially with regard to the distribution of oxygen in the different parts of hill streams, and the annual rhythm of this distribution. He finds that, near the source, the water is always rich in dissolved oxygen—slightly less so in summer than in winter, but the difference is negligible. In the lower reaches, on the contrary, there is a marked seasonal variation, the water being poor in dissolved oxygen during the warmer months and relatively rich during the colder months of the year. Thus, in summer there is a considerable difference between the oxygen content of the upper and lower reaches of rivers and streams, while in winter the uniformly cold waters are throughout rich in oxygen. Nevertheless, although there is little or no seasonal variation near the source, there is a noticeable 'diurnal oscillation' of oxygen concentration, the volume of water here being small, and considerable diurnal change of temperature taking place. The concentration reaches a maximum about sunrise, and falls to a minimum shortly after mid-day. Change of temperature alone is held to be responsible for this daily rhythm, phytoplankton being non-existent, and other aquatic vegetation scanty. Farther down where the volume of water is greater, the temperature remains practically uniform throughout the twenty-four hours, and there is no 'diurnal oscillation' of oxygen concentration.

A striking example is given of the effect of the action of aerobic bacteria in reducing the oxygen content of water, and thus constituting a very real menace to the life of higher organisms. On the banks of the small stream Saint-Benoît there are, at one place about the middle of its course, four potato-starch factories situated a short distance apart. In November 1924 the difference in oxygen concentration immediately above and below these factories was 1·55 c.c. per litre, in spite of the fact that the stream was then in flood. In October 1925 the stream was normal and, although only three factories were working, the difference above and below them was 1·73 c.c. per litre.

Correlated with these investigations on oxygen concentration and distribution, the author has determined the oxygen consumption of various organisms from different fresh-water habitats. He finds that forms found in rapidly running or other waters more or less uniformly cold throughout the year have, in general, a higher oxygen consumption than those found in waters such as slowly moving streams, where the temperature rises considerably in summer. The amount of dissolved oxygen present in the water is therefore an exceedingly important factor in determining the distribution of the inhabitants of fresh waters.

In this connexion Dr. Hubault lays great emphasis on the fact that, in the life of the inhabitants of rapid waters, the actual current plays only a secondary rôle, the primary conditions governing their existence being such factors as temperature, salinity, and, more particularly, oxygen concentration. Only in running waters do these organisms find those physico-chemical conditions which are essential to them. Of necessity,

therefore, they must 'put up with' the current—an inconvenient mechanical force which they have overcome with varying degrees of success by means of a remarkable series of tropisms and morphological adaptations, ranging from those exhibited by the most highly specialised forms adapted for life in cascades and waterfalls, down to the very slight modification of such as, although living in streams, ensconce themselves amongst moss or under stones where the current is little felt. Chapter v. is devoted to the study of tropisms, especially the three principal tropisms exhibited by these hill stream organisms—rheotropism, stereotropism, and phototropism with its corollary, nycthemeral rhythm—upon which the author has made extensive observations.

Chapter vi. deals mainly with the biology of the Trichoptera and Blepharoceridæ. The former group is considered only in outline, the latter more fully, the author having focused his attention particularly upon *Liponeura vogesiaca* nov. sp., the biology of which he has followed out in detail in the upper courses of the river Meurthe in the High Vosges.

Finally, Dr. Hubault passes in review the evidence bearing upon the origin of a rapid water fauna. An extensive bibliography of more than three hundred references completes the work.

G. A. S.

Progress of Research in Tropical Medicine.

(1) *An Introduction to Medical Protozoology: with Chapters on the Spirochætes and on Laboratory Methods.* By Lieut.-Col. Robert Knowles. Pp. xii + 887 + 15 plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1928.) Rs. 25.

(2) *Recent Advances in Tropical Medicine.* By Sir Leonard Rogers. Pp. viii + 398. (London: J. and A. Churchill, 1928.) 12*s.* 6*d.* net.

IN a little more than a quarter of a century the patient and often brilliant researches of numerous scientific workers have elucidated many difficult problems regarding the causes and dissemination of diseases so prevalent in the tropics. The parasites of malaria, sleeping sickness, relapsing fever, amœbic and bacillary dysentery, cholera, plague, and leprosy are now readily detected. It is perhaps of even greater importance that in many instances the life histories and transmission of these organisms to man have been clearly demonstrated.

Such discoveries have placed in the hands of the hygienist methods of control against the spread of disease, which in time will convert huge tracts of valuable territory previously known by such names as 'the white man's grave' into veritable health resorts.

Our present knowledge regarding some of these diseases might seem to be ample and complete, but there is no finality, as is exemplified by the continued careful investigations which are being carried on all over the world. New facts regarding the parasites and the bionomics of their vectors are being slowly accumulated, and many unknown factors await elucidation in order to place the control of such diseases as malaria or sleeping sickness over large areas of the tropics on an economic basis.

(1) A striking example of the growth of knowledge regarding diseases of man and other animals is afforded by the publication of the substantial volume before us entitled "An Introduction to Medical Protozoology." Here Lieut.-Col. Knowles, in an interesting manner and in a style peculiarly his own, describes those unicellular animals which parasitise man. The most interesting chapters are those on leishmaniasis (kala-azar and Oriental sore); for the author was one of those concerned with the initiation of a new line of research. The causal organism of this disease was discovered independently by Leishman and Donovan in 1903. Rogers, the following year, succeeded in cultivating the parasite, so demonstrating that during a part of its life history it became a motile flagellate known as a leptomonad or herpetomonad.

The problems concerned with the transmission of leishmaniasis have for years baffled all workers. Bed bugs, fleas, lice, mosquitoes, and other blood-sucking arthropoda have been studied, but no proof was forthcoming to show that any of these was responsible. A new line of investigation was opened up by Sinton in 1922, who noted that the distribution of a certain species of sand fly (*Phlebotomus argentipes*) corresponded geographically with kala-azar. Knowles, Napier, and Smith (1924) quickly demonstrated that laboratory-bred specimens of this fly could be readily infected with leptomonad flagellates when fed on cases of kala-azar. Christophers, Shortt, and Barraud confirmed this, and the Indian commission composed of Shortt, Barraud, and Craighead has definitely shown that the flagellates make their way forwards in *Phlebotomus argentipes* to the buccal cavity, pharynx, and biting parts. All attempts to infect man or a susceptible animal (the Chinese hamster) by the bites of experimentally infected sand flies have failed. Workers in China have confirmed the observations of those in India.

In Palestine, Adler and Theodor have infected *Phlebotomus papatasii* by feeding it on 'Oriental sore,' and here again the flagellates make their way forward to the proboscis of the fly. Experimental production of cutaneous leishmaniasis, however, has not been accomplished through the bite of infected flies, although the crushed-up contents of the gut inoculated into the skin of man produces a typical sore.

These researches indicate that certain species of sand flies act as the vectors of visceral and cutaneous leishmaniasis, but that some unknown factors involved in the transmission of both diseases to man require further investigation.

(2) *Pari passu* with observations on the pathogenic parasites and the biology of their vectors, great progress has been accomplished in chemo-therapy. Sir Leonard Rogers has compiled a most valuable short book on "Recent Advances in Tropical Medicine." Here he gives a lucid account of the remarkable advances in the treatment of diseases by drugs. The use of sodium or potassium antimony tartrate, for example, in the treatment of kala-azar, Oriental sore, and schistosomiasis is a triumph of modern therapy. The introduction of 'Bayer 205' and tryparsamide for the cure of African sleeping sickness, and emetine in the treatment of amœbic dysentery and liver abscess, has added potent preparations to the pharmacopœia.

Rogers has demonstrated the value of hypertonic alkaline injections in the treatment of cholera, and also has reported most interesting results in cases of leprosy which have been treated with injections of chaulmoogra oil and its derivatives. His results far surpass those given by any other treatment of this most dreaded of diseases.

In conclusion, attention must be directed to some very important researches recently made on yellow fever. In 1901, Reed, Carrol, and Agramonte proved that the vector was *Aëdes argenteus* (*Stegomya fasciata*). The organism remained unknown, but interest was revived in it in 1919 by Noguchi, who announced that the causal organism was a spirochæte (*Leptospira icteroides*). Other workers failed to confirm Noguchi, and a commission of the Rockefeller foundation continued researches in West Africa. Stokes, Noguchi, and Young lost their lives during these investigations, and recently the whole evidence points to the fact that the causal organism is a filterable virus. Great credit is due to Dr. Sellards, of Harvard University, who brought to England in 1928 the frozen virus from Dakar which enabled researches to be continued in this country.

Hindle, by applying the technique successfully used by Laidlaw and Dunkin in the protection of dogs against dog distemper, has prepared vaccines from the liver of yellow-fever monkeys which absolutely protect monkeys against large doses of the virus. Aragão (1928) has proved the viruses of America and the west coast of Africa to be identical, and, further, has used the protective vaccine with apparently good results in a small epidemic in Brazil. About three or four hundred people were vaccinated, and none of those so treated caught yellow fever. Evidence points to the important fact that by the use of vaccine the population can be protected absolutely from the ravages of an epidemic of yellow fever.

J. G. THOMSON.

Historical Aspects of Science.

The Bases of Modern Science. By J. W. N. Sullivan. Pp. x + 246. (London: Ernest Benn, Ltd., 1928.) 12*s.* 6*d.* net.

IT is, perhaps, not unnatural at a time when science is developing at an unprecedented and somewhat embarrassing rate that the study of the history and philosophy of science should have fallen into neglect. When the newspaper is so interesting, it is not surprising that the historical treatise meets with less than its due share of attention. It is unfortunately true that very few of our physics students of to-day have any clear conception of the way in which their subject has been developed, and this neglect of the historical or, as some prefer to term it, the humanistic aspect of science is a weakness in science teaching which is being more and more generally recognised. One of the difficulties in introducing this desirable element into our studies has undoubtedly been the absence of suitable books. It is true that a few men of science have achieved the distinction of a biography, but it is the history of science rather than the lives of men of science with which we wish to concern ourselves; it is the development of ideas, and not of men, which is our proper study; and of such histories there are very few in the English language.

It is from this aspect that we welcome this very able and interesting volume from the pen of Mr. J. W. N. Sullivan. The title, "The Bases of Modern Science," is perhaps a little misleading. The book deals only with physical science, and there are others (a fact which physicists are perhaps a little prone to forget), and only about half of the book deals directly with what we call modern science. What Mr. Sullivan has done, and done

well, is to give us, without bewildering and unnecessary detail, and without the intrusion of ugly mathematical formulæ, a history of the growth and development of physical science from the time of Copernicus to the present day. He has traced in a simple but adequate way the rise, decline, and fall of the different conceptions which have dominated physics in that interval, and has attempted to make clear the often unspoken ideas and aims in the minds of those who formulated them.

Mr. Sullivan has selected the material for his purpose well, and has marshalled it with skill. Though the book is short in comparison with the vastness of its subject matter, the treatment is by no means superficial, and though it cannot be called light reading, it holds the attention and the imagination from beginning to end. It is not likely that the more advanced physicist will find himself in agreement with all that the author puts forward. There is apt to be more disagreement on the bases and aims of science than on its methods and results. Some of the disagreement will be more verbal than real. Mr. Sullivan, for example, uses the term 'mathematical' in a much broader sense than that to which we are accustomed, so broad, indeed, that it allows him to describe Faraday as "a mathematical genius." It is presumably in this wider sense that we must understand the word when he insists, as his main contention, that the aim of science is a mathematical description of the real world. It is, however, immaterial whether we agree with the author or not. He has written a book which will widen the outlook and deepen the interest of the new generation of science students, and one which they should certainly be advised to read.

It is only fair, in conclusion, to record that the author describes his book as "an attempt to expound the main ideas of physical science in non-technical language," and that it is intended for "intelligent readers who have had no scientific training." It is difficult to judge how closely such a reader will be able to follow Mr. Sullivan's argument. The language does not appear to be particularly different from that which a physicist would use in addressing fellow physicists, if he were fortunate enough to command Mr. Sullivan's mastery of style. Explanations are, however, given of the more unusual terms, and the non-scientific reader who is interested in scientific thought might be very well advised to attempt this book. He may not find it easy, but it is unlikely that he will be able to acquire any real understanding of the matter on easier terms. J. A. C.

Our Bookshelf.

Organic Chemistry: a Brief Introductory Course. By Prof. James Bryant Conant. Pp. x+291. (New York: The Macmillan Co., 1928.) 10*s.* 6*d.*

IN his preface the author states that he wishes to find a stimulating approach to organic chemistry, and so has deliberately departed from the usual arrangement found in most organic text-books of dealing first with methods of purification and analysis, and then with the paraffins, etc.; in fact, he has definitely omitted all practical details throughout the book, leaving these to be dealt with in a practical course. The alcohols are chosen as a starting-point, in view of their relationship to water, and from these there is a natural development of derived compounds.

The author has certainly succeeded in giving a really readable exposition of organic chemistry. The book is not a mere collection of facts and formulæ, but follows in a natural sequence from one compound to another, and though, as would be expected, it is by no means complete, it gives the main facts about the simpler compounds of each series.

Moreover, the author has brought his facts up-to-date. Thus the preparation of methyl alcohol from water-gas is fairly fully described, as is the use of butyl alcohol and its derivatives in the new nitro-cellulose lacquers, whilst the cracking of petroleums and the use of ethylene from natural gas for the preparation of ethylene glycol are mentioned. The only points noted to be incorrect are the statements that "gun-cotton is a completely nitrated cellulose" and that "smokeless powder is made by treating gun-cotton with alcohol and ether." Otherwise the author has been successful in the difficult task of writing an interesting and at the same time accurate introduction to organic chemistry. J. R. H. W.

Graphische Darstellung der Spektren von Atomen und Ionen mit ein, zwei und drei Valenzelektronen. Von Prof. Dr. W. Grotrian. (Struktur der Materie in Einzeldarstellungen, herausgegeben von M. Born und J. Franck, Band 7.) Teil 1. Pp. xiii+245. Teil 2. Pp. x+168. (Berlin: Julius Springer, 1928.) 34 gold marks.

THIS is a really admirable companion volume to tables of the simpler spectra such as A. Fowler's or Paschen and Götze's. It may be said to cover the same ground as Fowler's book, for it deals only with the simpler spectra which exhibit singlet, doublet, or triplet terms, and not spectra of higher multiplicities, but it deals of course with many more examples of such spectra taken from other atoms in higher stages of ionisation. It deals with them, too, in the light of the general systematisation of spectra which we now possess, which allows of a confident handling of the material at every stage.

The book deliberately sets out to exhibit graphically the structure of the spectra in all their details, so far as this is possible. The resulting 163 figures are published in a volume separate from the text, and for many purposes they will be found quite

admirable. It is obvious that a working spectroscopist will require tables of wave-lengths, wave numbers, and terms as well as the best diagrams, and it is much to be hoped that this book will stimulate new editions of the classical tables we have mentioned, extended to cover the same material as Prof. Grotrian's diagrams. The text gives an excellent description of the simpler atomic spectra, their nature, origin, and analysis, in complete detail. There is an especially admirable account of the finer details of the spectra of hydrogen and helium.

R. H. F.

The American Annual of Photography, 1929. Vol. 43. Edited by Frank R. Fraprie and E. J. Wall. Pp. 240 + Adv. 68. (Boston: American Photographic Publishing Co.; London: Sands, Hunter and Co., Ltd., 1928.) 7*s*. 6*d*.

THIS long-established annual is no longer just another of the same sort, although it includes a hundred or more pictorial illustrations and about twenty articles on various subjects by about as many different authors. The pictures include a great variety of types of subjects, some excellent portraits and views, and a few that we can only refer to as grotesque. Similarly, the articles range from the severely technical to the highly popular. One of the special features is "Who's Who in Pictorial Photography, 1927–8." This is a list of the contributors to fifty exhibitions practically all over the world, with the number of exhibitions that each has contributed to and his total number of prints hung. It includes similar lists for the two preceding years. As each person's address is given, this unique feature will doubtless be useful to many.

Among the articles that call for special notice is Mr. E. J. Wall's "Practical Digest of the Year's Work in Photography." His recent death reminds us that this is the last time that we shall have the advantage of Mr. Wall's wide knowledge and his ability to set forth the essence of the facts in an interesting and readable form. There is also from his pen an article on the very early history of the daguerreotype process, "prompted by the discovery of an early pamphlet while the library of American Photography was being catalogued." This appears to settle some matters as to priority, etc., that have been in dispute for many years.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1929. Edited by George E. Brown. Pp. 800 + 63 plates. (London: Henry Greenwood and Co., Ltd., 1929.) 2*s*. net.

THE general appearance and arrangement of this annual are well known. Though not equal in size to the pre-War volumes, it is getting on in that direction. The pictorial section, introduced a year or two ago, is growing, and the photogravure reproductions are of the usual high quality. In turning over the pages there are two matters that force themselves upon one's attention in connexion with the progress of photography: First, the large number of firms that make apparatus for general kinematography, cameras, projectors, and supplementary items, and the large range of prices charged for them, from £5 up to £250; secondly, that although plates and films are more sensitive than ever before, lenses are being made with larger and still larger apertures, even up to *f*/1·5. The trend, therefore, continues to be in the direction of shorter exposures, and the results that were surprising a few years ago have become commonplace.

The contribution of the editor is on photography in connexion with crime and the criminal, and is illustrated with several interesting examples, many of which are of foreign origin. The technical and historical details are arranged in the same way as heretofore, and include a list of tables in past "Almanacs" that are not included in the present volume, with the dates when they last appeared.

Soviet Union Year-Book, 1928. Compiled and edited by A. A. Santalov and Dr. Louis Segal. Pp. xxxi + 587. (London: George Allen and Unwin, Ltd., 1928.) 7*s*. 6*d*. net.

THIS year-book, now in its fourth year of publication, is much enlarged, though planned on the same lines as previously. It opens with the constitution and foreign relations, and gives in full various decrees of the Soviet government. The greater part of the book is devoted to the agriculture, mineral resources, foreign trade, and finance of the Union. The section on foreign trade has been much expanded and now gives full details of imports from and exports to various countries. These figures should prove useful, since they are not easily obtainable elsewhere. Under the heading of education it is noted that the Soviet Union claims to have 6122 technical schools, 124 universities, and 109 workers' faculties. There is also a long list of scientific institutes, the function of which is to assist in the industrial development of the country. Two maps show mineral resources, and two others show the political divisions of the Union. The list of books is almost entirely confined to publications in Russian.

Some Fundamental Problems of Cellular Physiology. By W. J. V. Osterhout. (The Third William Thompson Sedgwick Memorial Lecture. Published under the Auspices of the Yale School of Medicine on the Foundation established in Memory of Dr. William Chauncey Williams, of the Class of 1822, Yale Medical School, and of Dr. William Cook Williams, of the Class of 1850, Yale Medical School.) Pp. vi + 55. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1927.) 4*s*. 6*d*. net.

IN this Sedgwick memorial lecture the author deals with the mechanism of certain fundamental activities of the cell, especially those depending upon the existence of semi-permeable surfaces in the living state.

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.*]

Knock Ratings of Pure Hydrocarbons.

IT is well known that different hydrocarbons, when used as fuels for internal combustion engines, possess different tendencies to detonate or knock, and one of the factors which decides the amount of knocking occurring is the chemical composition of the hydrocarbon used. In the course of a research on the chemical analyses of gasolines and hydrocarbon mixtures generally, we have prepared pure samples of various hydrocarbons in fairly large quantities, being of the opinion that trustworthy methods of analysis can only be evolved by this method. These hydrocarbons have recently been examined, through the kindness of the Anglo-American Oil Company, in an internal combustion engine, with the view of determining their knock ratings, this being done in an attempt to correlate chemical properties with engine performances.

At the present time it is the commonly accepted idea that, of the four typical hydrocarbon groups, the aromatics possess the best anti-knock values and paraffins the worst, olefines and naphthenes possessing intermediate figures of merit. Some time ago Egloff and Morrell (*J.I.E.C.*, **18**, 354; 1926), using data obtained by Ricardo (Empire Motor Fuels Committee Report, 1924), described a method for the chemical analysis of gasolines which they claim is capable of indicating comparative anti-knock values. In this they assume, so far as anti-knock properties are concerned, that 5 per cent of unsaturateds or 4 per cent of naphthenes is equivalent to 1 per cent of toluene; the paraffins being considered as knock inducers.

Egloff and Morrell have themselves pointed out the discrepancies of such a generalisation, and only advise this analytical method for the determination of knock ratings in the case of those fuels which have been shown by analysis and motor tests to give check results (*Oil and Gas Journal*, Jan. 27, 1927). More recently, Edgar (*J.I.E.C.*, **19**, 145; 1927) has demonstrated that all paraffins must not be classed as knock inducers, for 2.4.4 trimethyl pentane, first described by him, has anti-knock properties equivalent to benzol (see also Boyd, *Oil and Gas Journal*, Jan. 27, 1927).

Egloff and Morrell perforce based their method upon the only data at that time available, and seeing that Ricardo found it impracticable to use chemically pure hydrocarbons, it is imperative that the factors chosen for converting the different series into aromatic equivalents should afterwards be criticised. Stevens and Marley (*J.I.E.C.*, **19**, 228; 1927), working on the same subject, used pure samples of heptane, methyl cyclohexane, hexylene, and toluene as representatives of the four typical hydrocarbon groups, and showed that under their experimental conditions, 1 per cent of toluene was equivalent to 2 per cent of either hexylene or methyl cyclohexane in its ability to suppress detonation. It will be seen that these figures are not in agreement with those of Egloff and Morrell and Ricardo.

Apparently, the failure of chemical analyses to give correlation with engine performances is due to the fact that the various members of one certain general hydrocarbon class, for example, olefines or aromatics, do not possess the same knock ratings. For example, toluene is slightly better than benzene, whereas pseudo-cumene has pro-knock tendencies (*Aeronautical Res. Comm. Rep.*, No. 1013, 1925); normal heptane is a very bad detonator, while Edgar's octane is a valuable anti-knock.

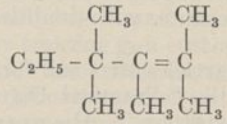
While studying the unsaturateds present in motor fuels, we have observed that the various members of this general class differ widely in their reactivities towards oxidising agents, and this gave us the idea that these hydrocarbons would possess widely different anti-knock values; this has been shown to be the case. These unsaturated hydrocarbons were each separately dissolved in a highly paraffinoid spirit (sp.g. 0·7334 at 15° C., 72·7 per cent paraffins) which possessed exceptional tendency to knock. The resulting blends were then matched with tetra-ethyl lead dissolved in the same spirit. The engine used was fitted with the Boyd and Midgley bouncing pin apparatus for the determination of knocking, and was run at a constant speed of 500 rev. per minute throughout the tests. A 20 per cent concentration of unsaturated hydrocarbon was maintained in each of the synthetic mixtures made.

The following results were obtained:

20 per cent	Cyclohexane	= 1·0	c.c.	ethyl fluid	per
20 ,,	Benzene	= 2·1	c.c.	gallon.	
20 ,,	Cyclohexene	= 2·4	c.c.	,,	,,
20 ,,	Toluene	= 2·75	c.c.	,,	,,
20 ,,	Pentene-2	= 3·5	c.c.	,,	,,
20 ,,	Trimethyl ethylene	= 4·5	c.c.	,,	,,
20 ,,	Diamylene	= 6·0	c.c.	,,	,,
20 ,,	Diisobutylene	= 6·6	c.c.	,,	,,

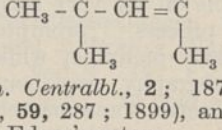
Owing to the difficulty of obtaining a sufficient amount of these hydrocarbons, it was not found possible to use synthetic mixtures containing a greater concentration than 20 per cent of the above substances.

The diamylene was prepared by the polymerisation of trimethyl ethylene and has the probable structure:



(Joubert and Norris, *J.A.C.S.*, **49**, 873; 1927). As used, it had a boiling range of 150°-156° C.

The diisobutylene has the structure:



(Butleroff, *Chem. Centralbl.*, **2**; 1877; Kondakow, *J. Prakt. Chem.*, **59**, 287; 1899), and is the olefine corresponding to Edgar's octane.

The above results show that cyclohexene has anti-knock properties equivalent to benzene, while the others are far more effective than benzene, especially diamylene and diisobutylene, which at a concentration of 20 per cent are found to be equivalent to 37·5 per cent and 40 per cent benzol respectively. Tested on the same scale, 20 per cent of toluene was found to be equivalent to 22·5 per cent of benzol. Thus it will be seen that aromatic hydrocarbons have lower knock ratings than the above unsaturateds.

Diisobutylene and diamylene offer certain advantages as anti-knock dopes over benzol. Benzol has a freezing-point too high (- 14° C.) for aviation purposes when used in an undiluted state, and a 50/50 petrol-benzol mixture freezes at about - 20° C.; consequently, 60 per cent of benzol is about the greatest concentration permissible. This limits the Highest Useful Compression Ratio (H.U.C.R.) of an

aero-engine to below 7 : 1 ; hence there is a distinct loss of possible efficiency. Diisobutylene or diamylene, having better anti-knock properties than benzol, could permit of a higher H.U.C.R., and, moreover, blends of these hydrocarbons would not be liable to freeze at high altitudes, both substances being liquid at − 45° C. in an undiluted state. Diisobutylene may be conveniently prepared by the polymerisation of the isobutylene content of ' cracked ' gases by means of sulphuric acid, while diamylene may be obtained by the similar treatment of either trimethyl ethylene or tertiary amyl alcohol.

Since this work was completed it has been found that E.P. 253,131 covers the use of these two olefines, among others, as anti-knock dopes, and describes them as being better than benzol for this purpose, but no comparative figures are quoted.

It is interesting to note that of the olefines we have tested, those which are the more stable towards bromine, sulphuric acid, potassium permanganate, and potassium bichromate, are the more effective in suppressing knocking.

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A Permeability Test with Radioactive Indicators.

CERTAIN investigators (see, for example, W. J. V. Osterhout, " Some Fundamental Problems in Cellular Physiology," 1927 ; especially pages 36-48) believe that the protoplasm of the living cell is permeable only to undissociated molecules but impermeable to ions.

It seemed possible to me to test this theory with the method of radioactive indicators [1] (Hevesy-Paneth). The advantage of this method is that only very small amounts of the ions which enter the cell are necessary and that a very small concentration can be detected. Radioactive lead (thorium-B) was used as an indicator for lead ions, and therefore lead nitrate was dissolved in sea water so as to make it 10^{-5}–10^{-6} M in respect to lead ions. Cells of *Valonia macrophysa* were used since the large volume and the amount of sap available make the investigation easier, and since investigations of the permeability of this cell were carried out by Osterhout and his collaborators.

To test whether or not the presence of lead causes any injury to the cell, the cells were placed in sea water with different amounts of lead nitrate added, and for several months the behaviour of the cells observed. The cells did not change in colour or rigidity, and were, according to Dr. L. R. Blinks, who kept them in the same laboratory with other cells, in a normal state, judged from macroscopic appearance.

For the permeability experiments, the cells were placed in sea water containing a known amount of lead nitrate and thorium-B. After 20 or 30 hours the cells were taken out, washed off with inactive sea water, and dried on blotting paper. The sap was removed, a certain amount (0·2–0·3 c.c.) evaporated in a watch glass, and the radioactivity measured in an α-ray electroscope. The activity of the same amount of the original solution and of the sea water in which the cells were kept was measured. In this way we ascertained how much lead is absorbed by the cell wall and how much enters the vacuole. In all experiments (14 cells) it was found that about 50 per cent of the lead ions present in the original solutions are absorbed by the cell wall, but that practically no lead enters the vacuole.[2] The same experiments were carried out with cells which had been kept in sea water plus lead nitrate for four months. Also in this case no lead could be found in the vacuole.

One may conclude that all the lead which disappears from the sea water is adsorbed by the cell wall or the protoplasm forming an insoluble compound which cannot enter the vacuole. In this case one would expect that in dead cells also the lead would be fixed at the cell walls and therefore cannot be found in the sap. Experiments with three dead cells have shown that lead does enter a dead cell. It is apparently fixed there to small particles of organic matter which are to be found always in dead cells. Therefore it cannot diffuse back into the surrounding sea water and *an apparent concentration* of lead in the dead cells takes place.

It was interesting to see whether radium emanation, being a rare gas, would enter the cells, as one would expect from the theory. Small capillaries (16 mm. long), filled with radium emanation (about 0·01 m.c.), were broken under the sea water containing the cells to be tested. It was found that already after one hour the sap is approximately as active as the surrounding sea water (15 cells were investigated).

After every experiment, Dr. L. R. Blinks examined the macroscopic appearance of the cells and tested the sap for sulphate ions. (The presence of sulphate ions would indicate a severe injury.) Part of the sap in our lead experiments and the sap of every single cell in the experiments with radium emanation was tested in this way. Injury was found in one cell out of a total of three, exposed for 20 hours in radium emanation, and traces of sulphate ions in two cases out of twelve, after 1 to 2 hours exposure in radium emanation. One cell that had been in lead nitrate for four months was soft, but did not give any sulphate reaction and did not show any sign of injury in our test.

Summary.—Using radioactive indicators for testing the permeability of single cells of *Valonia macrophysa*, it was found that lead ions do not enter the sap of the living cell even if the cells are kept for several months in lead nitrate solution. Lead ions enter readily the sap of dead cells. Radium emanation, being a rare gas, is already after one hour distributed evenly between the cell sap of living cells and the surrounding sea water.

This investigation was carried out in the spring of 1927 during our stay at the Rockefeller Institute for Medical Research, New York City, and we are indebted to the International Education Board who made our stay at the Rockefeller Institute possible.

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Molecular Constants of Hydrogen.

ONE of us recently published a table of constants for the neutral hydrogen molecule (*Proc. Nat. Acad. Sci.*, **14**, 12; 1928). The most uncertain quantity in that table was the value of the moment of inertia for the ' B ' level. The value given ($1{\cdot}99 \times 10^{-40}$) is based on Hori's very doubtful interpretation of Witmer's band progression B_3-A_n. We have now photographed the entire B-A system in the second order of a ten-foot vacuum spectrograph, designed by Prof. J. J. Hopfield

[1] That is, to determine the amount of ions present, of a certain kind, by the determination of the radioactive isotope mixed with them. Since a chemical separation of isotopes is impossible, the change in activity of the radioactive isotopes is the indicator for changes in the concentration of the inactive ion.

[2] A trace of activity which was found twice immediately after drying is due to traces of thorium-C. This may have entered the cell in ionic form, but since thorium-C is present only in an extremely small concentration, this is not contradictory to any other experiment on permeability. Such a small amount may possibly also enter in other cases, but could not be detected. On the other hand, thorium-C shows in neutral solutions a quasi-colloidal behaviour and may have entered the cell in form of an undissociated complex.

and constructed in the shop of this laboratory. The new plates show clearly that the bands of the B-A system, originally analysed by Dieke and Hopfield, consist of R and P branches only, in contrast to Hori's assumption of an R branch plus coincident P and Q branches. On this new interpretation a complete verification of the combination principle has been obtained. The lines show clearly the alternating intensity to be expected for a symmetrical molecule.

While this work was in progress there appeared an article by Kemble and Guillemin (*Proc. Nat. Acad. Sci.*, **14**, 782 ; 1928), in which they conclude, on theoretical grounds, that the B-A bands must consist of R and P branches only. Using the published data of Dieke and Hopfield (*Phys. Rev.*, **30**, 400 ; 1927) and of Witmer (*Phys. Rev.*, **28**, 1223 ; 1926), they then calculated, on this interpretation, a moment of inertia for the B level of $1{\cdot}51 \times 10^{-40}$. Because of the incompleteness and relative inaccuracy of the data, no great accuracy is to be expected for this value.

Our own data are far more complete and accurate, the lines having been measured directly against first order iron standards. The spacing of the rotational levels (values of ΔF) for the band progression B_0-A_n fulfils accurately the expected relations between the vibrational and rotational energy constants. Hence it is possible to obtain a very trustworthy value of the moment of inertia. Using the best analytic method now known, we obtain on the basis of the old quantum mechanics, for the zero vibrational level of the B state, $B_0 = 19{\cdot}46 \pm 0{\cdot}04$, giving with the usual constants, $I_0 = (1{\cdot}423 \pm 0{\cdot}003) \times 10^{-40}$ gm.cm.^{2}. The rotational energy is given by $B_0hm^2 + D_0hm^4 + \ldots$, with m a half-integer to within about 0·005. In obtaining the calculated value of $D_0 (= -4B_0^3/\omega_0^2)$ we used $\omega_0 = 1330$ cm.$^{-1}$, derived by us from the recent accurate data of Richardson and Davidson (NATURE, **121**, 1018 ; 1928), in place of the value 1325 given in the table previously mentioned. Analysis of the higher vibrational levels of the B state is in progress.

H. H. HYMAN.
R. T. BIRGE.

University of California,
Jan. 1.

Homing of an Owl.

THE following authentic case of the homing of an owl is of general interest in connexion with the fascinating, but often very baffling, problem of how animals find their way about.

A pair of Cape barn owls (*Strix flammea maculata* Brehm.) had taken up their abode in the roof of the verandah of the homestead of Mr. F. C. Pope-Ellis in Natal (Ashburton, altitude 2302 ft.), and one of the fledglings was reared by hand. One of the wings was afterwards partially clipped, and this prevented any great power of flight. The bird was free, but was quite tame ; it was fed regularly by hand and never appeared to go far from the homestead. With the clipped wing the bird was unable to fly more than about fifty yards without alighting, and it was never seen to fly to any appreciable height in the air. It retired at will to a sheltering box provided for it.

At the age of seven months the owl was taken (Dec. 3, 1928, at 9 A.M.) in a closed box by motor-car to another farmstead (Cotswold, altitude 4807 ft.) which is distant about sixty miles from the first-mentioned farm. In its new quarters the bird remained for four days and then disappeared. Eight days later, at 6 A.M., it was found in its shelter at its original home and in a perfectly placid condition.

Thus in eight days the young bird, with weak powers of flight owing to its cut wing, travelled sixty miles over hilly and much broken country, including both bush and veld. How did the bird find its way back ?

We cannot invoke racial memory as in the case of a fixed annual migration to a distant land. Apparently the only other alternatives are : (1) that in its original home the bird had acquired a general knowledge of the major distant features of the landscape and was led back by such clues, or (2) that it was conducted back by certain orientating influences, the nature of which we can only dimly surmise.

The tendency at the present time is to deny the existence of these obscure directing influences in the homing of animals ; and in the case of pigeons, bees, etc., it seems to be experimentally proved that the ability to return depends mainly on the recognition of clues in the surroundings which show the way home.

The existence of recondite influences which are capable of directing movement is, however, evidenced by the assembling of male moths around the female, and it is extremely probable that the meeting of the sexes in many animals is largely affected by analogous influences.

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Anomalous Magnetic Rotation of Excited Neon.

IN a paper on the anomalous magnetic rotation in excited neon (*Phys. Rev.*, **32**, 681 ; 1928), I published values of the dispersion constants determined from the anomalous rotation which were erroneous. Due to the omission of the factor $\pi/180$ from the numerical part of equ. (4) of that paper, the values of the dispersion constants given are much larger than they should be. If this factor is included, the values so found are considerably smaller than those of Kopferman and Ladenburg, instead of much larger. This result is also more in accordance with what one might expect from their work on the effect of the different conditions of excitation on the anomalous dispersion. The pressure in the tube and the exciting current used by me were both such as to give results considerably below the maximum, whereas the values of Kopferman and Ladenburg are saturation values.

The corrected values for each wave-length are given below in the second column, in comparison with those of Kopferman and Ladenburg in the third column.

6266	$0{\cdot}55 \times 10^{11}$	$2{\cdot}15 \times 10^{11}$
6532	0·34	1·36
6163	0·31	1·32
6506	$0{\cdot}75 \times 10^{11}$	$3{\cdot}38 \times 10^{11}$
6382	0·60	2·45
6096	0·44	2·15
6074	0·29	1·40
6304	0·22	0·9
6029	0·24	~0·6
6402	$3{\cdot}06 \times 10^{11}$	$7{\cdot}25 \times 10^{11}$
6143	1·14	2·16
6334	0·97	3·26
5944	0·58	1·59
6217	0·34	0·9
5881	0·35	1·0
5975	0·28	~0·5

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The Raman Effect with Hydrochloric Acid Gas: the 'Missing Line.'

I HAVE obtained lines of modified wave-length by the excitation of hydrochloric acid gas at atmospheric pressure, by the light of a glass Cooper-Hewitt lamp about five feet in length, placed parallel to and in contact with the tube containing the HCl, the whole being completely surrounded by a cylindrical reflector of very highly polished aluminium, which was in contact with the two glass tubes. Under these conditions the temperature of the gas was about 100° C., as indicated by a thermometer introduced into the metal cylinder.

With an exposure of only twenty-four hours, and a Hilger constant deviation spectroscope, I obtained a very sharp and distinct line nearly midway between the mercury lines 4358 and 4915. It was almost in coincidence with the argon line 4579 (used as a comparison spectrum). Considering this line as excited by the mercury line 4046, the frequency difference between the exciting line and the modified line ($\lambda = 4581$) corresponds to the frequency in the infra-red which would represent a line at 3·47 μ, almost exactly the centre of the vibration rotation band. The line thus appears to be the so-called 'missing line,' corresponding to a vibration transition unaccompanied by change of rotation, which does not appear in the absorption spectrum of the gas.

The first photograph which I obtained showed a double line, namely, the 'missing line' and the first vibration-rotation line next to it. In this case the tubes were not completely surrounded by reflectors and the temperature was lower; the tube may also have contained some air and a trace of moisture. This point is under investigation. In my last photograph, I find also six lines immediately on the long wave-length side of 4358, but have not yet determined whether they represent a part of the infra-red band or are due to interference produced by the thin glass of the bulb. As they appear on one side only of 4358, I feel sure that they are real. R. W. WOOD.

Magnetic Properties in Relation to Chemical Constitution.

IN the recent letter by Prof. Lowry and Mr. Gilbert (NATURE, Jan. 19, p. 85) some interesting points are dealt with concerning the evidence afforded by magnetic data as to the chemical constitution of various compounds. The authors note that the fact that cupric sulphide, CuS, is diamagnetic suggests that this compound must be a cuprous compound with a double molecule rather than a cupric salt as previously supposed. They also mention that X-ray analysis has shown that iron pyrites must be a ferrous disulphide, $Fe^{++}\bar{S}\text{-}\bar{S}$.

Magnetic measurements can furnish further information as to the chemical constitution of the latter compound. The magnetic properties of the cubic crystals of the type represented by iron pyrites, FeS_2, cobaltite, CoAsS, etc., were recently investigated. The case of iron pyrites may be taken as typical. It was found that after allowing for the diamagnetic properties of the sulphur atoms, the iron atom possessed a small residual positive magnetic moment, and the susceptibility was independent of the temperature. These properties are in agreement with what would be expected for a twofold co-ordination compound of *ferrous* iron, but are quite different from those of simple ferrous salts. The Fe^{++} ion in iron pyrites must therefore have a constitution corresponding to that of the iron atom in, say, potassium ferrocyanide, and not to that of the iron atom in, say, ferrous sulphate.

We must therefore classify these minerals, of which iron pyrites is typical, as co-ordination compounds. Incidentally, their properties are in agreement with Cabrera's scheme for the relation between constitution and magnetic properties in co-ordination compounds, but the above conclusions are independent of the view taken as to the arrangement of the electrons in such compounds. L. C. JACKSON.

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Energies of Dissociation of Cadmium and Zinc Molecules.

THE 2288 ($1^1S - 2^1P$) absorption line of cadmium broadens symmetrically with pressure until it reaches a sharp limit at the 2212 cadmium absorption band, but reaches no definite limit on the long wave-length side. In the electrodeless discharge in cadmium vapour, the 2288 line is surrounded by a continuous spectrum corresponding to the broad band found in absorption, but the limiting band at 2212 does not appear.

These facts can be correlated with a pair of potential energy curves for the cadmium molecule, and from these curves the energy of dissociation of Cd_2 can be found.

The limiting band at 2212 is correlated with the transition of an electron from the non-vibrating 'grund' state of Cd_2 to the 2^1P level of the cadmium atom; that is, to the limit of the vibrational levels of the excited molecule. The transition from the limit of the vibrational levels of the normal state to the limit of the vibrational levels of the excited molecule is an atomic transition which in the present case is $1^1S - 2^1P$ ($\lambda 2288$). Therefore the difference in energy between the limiting band at 2212 and the atomic line at 2288 gives the energy of dissociation of the normal Cd_2 molecule. This equals 0·200 volt for Cd_2 and 0·246 volt for Zn_2.

The full report of this work, which was done in Palmer Laboratory, Princeton University, will appear in the *Philosophical Magazine*.

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Piles of Pebbles on Beaches.

IN a letter published in NATURE of Dec. 1, a correspondent directs attention to the occurrence of regularly spaced groups of pebbles along a beach in the New Hebrides, separated by patches of sand devoid of pebbles. I may say that a similar occurrence is frequently to be observed on the beach in Bournemouth Bay to the west of Alum Chine, where the piles of stones collect at distances of from 15 to 25 yards between centres, to a height of one or two feet, and appear to contain all sizes indiscriminately between ¼ in. and 4 in. The regularity of the spacing along the water's edge can be well observed from the cliffs above.

The action of the tides and wind in this part is such as to cause frequent changes in the nature of the beach, both in position of normal high-water mark and in the *slope* of the beach, and the occurrence of the regular spacings is therefore apparently haphazard.

It might be suggested that when the slope of the beach bears a certain relation to the mean distance between waves, to the angle of incidence, and to the mean quantity of water in each wave, then the time of return of each exhausted wave may be in agreement with, or bear some integral relation to, the time interval between waves. It would then seem possible for a regular condition to arise which might cause the observed facts. R. M. CLARK.

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Einstein's Field-Theory.[1]

By Prof. A. S. EDDINGTON, F.R.S.

THE new 'Unified Field-Theory' of Einstein is contained in two papers amounting altogether to eleven pages in the Berlin *Sitzungsberichte*, **17**, 1928, and **1**, 1929. There is an intermediate paper which does not concern us, since it follows a line of development now abandoned. For the present, at any rate, a non-mathematical explanation is out of the question, and in any case would miss the main purpose of the theory, which is to weld a number of laws into a mathematical expression of formal simplicity. We are chiefly interested in how it compares, both as to methods and results, with the existing field-theories which have had some measure of success.

Each attempt to unify gravitation and electromagnetism has been associated with what may be called an 'illustrative' geometry or world-geometry. A qualifying adjective is necessary, because I think it is now common ground that the actual geometry (obeyed by measured lengths, angles, etc.) is Riemannian. Einstein's world-geometry may be briefly described as a geometry in which there are *parallels* but not *parallelograms*. Thus he admits the existence, even at great distances, of a line CD equal and parallel to AB; but the line through B parallel to AC fails to cut CD. (We are dealing with at least three dimensions, so that lines are not necessarily coplanar.) The geometrical idea of an abortive parallelogram, which fails to close up at its fourth corner, does not carry us very far, and it is necessary to proceed analytically. The following is a modified and shortened version which, I think, is equivalent to the original analysis.

We take a general system of co-ordinates x_μ with a Riemannian metric given by $g_{\mu\nu}$, and also in each small region a local system of co-ordinates x'_a which are orthogonal and have a Euclidean metric so that $g'_{ab}=\delta_{ab}$. These systems are connected by vector transformation formulæ

$$dx_\mu = h_a{}^\mu dx'_a \qquad dx'_a = h_\mu{}^a dx_\mu. \qquad (1a, b)$$

The coefficients h are functions of the co-ordinates, and the symbol denotes a different (but related) set of functions according as the Greek or Latin suffix is uppermost. It is not supposed that (1b) is integrable, that is to say, the co-ordinates x'_a are not determinate, but only their differentials dx'_a. By the law of tensor transformation

$$g^{\mu\nu} = h_a{}^\mu h_b{}^\nu g'^{ab} = h_a{}^\mu h_b{}^\nu \delta^{ab} = h_a{}^\mu h_a{}^\nu. \qquad (2)$$

Also, if we displace a vector A'^a so that its components in local co-ordinates are constant, that is, if $\partial A'^a/\partial x_\sigma = 0$, we have

$$\frac{\partial A^\mu}{\partial x_\sigma} = \frac{\partial}{\partial x_\sigma}(h_a{}^\mu A'^a) = A'^a \frac{\partial h_a{}^\mu}{\partial x_\sigma} = A^\epsilon h_\epsilon{}^a \frac{\partial h_a{}^\mu}{\partial x_\sigma}$$

by using the transformation law of contravariant vectors (1). This result is written

$$\frac{\partial A^\mu}{\partial x_\sigma} + \Gamma^\mu_{\epsilon\sigma} A^\epsilon = 0, \qquad (3)$$

with

$$\Gamma^\mu_{\epsilon\sigma} = -h_\epsilon{}^a (\partial h_a{}^\mu / \partial x_\sigma). \qquad (4)$$

As already stated, Einstein's geometry admits that up to any distance there can exist equal and parallel vectors, or (to use a less arbitrary description) vectors in one-to-one correspondence. The purpose of the local co-ordinates is to indicate this correspondence directly, the components A'^a of two such vectors having equal values. Equation (3) then indicates how to move a vector about in space without varying A'^a, and therefore remaining equal and parallel to itself. Einstein's geometry postulates that the parallelism is unique and independent of the route of transfer; accordingly (3) must be integrable.

The general idea is that the nature of the field can be completely described by specifying the values of the 16 quantities $h_a{}^\mu$ at every point. Such a description is more comprehensive than if the 10 quantities $g^{\mu\nu}$ required to define the gravitational field are specified, so that it is able to embrace the electromagnetic field in addition. The gravitational field is determined immediately from the h's by (2); they also furnish the quantities Γ by (4). Einstein sets $\Lambda^\mu_{\epsilon\sigma} = \Gamma^\mu_{\epsilon\sigma} - \Gamma^\mu_{\sigma\epsilon}$, and identifies the electromagnetic potentials with the four quantities $\Lambda^\sigma_{\epsilon\sigma}$.

We are now in a position to see the manner in which the present theory deviates from existing unified field-theories. I make the comparison with the affine field-theory which I gave in 1921;[2] it was used by Einstein in 1923 as the basis of one of his former researches on this problem. The affine theory also rests on equation (3), but does not limit Γ to the special form (4); on the other hand, it makes the limitation $\Gamma^\mu_{\epsilon\sigma} = \Gamma^\mu_{\sigma\epsilon}$, which is by no means implied by (4).

The complete contrast of the two theories which have equation (3) in common is rather remarkable:

(1) In Einstein's theory equation (3) is integrable; in the affine theory it is essential that it should be non-integrable.

(2) In the affine theory $\Gamma^\mu_{\epsilon\sigma} = \Gamma^\mu_{\sigma\epsilon}$; in Einstein's theory it is essential that they should be unequal.

(3) The curvature tensor $(*B^\epsilon_{\mu\nu\sigma})$ which provides all the gravitational and electrical field-variables on the affine theory, vanishes identically in Einstein's geometry; the expression $\Lambda^\mu_{\epsilon\sigma}$ which provides all the gravitational and electrical field-variables on Einstein's theory, vanishes identically in affine geometry.

It has of course been realised that an extension of affine geometry with non-vanishing $\Lambda^\mu_{\epsilon\sigma}$ is possible. This has been developed mathematically by Schouten and others, but no particular physical application has resulted. The fact is that such an

[1] "Zur einheitlichen Feldtheorie." Von A. Einstein. (Sonderabdruck aus den *Sitzungsberichten der Preussischen Akademie der Wissenschaften*, Phys.-Math. Klasse, 1929, 1.) Pp. 8. (Berlin: Walter de Gruyter und Co., 1929.) 1 gold mark.

[2] *Proc. Roy. Soc.*, **99**, p. 104. I have followed this theory in "The Nature of the Physical World," chap. vii. and xi.

extension provides far more mathematical variables than the physicist can utilise. Einstein's development is more promising, since he boldly accompanies this extension with a restriction ; and room is made for the new variables by sweeping away old ones. Moreover, he renders his restriction plausible by putting it in the form of a geometrical postulate of distant-parallelism.

It will thus be seen that Einstein makes a striking new departure ; the rest of the development may be briefly summarised. The condition for integrability of (3), namely, the vanishing of the curvature tensor, leads to two important identities satisfied by the $\Lambda^{\mu}_{\epsilon\sigma}$. This rather raises an expectation in the reader's mind that the field laws are about to appear as identities ; but this is not fulfilled. A field law of simple form is duly announced, looking indeed so much like one of the identities that it requires a careful inspection of the suffixes to see the distinction. Here I would venture on a criticism. Can any theory which requires field laws other than identities give real satisfaction ? To introduce a field law limiting the geometrical possibilities is a confession that the initial geometry was too wide. The ideal should surely be either to start with a geometry which precisely fits the phenomena so that it needs no supplementary field laws, or to start with the most unrestricted geometry and treat every limitation as a field law.

The consequences of the field law are worked out only to a first approximation, and therefore some of the questions we should wish to put remain unanswered. "A fuller investigation will have to show whether a Riemann-metric in conjunction with distant-parallelism actually gives an adequate conception of the physical qualities of space. According to this research it is not improbable."

In any comparison of these theories it should be borne in mind that what is being given is a graphical representation bound by no particular rules. To say that Einstein's or Weyl's or Eddington's illustrative geometry is the only right one would be like saying that a graph of a moving particle with time and space as co-ordinates is right but a graph with velocity and curvature as co-ordinates is wrong. World-geometry is very like other graphs ; if wisely chosen it may exhibit or suggest relationships, provide useful nomenclature, and generally assist the mind in orderly thought. More hazardously it may be supposed to shadow the structure of the substratum of physical phenomena. I do not think Einstein has this last aspect in mind, or he would have stressed the vanishing of the curvature tensor (which might be visualised as a structural attribute of the æther) rather than the formal property of distant parallelism. I take it that he commends his graph to our notice as a means of exhibiting in its simplest form the mutual interdependence of gravitational and electrical quantities. For my own part I cannot readily give up the affine picture, where gravitational and electrical quantities supplement one another as belonging respectively to the symmetrical and antisymmetrical features of world measurement ; it is difficult to imagine a neater kind of dovetailing. Perhaps one who believes that Weyl's theory and its affine generalisation afford considerable enlightenment, may be excused for doubting whether the new theory offers sufficient inducement to make an exchange.

Human Speech.[1]

By Sir RICHARD PAGET, Bart.

HUMAN speech—which is practised by all races of mankind—is a rough combination of two separate arts, namely, phonation, due to the reed-like action of the vocal cords, and articulation, due to the various movements of the jaw, lips, tongue, soft palate, epiglottis, and false vocal cords. Phonation is the language of the emotions, while articulation is the language of the mind—phonation being, as Darwin realised, the older art.

The mechanism of the vocal cords may be very simply imitated by cutting a longitudinal slit about 3 cm. long in an indiarubber tube of, say, 1 cm. internal diameter. If the tube be stopped at about 5 cm. from the slit, and air be blown in at the other end, the air passing through the slit may be set in vibration so as to produce a musical note. The conditions for this effect are most easily obtained by adjusting the resonance of the air inside the tube adjoining the slit—by varying the position of a constriction or partial stop applied between the slit and the air supply. At any position at which 'phonation' occurs under normal conditions of the slit, a musical range of about six or seven semitones can be obtained by varying the tension of the slit portion of the tube, the note rising as the tube is stretched. As the resonating length is shortened (so as to raise the resonant pitch) the musical range is transposed to a higher key, the range of transposition in the present experiment being also about seven semitones.

It is suggested that the so-called 'registers' of the human voice are due to a similar set of conditions, and that the changes of resonance are produced by variation of the size and shape of the cavity into which the vocal cords 'deliver,' namely, that made by the false vocal cords and other movable parts of the pharynx. At each setting of this cavity a new range of notes is then obtained, depending on the tension and thickness of the vocal cords.

The lips of a trumpeter behave in a very similar way, but the resonance changes, if any, must then be made (as in the rubber-tube model) in the passage behind the reed instead of in the cavity into which it delivers, as in the case of the vocal cords.

The lungs, besides functioning as bellows, are a very efficient sound absorber, the branching air

[1] Substance of two lectures delivered at the Royal Institution on Dec. 6 and 13, 1928.

passages and air cells acting like a shelving beach towards waves of the sea, to convert the sound waves that pass down the windpipe into heat.

In whispered speech we have articulation without phonation. Whispered speech, therefore, lacks the emotional range of voiced speech. All the English speech sounds can be rendered in a whisper, and it appears that the real distinction between the so-called voiced and unvoiced consonants, such as *b* and *p*, *v* and *f*, *dh* and *th*, *z* and *s*, etc., is due to the action of the false vocal cords.

The action may be illustrated by a model in which the vocal cords are shaped in plasticene, as if in an open (whispering) position, and deliver their air jet into a rubber tube 2·5 cm. in diameter, which acts as the pharynx of a vowel-sounding tube. If, while air is supplied to the model, its mouth is alternately obstructed and released by hand, a whispered *p* is heard when the pharynx tube is uncompressed, but the sound is changed to a whispered *b* if the pharynx tube is compressed so as to form a constriction at 2 to 3 cm. in front of the fixed vocal cords. These conclusions have been confirmed by direct observations made in America by Prof. Oscar Russell, of Ohio University.

Another recently observed action of the pharynx is its production of the high-pitched resonances—of the order of 2500-3000~—which I have observed by ear in the case of certain of my own vowel sounds, and which have also been disclosed by instrumental methods at the Bell Telephone Laboratory in New York. That these resonances (in my own case) are pharyngeal, is shown by the fact that they can be lowered in pitch by five or six semitones by external (transverse) pressure on the throat immediately above 'Adam's apple.' They cannot be consciously varied without external aid. It is evident that the pharynx plays a very large part in the process of articulation in modern speech.

Originally, it is suggested, articulation was evolved as a specialised form of pantomimic body gesture, by which primitive man, like his animal relations, was accustomed to explain himself to his fellows. Darwin, in "The Expression of the Emotions," pointed out that there is, in man, a natural sympathy of movement between the human jaw and tongue and the human hand, so that children learning to write are seen to twist about their tongues as their fingers move 'in a ridiculous fashion.' As primitive man pantomimed with his hands and body generally, his tongue took part in the game without his being aware of the fact, and thus it developed a pantomimic technique of its own. When the pantomimist wished to direct attention to his actions, he made grunting or blowing noises, and the (unconscious) movements of his tongue then modified the air flow and the acoustic resonances of the vocal cavities through which the air passed. In this way the bodily pantomimic code became associated with an acoustic code, which developed into speech.

The various tongue gestures were necessarily simpler and fewer in number than the corresponding hand gestures, since (as would be found by experience) lateral movements of tongue, lips, and jaw do not appreciably alter the vocal resonances. The movements of articulation are therefore practically limited to two dimensions, whereas the hand and body gestures work in three. It follows that in human speech a particular gesture of articulation may represent several originally different body gestures—in other words, that speech was always more ambiguous than the pantomimic sign-language.

The original pantomime and speech of primitive man may be conceived as analogous to the bodily pantomime which is naturally developed by deaf-mutes, and by which a deaf-mute of one country can without difficulty make himself understood by one of another country, of whose written and spoken language he is wholly ignorant. Just as various communities of deaf-mutes naturally evolve new signs and conventions of their own—which other deaf-mutes cannot understand until they have especially learnt them—so the tribes of primitive men may be imagined to have evolved local words, idioms, and conventions from which the various language groups of the world were developed.

The theory that speech is due to mouth pantomime was, I believe, first enunciated by Dr. J. Rae, of Honolulu, in *The Polynesian* newspaper for 1862, but Socrates, according to Plato in the Cratylus, came very near the same idea; Dr. A. R. Wallace, writing in 1895 in *The Fortnightly Review* (No. 64), also put forward the theory that mouth pantomime constituted a "fundamental principle which has always been at work, both in the origin and in the successive modifications of human speech."

The evidence which has now been accumulated seems to justify a more serious consideration than has yet been given to the theory. Thus it appears, on experimental grounds, that in listening to speech our ears are not primarily interested in the sounds themselves, but rather in the evidence which the sounds afford as to the postures or gestures of the tongue and other organs of articulation. The facility with which the deaf may be taught to understand speech by 'lip-reading,' in spite of the very limited information which sight alone can afford as to the movements going on inside the mouth and throat, points in the same direction. Children, when inventing words of their own, very commonly employ a form of mouth pantomime—thus, of 18 such words mentioned by Prof. O. Jespersen at p. 152 of his book on "Language," 12 appear to be pantomimic: for example, ·fu·wɛ = soap—a gesture of blowing away soapsuds; dɛ·dɛtsh = horse—a galloping gesture made with the tongue.

Grown-up people occasionally do the same—as witness the invention of the word 'blimp' to denote the small podgy dirigible balloons which were developed during the War. The word is produced by a small-mouth gesture (producing the sound *bi*) followed by the 'podgy' gesture *mp*, with an intermediate upward flick of the tongue, *l* (as if to suggest an attachment to the middle of the 'bimp'), which completes the word—'blimp.'

Arguments of this kind seem at first sight fantastic, but it must be remembered that in the

evolution of speech we are dealing with a product of man's subconscious mind—" such stuff as dreams are made of "—and that it is no more strange that our speech symbolism should be fanciful than that our dreams should be so. For flights of fancy we come into life fully fledged—but we moult early or are plucked in the course of our education, and we come to despise the arts of imaginative flight at which our distant ancestors were such adepts.

There are other ways of testing the theory. We may invent ' synthetic ' words by making (consciously) a pantomimic gesture with our tongue, or tongue and lips, and convert it into speech by grunting as we make the gesture. Of 19 such words, 18 were identified by Dr. Neville Whymant as actually occurring with the same meaning, and in the same or a phonetically allied form, in Polynesian, early Japanese, Indo-Chinese, or related languages. Thus, the tongue symbolising " to dance up and down to and fro " produced the synthetic word *li-lɔ* (lee-law). Dr. Whymant cited the Indo-Chinese words ' li-lo ' and ' li-lŭ,' meaning to dance; Prof. Louis Gray, of Columbia, cites the Sanscrit word ' lila,' meaning game or enjoyment; to these I would add the English word ' lulla-by,' meaning to ' dance (a child) up and down, to and fro ' in order to put it to sleep.

It is evident that if the pantomimic theory is true, it should appear (more or less) in all languages; a preliminary study has therefore been made of several ' unrelated ' language groups, namely, Indo-European, archaic Chinese, Sumerian (as written at Ur of the Chaldees), Semitic, Polynesian and allied languages, and the Hoka languages of the west coast of North America. In all of these, pantomimic words are found to be common. Thus, of the first 100 ' Aryan roots ' listed in Skeat's " Etymological Dictionary," 77 were found to be pantomimic, 12 were probably pantomimic, and only 11 showed no evidence. In Karlgren's " Analytic Dictionary of Archaic Chinese," 85 per cent of the 73 word-groups listed in the first twenty pages showed pantomimic structure, while in a list of comparable Polynesian and allied words, and Hoka words, published by Paul Rivet (" Les Malayo-Polynésiens en Amérique "), 86 per cent of the word groups showed the same principle.

Many words are common to each of these groups; thus, in all of them the word for *one* is made by an erect tongue gesture—symbolic of the index finger held up. Thus, Indo-European has ' oin,' archaic Chinese has ' iet,' Sumerian has ' aś ' (compare with our word ' ace '), Semitic has ' ahad,' Polynesian has ' ta,' Hoka has ' ta,' ' tsâ,' ' chà,' and forms like ' pun ' and ' pola.' In all of these the characteristic gesture is an erection of the tongue. A similar analogy is found in the case of the numerals *two* (made by a protrusion of the two lips) and *three* (made by protruding the tongue between the two lips).

Figs. 1 and 2 show the approximate tongue positions which correspond with the various English vowels and consonants; from these it is possible to draw the approximate tongue track of any given word so as to compare the gesture with its verbal meaning. It then becomes apparent that the same gesture may be construed in several different ways. Thus the tongue track may represent a direction of motion, or the outline of a form—it may be

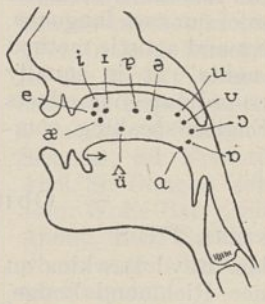

FIG. 1.

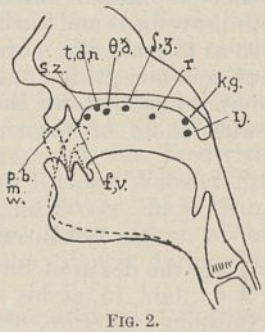

FIG. 2.

construed literally or figuratively—and, finally, it may be significant at the beginning, middle, or end of its course. For example, the archaic Chinese word ' kân,' of which the tongue track is shown in Fig. 3, means ' dawn ' (sun rising up) or the trunk of a tree (an up-swinging outline). Of figurative words may be instanced the Sumerian ' daria ' or ' duria,' meaning ' eternity,' in which the tongue track (see Fig. 3) forms a closed figure very similar to that of the hand gesture which deaf-mutes make to-day to express the same idea.

As to the significance of different parts of the tongue track, a good example is the word ' al '—formed by an upward thrust of the tongue—which may mean (1) ' up ' or ' high ' (Latin ' altus '), or (2) ' slack,' ' weak,' ' relaxed,' or (3) ' sweet,' that is, touching the palate as in tasting. In (1) the first part of the travel, in (2) the return journey, in (3) the mid-portion is significant.

It follows that ' homophones ' (words with two or more different meanings) are natural to human speech. It also follows from our theory that the many instances in which the same sound bears a similar meaning in (presumably) unrelated languages are not due to chance, but to a common method of production—if not actually to a common origin. It is not a matter of chance that in archaic Chinese ' ma ' meant mother (a sucking gesture) and that it also meant ' leach ' (one who sucks); or that ' kât ' meant ' cut,' ' suk ' meant ' suck,' ' pa ' meant ' father,' ' k'âp ' meant ' cup,' ' kap ' meant ' cap ' (of a seed or bud), and ' sieu ' meant ' sew ' (embroider); such coincidences are rather to be expected.

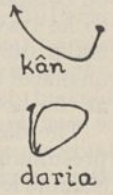

FIG. 3.

Surveying human speech, as a method of symbolising thought by gesture of the organs of articulation, we can scarcely escape the conclusion that it is still in a very barbaric and imperfect condition. It is full of ambiguities, anomalies, and homophones; it is cumbered (in most cases) by a quite unnecessary complexity of grammar and syntax; it mixes up voiced and unvoiced speech sounds with a corresponding loss in audibility, intelligibility, and musical and emotional quality.

The notation of language—especially in the case of English—is in worse case than the language itself, since in it our spelling now lags some centuries behind the spoken word. It is of prime importance for the advancement of human thought that we should now prepare for the systematic improvement and purification of our own language, so as to make it a more perfect and artistic method of symbolism for our thoughts. It is equally important that we should co-ordinate our efforts with those of the other English-speaking communities, so as to aim, in the future, at a standardised language and pronunciation with a rational spelling. The development of world broadcasting will make unification comparatively easy.

In the meantime we should ensure that our children are taught, in the first instance, to read and write phonetically, to articulate clearly, and to take an interest in the history and structure, the virtues and defects of our language, so that they may be prepared for the important task which lies before them.

Obituary.

SIR W. BOYD DAWKINS, F.R.S.

BY the death of Sir William Boyd Dawkins on Jan. 15, at his residence, Richmond Lodge, Bowdon, Cheshire, the sciences of geology and archæology have alike lost one of their most outstanding personalities. He was born on Dec. 6, 1837, at Buttington Vicarage, Welshpool, and was therefore just over ninety-two years of age at his decease. He was the only son of the late Rev. Richard Dawkins.

Boyd Dawkins was educated at Rossall and at Jesus College, Oxford: he won the (first) Baroness Burdett-Coutts Scholarship and graduated first class in natural science in 1860, and second class in Classical Mods., and was the first undergraduate to take geology in the honours school. Afterwards he became an honorary fellow of his College.

On leaving Oxford, Boyd Dawkins was given an appointment in 1861 as a field geologist on the staff of H.M. Geological Survey of Great Britain, and was allotted to the unit then surveying the south-eastern counties of England. In 1869 he resigned to take the post of curator to the Manchester Museum and lecturer in Owens College. He became professor of geology and palæontology in 1872 at the Victoria University, Manchester, and acted as a consultant on questions of mining and civil engineering involving geological problems. This post he held until 1908, but after his resignation he occasionally gave lectures on geology as an honorary professor.

Boyd Dawkins was not content to confine his researches to his own country, but was always keen on comparing the story of the rocks elsewhere, and so he travelled widely in North America and Australia during the long period, 1874–1890. It was on one of these visits that he gave his notable lecture at the Lowell Institute, Boston, on ancient man.

The discoveries by Boucher de Perthes of flints presumably worked by man in the valley of the Somme led to much controversy on both sides of the Channel, and was one of the contributory causes of the intensive search among the river gravels and cave deposits for reliquiæ of man. A distinguished band of observers, including Evans, Lyell, Lubbock, Prestwich, and Boyd Dawkins attacked this problem, and as a result raised the study of archæology from its former position as an amusement for the dilettante to that of scientific philosophy.

As a palæontologist Boyd Dawkins will always rank high, because he did not allow his conclusions to get beyond the region of legitimate inferences drawn from available evidences. As an archæologist he preferred the 'field-work' of exploration to theorising about results in the museum and library, and he therefore was always sympathetic with other workers who were labouring under the disadvantages of imperfections of the geological record, but was rather impatient in later years with some who held advanced views as to classification.

Boyd Dawkins' earliest work was his explorations of Wookey Hole, near Wells, in the Mendips, one of the great limestone caverns which was occupied by Pleistocene beasts. The fossil bones embedded in the cave breccias and cave-earths were a source of inspiration that led him to make a critical examination of that and of other caves in different parts of England, and the knowledge gained by the discoveries then made, and also those in the gravels and brick-earths of the river valleys was partly expressed in his classical monograph on the British Pleistocene Mammalia, published by the Palæontographical Society. In this piece of research he co-operated with the late W. A. Sandford. His "Cave Hunting," published in 1874, was dedicated to "The Baroness Burdett-Coutts as a slight acknowledgment from her first scholar." In this volume he described and discussed the notable discoveries of human relics not only in the caverns of England, but also in those of Aquitaine, Belgium, Switzerland, and other countries. His conclusions as to the antiquity and sequence of the different races of Stone Age man, expressed in this book, were more or less maintained to the last: namely, that the hunting and fishing race of cave-dwellers in the remote Pleistocene age in possession of France, Belgium, Germany, and Britain were probably of the same stock as the Eskimos, living and forming a part of a fauna in which northern and southern living and extinct species are strangely mingled with those now living in Europe.

Boyd Dawkins followed up his attack on the problem of prehistoric man by detailed examination of the fluviatile deposits of the European rivers, and to prepare himself for the inquiry he visited the more important museums in France and Italy and some of those in Germany and Switzerland, where he became a welcome visitor and friend of the curators. In the preface to his next work, "Early Man in Britain" (Macmillan, 1880), he acknowledges his debt to a number of geologists and archæologists who now rank among the fathers of the sciences, and include Sir Charles Lyell, Sir John Lubbock, Sir John

Evans, Dr. Thurnam, and Profs. Gaudry, Steenstrup, Capellini, Broca, Rütimeyer, and Virchow. In this book Boyd Dawkins draws the important conclusion that "it is unlikely that man lived in Europe in the Pliocene age" . . . but that "he appears just in the Pleistocene stage in the evolution of mammalian life in which he might be expected to appear." He divided palæolithic man into two great groups, river-drift man and cave man; a classification which is accepted in a broad way today, but the differentiation into the several stages that has resulted from the researches of later observers he was never inclined to accept; he was not, indeed, willing even to accept the classification of de Mortillet without reserve. "Early Man in Britain," however, is still in demand, and is an example of his extremely clear and logical presentation of facts, often of a highly technical nature, in such a way that the reader, while grasping the details, never loses sight of the main conclusions. It is eminently a readable book and impresses one as the work of a master-hand.

Boyd Dawkins was never content to study geology as pure science only, for he applied himself to its industrial and commercial applications, and acted in the capacity of 'expert adviser' on numerous questions involving geological knowledge. Like Prestwich, he devoted much time to the study of water supply to cities, and was consulted with regard to the schemes involved in those of London, Manchester, and Liverpool. His knowledge of the geology of the areas where engineering works were contemplated was employed in the schemes for the Manchester Ship Canal and the Humber Tunnel, and he was entrusted with the survey of the English and French coasts when the question of the Channel tunnel came up in 1882. His civic work in Manchester is still highly prized. As a result of his inferences, the search for coal in the concealed coalfield under Kent was largely undertaken, and his advice was often sought in working the Cheshire salt deposits.

His work was early recognised by his election to the Royal Society in 1867, and in after years numerous honours were bestowed upon him. The Geological Society of London, to which he was elected fellow in 1861, awarded him its Lyell medal in 1889, and very appropriately the Prestwich medal in 1918; he served on the council for four long sessions. He received the degree of D.Sc. from Oxford in 1900 and from Manchester the Hon. D.Sc. He was married twice, first in 1866 to Frances Evans (died 1921), by whom he had a daughter, and secondly in 1922 to Mary, widow of Mr. Hubert Congreve.

Sir Henry Trueman Wood.

THE death of Sir Henry Trueman Wood on Jan. 7, at eighty-three years of age, removes from the intellectual and the administrative world a remarkable figure, who, in his prolonged years of great activity did much, indirectly, to shape the conditions under which many of us live. Numerous notable persons, still living, and eminent in the manifold fields in which he laboured, will sincerely regret the disappearance of his well-known tall and spare but distinguished figure, which is so well portrayed by Herkomer in his oil painting which hangs in the council room of the Royal Society of Arts, in the home which Robert Adam, one of the famous brother architects, built for the Society in 1774, in John Street, Adelphi. Here he did much for the Society, as secretary, for thirty-eight years, and was largely instrumental in bringing together a galaxy of talent which included Sir William Siemens, Sir Frederick Bramwell, Sir Frederick Abel, Sir Douglas Galton, Sir Richard Webster, Sir John Wolfe Barry, Sir William Preece, Sir William Abney, Lord Sanderson, and many others, all of whom were chairmen of the council during his secretaryship.

Born in 1845, Sir Henry was educated at Harrow, and at Clare College, Cambridge, where he was a scholar and twice won the Le Bas prize for the best English essay on a subject of general literature. On leaving the University he became a clerk in the Patent Office, where he acquired a knowledge of inventions which afterwards proved very useful to him and to others, while it enabled him to suggest very useful modifications in the patent laws which were dealt with by Parliament by a special Act in 1883. In 1872 he became editor of the *Journal of the Royal Society of Arts*, where, six years later, he became, in 1878, secretary, in which capacity he followed a so well known and eminent predecessor as Peter le Neve Foster, and where he occupied a seat which, more than a hundred years before, had been coveted by no less considerable a personality than Oliver Goldsmith, the author and poet.

Before concluding this account of Sir Henry Wood's services to the Royal Society of Arts, there must not be omitted some reference to the history of the Society, which he wrote. This was published by John Murray in 1913, and gives an illustrated and vivid account of the very varied activities of the Society from its inception in 1754, with references to the many eminent persons that were from time to time connected with it.

On his retirement from the secretaryship Sir Henry Wood was elected a member of the council, and served as its chairman for the year 1919-20. Later, in recognition of his signal services, he was nominated, by H.R.H. the Duke of Connaught, the president, to a vice-presidency, which he held up to his death, while at the same time members of the council raised a fund to provide an annual Trueman Wood lectureship, in connexion with which a number of brilliant addresses have been delivered by eminent men of science.

Sir Henry Wood took a leading part in the inauguration and management of many and great exhibitions, where the knowledge of inventions that he had gained at the Patent Office proved to him invaluable. Among these were the series of international shows started at South Kensington in 1871 by Sir Henry Cole, in close association with the Royal Society of Arts. Sir Henry edited many of the reports of these exhibitions, and served in

various capacities in connexion with them, which included the Health Exhibition of 1884, the Inventions Exhibition of 1885, and the Colonial Exhibition of 1886.

When it was proposed to hold an International Exhibition in Paris in 1889, the British Government declined co-operation owing to an objection by Queen Victoria, because the exhibition was to be a celebration of the taking of the Bastille in 1789, and of the French Revolution. It was proposed that the Society of Arts should undertake the organisation, and the Prince of Wales at first consented, but afterwards withdrew his consent. Eventually a committee was formed under Sir P. de Keyser, the Lord Mayor of London, as chairman, and Sir Henry Trueman Wood as secretary. The British section was successfully organised and carried through without Government aid, this being the first and only occasion on which the British section at a great international exhibition was established without Government funds. On the conclusion of this successful exhibition, Sir Henry received the honour of British knighthood, and that of an Officer of the Legion of Honour from the French Government.

In 1893 the council of the Royal Society of Arts was appointed a Royal Commission to administer a sum of £70,000 granted by the British Government to support a British Section at the Chicago Exhibition, and Sir Henry Wood went to Chicago and remained there throughout the holding of the Exhibition.

Nor must there be forgotten the contributions that Sir Henry made to technical education. In 1877 reports were asked for from him, as also from Prof. Huxley, Sir John Donnelly, Sir Douglas Galton, Sir William Armstrong (afterwards the first Lord Armstrong), and Sir George Bartley, for formulating a scheme of technical education for the committee of the City Guilds, who had recently taken up the subject. The suggestions of Sir Henry Wood were practically adopted, which led to his acting as secretary for some time to the committee of the City Companies.

In 1878, Sir Henry became secretary to Section G (Engineering) of the British Association, and continued to hold this office for seven years.

Sir Henry's interest in photography went back to wet collodion days, before the introduction of the dry plate. He read papers on photography both before the Royal Photographic Society and the Camera Club, and became president of the former Society from 1894 until 1896, after having previously been several years on its council. After this, it is perhaps not surprising to learn that for many years he served as a director on the board of Kodak, Limited, and until recently was chairman of the European section of that world-famous company. For more than a quarter of a century he was a well-known member of the Athenæum Club, and served on the executive committee, of which, for several years, he was chairman.

Amongst Sir Henry's other publications was a volume on "Industrial England in the Middle of the 18th Century"; a volume on "Methods of Illustrating Books," which, for its date, was full of information; besides numerous articles in magazines and in the daily press. Sir Henry leaves behind him a memory of a kindly but sagacious personality, with wide culture, both scientific and literary, and a record of unusual capacity and industry directed by a very sound judgment both as regards affairs and also concerning men.

A. A. CAMPBELL SWINTON.

MR. R. H. CAMBAGE, C.B.E.

BY the death of Richard Hind Cambage, which took place suddenly on Nov. 28, 1928, Australian science has lost one of its most prominent figures. He was born at Milton, N.S.W., on Nov. 7, 1859. Having been trained as a surveyor, he joined the public service in 1882, serving for three years as a draftsman in the Department of Lands. He was then, in 1885, appointed mining surveyor in the Mines Department, and his duties in this position carried him to all parts of the State and gave him the opportunity of obtaining a wide field knowledge of the botany of the State. In 1902 he became Chief Mining Surveyor, which position he held until he became Under Secretary for Mines on Jan. 1, 1916. He retired from the public service on Nov. 7, 1924, at the age of sixty-five years. He was a member of the Licensed Surveyors' Examination Board from 1903 until 1918, and also lecturer in surveying at the Sydney Technical College from 1909 until 1915. He was elected president of the Institute of Surveyors of New South Wales for three successive years, 1907–1909.

In the work of scientific societies in Australia, Cambage was one of the recognised leaders, and at the time of his death he was president of the Australasian Association for the Advancement of Science and of the Australian National Research Council. His wide and active interests are indicated by the offices he had held in scientific societies, amongst them being president of the Royal Society of New South Wales in 1912 and 1923, of the Linnean Society of New South Wales in 1924, of the Wild Life Preservation Society in 1913, and of the New South Wales Branch of the Australian Forest League in 1928. He was honorary secretary of the Australian National Research Council from 1919 until 1926, and one of the honorary secretaries of the Royal Society of New South Wales, 1914–1928 (except 1923 and 1924). As honorary secretary of the Australian National Research Council he did the lion's share of the organising work for the second Pan-Pacific Science Congress held in Melbourne and Sydney in 1923. For several years he was also a trustee of the Australian Museum. He was one of the few who are willing and able to shoulder the onerous duties inseparable from the successful management of scientific societies. He was elected a fellow of the Linnean Society of London in 1904, and in 1905 was created C.B.E.

Mr. Cambage's scientific work was chiefly botanical and may be divided into three sections. He had a very wide field knowledge of the Australian flora, and it may safely be said that there are few, if

any, botanists of the present century who have such a knowledge of the flora of a country so extensive as Australia. He had special knowledge of the genera *Acacia* and *Eucalyptus*, and the endemic plant assemblages peculiar to the island continent. He contributed to the *Proceedings of the Linnean Society of New South Wales* eighteen papers dealing with the local development of the flora in various districts. Of the twenty-nine papers he contributed to the *Journal of the Royal Society of New South Wales*, thirteen detailed his observations on the growth and development of *Acacia* seedlings. This work he developed systematically and aimed at completing descriptions of the seedlings of ten species each year. He had dealt with one hundred and thirty species in the papers already published, and, having discussed the commoner species, was beginning to find it more difficult to obtain well-authenticated seeds of the more uncommon species. Cambage was also keenly interested in the degree to which species of plants exhibited a preference for certain types of soil. His general ideas on the subject were indicated in his presidential address to the Linnean Society of New South Wales in 1925. Another topic on which his many observations made him competent to speak with authority was that of the origin of the Australian flora, and this he developed in his address to the Australasian Association for the Advancement of Science at the Hobart meeting less than a year before his death.

Keen interest in the earlier explorers resulted in some valuable contributions by Mr. Cambage to the work of the Royal Australian Historical Society. His knowledge of bushcraft, perfected by his experience in surveying, caused him to delight in attempting to follow, step by step, some of the journeys of the explorers, for he was scarcely ever so happy as when he had, from some random observation in an explorer's diary, been able to prove just where the explorer must have been when the entry was made.

Mr. Cambage was a personality that will be sadly missed in scientific circles on account of his high principles. He possessed, to a rare degree, those qualities of tact, moderation, charitable judgment, and geniality which made him beloved by all his colleagues—many an awkward moment in the counsels of scientific societies has been safely negotiated by his tact. Only once in many years have I known him seriously perturbed, and then, in his usual tactful way, he set out to overcome the source of his perturbation with such success that few indeed knew anything about it.

A. B. WALKOM.

MRS. D. H. SCOTT.

BY the death of Victoria Henderina Scott, which took place quite suddenly at her home at Oakley, Hants, on Jan. 18, the Linnean Society loses one of its earliest women-fellows, and botany a keen and loyal supporter. Mrs. Scott was elected a fellow of the Linnean Society in February 1905, following the grant of the supplemental charter which removed the sex distinction. Her active interest in the Society's work was illustrated by an exhibition, shortly after, of a series of animated photographs, taken by the kinematograph, showing opening and closing of flowers, and other plant movements. Until recent years she was a frequent attendant at the meetings of the Society, and in 1911 gave a lantern exhibition of a new species of the fossil genus *Traquaria*. Communications on plant fossils and other subjects were also contributed to the *New Phytologist* and the *Annals of Botany*. In the preface to the second edition of the "Studies in Fossil Botany" (1909), Dr. D. H. Scott acknowledges the help of his wife in the preparation of some of the illustrations; and a similar service had been rendered in his "Introduction to Structural Botany" (1894–96).

Mrs. Scott also shared her husband's general botanical and scientific interests. We recall the International Botanical Congress at Vienna in 1905, to which they were delegates, the annual meetings of the British Association, where they were supporters of Section K, and of the South-Eastern Union of Scientific Societies, of which Dr. Scott has been president, in addition to the various activities of scientific societies and other functions in which they participated. Many botanists, at home and overseas, will recall the gracious hospitality of Dr. and Mrs. Scott at their charming home in Hampshire, and the interesting garden which Mrs. Scott loved to show to her guests. She will be greatly missed, and not in botanical circles only, for she had wide interests.

DR. WILLIAM JOHN BOWIS, whose death occurred on Jan. 25, was born in Nottingham in 1881, and entered the employment of Sir Jesse Boot in 1897, being engaged in the firm's analytical laboratories. From 1903 until 1905 he worked under Prof. A. Werner at the University of Zurich, and took part in Werner's researches on the co-ordination compounds of cobalt, receiving the Ph.D. degree in 1905. He afterwards returned to industrial work, and was largely responsible for the development of the soap and perfumery business of Messrs. Boots Pure Drug Co., Ltd., of which he became a director in March 1909. During the War he took a large part in organising the production of gas masks in Messrs. Boots' factories, and was made an O.B.E. in 1919. Dr. Bowis was a man of great ability and genial disposition, and the loss created by his death will be greatly felt.

WE regret to announce the following deaths:

Mr. T. H. Blakesley, for several years honorary secretary of the Physical Society of London, on Feb. 13, aged eighty-one years.

Dr. J. E. Eddison, emeritus professor of medicine in the University of Leeds and a former president of the Leeds Literary and Philosophical Society, on Jan. 27, aged eighty-six years.

Mr. Victor Plarr, librarian of the Royal College of Surgeons of England, Lincoln's Inn Fields, London, since 1897, on Jan. 28, aged sixty-five years.

Sir Bertram Windle, F.R.S., professor of anthropology in St. Michael's College, University of Toronto, on Feb. 14, aged seventy years.

News and Views.

DRAYSON'S astronomical conclusions, and their bearing on the ice age, formed the subject of a lecture by Lieut.-Col. T. C. Skinner at the Victoria Institute, on Feb. 18. Col. Skinner postulated that in 13,548 B.C. the obliquity of the ecliptic was about $35\frac{1}{2}°$, 12° more than at present, and assumed that this alone would suffice to cause an ice age. Quite apart from the astronomy, however, the meteorological inference is far from being self-evident. At present the winter climate of north-west Europe does not depend appreciably on the altitude of the sun; it is dominated by south-west winds from the Atlantic, and temperature is almost uniform from Ireland to the north of Norway. The south-west winds depend on the existence of an area of low pressure near Iceland, and the position of this Icelandic 'low' results solely from geographical factors. It does not change from winter to summer, so that there is no reason to suppose that a greater obliquity would displace it. It might be argued that a greater obliquity would make our winters more 'wintry'; that would simply mean that the Icelandic 'low' would become more intense. Our climate would be stormier, but no colder; our rainfall would increase, but not our snowfall.

THE solar control of our climate is already so small in winter that a further decrease would scarcely be noticeable. Any changes which might result in the winter climate of the coast would be offset by the greater power of the sun in summer, and Antevs has shown that a cool summer is more important for glaciation than a cold winter. On all counts one cannot but think that changes of the obliquity are inadequate to cause ice ages. Drayson's theory has the further consequence that for several thousand years the contrast of temperature between winter and summer should have been decreasing, and historical data are adduced in support of this. The historical data do not, however, furnish such a proof; there is not the slightest evidence that the contrast in Roman times was greater than it is now. Even in the post-glacial period, though there have been fluctuations, there is no trace of a progressive decrease in the annual range. Satisfactory support for Drayson's views is not forthcoming, therefore, from meteorology.

IN his address on the coming of age of the Eugenics Society, delivered at the Galton dinner on Saturday, Feb. 16, Major Leonard Darwin, who last year retired, after seventeen years, from the presidency of the Society, surveyed the changes which have taken place in the field of eugenics during his tenure of office. The most remarkable change has been the great advance in public opinion towards the recognition of the need for and practicability of eugenic reforms. Natural inheritance and the transmission of human qualities by means of tradition, though radically different processes, are often so alike in their results that the social policy to be advocated ought to be the same whichever of the two is regarded as the more important. The son of a criminal is ten times as likely to be a criminal as is the son of honest parents, and whatever is the actual cause of the fact, it follows that to reduce the fertility of criminals would confer a benefit at which all social reformers ought to aim. The fertility of the inefficient should be reduced, both for the immediate benefit to themselves and for the sake of posterity; while those doing good work of all kinds should have families fully large enough to fill their places when they die. The endless variety of good qualities could in this case be maintained. The important contrast in reproduction is that between the unskilled labourers and skilled workers of all kinds; this is so great that the children (and adults) of the worse-paid groups are drafted into the better-paid occupations at the astonishing rate of about two millions in three years.

THE absorption of this stream into the more cultural half of the community must be a most serious hindrance to national culture, and their continued removal leaves the less cultured half worse off than before. If the situation cannot be changed or reversed, Major Darwin foresees—and it is difficult not to agree with him—that while the physical surroundings of the people might continue for some time to improve, eventually our civilisation must show signs of decay. If any nation were to adopt a scheme of racial improvement, based on science and built up by common sense, and if it were to persist in this course, the improvement in moral, mental, and physical conditions would be so evident that all other countries would, Major Darwin suggests, follow such a lead.

NOT content with its achievement in erecting a landmark in the history of chemical industry, Imperial Chemical Industries, Ltd., has provided the Imperial metropolis with an outward and visible expression both of its work and of the status which that work has won for the company. Down by the River Thames, close to the Houses of Parliament (the division bell of which rings on the directors' floor) there has arisen in a surprisingly short time a noble building designed by Sir Frank Baines to combine beauty of form with commercial efficiency of a high order, and that degree of comfort which ministers to both; many will like to regard it as a new monument dedicated to chemists, physicists, engineers, and chemical engineers of the past, the present, and the future—a whim which will seem not altogether to lack reality when the carved portraits of Liebig, Priestley, Ludwig Mond, Alfred Mond, Harry McGowan, Lavoisier, Mendeléef, Cavendish, Dalton, and Berthelot are seen surmounting the arches of the main façades. Faraday is selected for special honour, for one of the panels on the massive main door—that intended to represent the achievements of modern science—will portray a lecture by Faraday at the Royal Institution.

IMPERIAL CHEMICAL HOUSE, which had to be designed while the construction progressed, contains 700 rooms, with a total floor area of 370,000 square feet, and its successful completion in less than one-third of the time which would normally have been required is no empty tribute to the efficiency of the scientific

co-ordination and control which has been applied to the task. Modern methods have been freely brought into service; ultra-violet rays will penetrate into the rooms; rubber flooring will contribute its special advantages; the artificial lighting will be exclusively of daylight quality. The requirements of a large staff have been amply and sympathetically considered; there is carving in the spirit of Grinling Gibbons and in the technique of the Wren period; the globe desk-lights bear a map of the world. These three representative facts in juxtaposition surely indicate that the company intends to advance beneath a banner inscribed "What is worth doing is worth doing well."

SINCE 1877, when Werner von Siemens and Sir William Thomson (Kelvin) discussed the feasibility of harnessing the Falls of Niagara and using the power for industrial purposes, it has often been pointed out that destroying the scenic grandeur of the Falls would be a great loss to the world. If the hydro-electric industry were allowed to proceed unchecked, towns full of factories would spring up, the woods would disappear, and where the Falls were would be a bare cliff. This has happened already in many places. Luckily both the United States and Canada have been considering the problem thoroughly for the past two years, and a treaty signed by the Prime Minister of Canada and the United States Minister in Canada has been drawn up containing effective measures for the preservation of the beauty of Niagara Falls and Rapids. This treaty will shortly come up for ratification. The power companies in Canada and the Unites States have offered to construct remedial works at their own cost, and would accept the limitation of the maximum amount of water that can be drawn from either side of the Falls. Surveys show that the escarpment is receding at an average rate of 3·7 feet per year, the maximum taking place at the notch of the Horseshoe Falls. Recession of the Falls and withdrawal of water for power purposes has resulted in baring the flanks of the Canadian Falls and thinning the flow over the American Falls. The remedial works would restore and enhance the scenic beauty of the spectacle, which attracts more than two million visitors annually. The redistribution of the water will modify the rate of erosion at the bend of the Horseshoe. It will also enable more accurate calculations to be made as to the amount of water that can be permitted to be used for industrial purposes.

THE statement prepared by the Controller of the London Telephone service for the Telephone Advisory Committee, describing the progress that has been made in the London area during 1928, shows that it has been satisfactory. The rate of conversion of the exchanges within the ten-mile circle from manual to automatic working is perhaps disappointing, as only six automatic exchanges with a capacity of 37,150 lines were opened during the year. There are now 130 exchanges in the London area, but in five years' time these will probably be 47 automatic exchanges. London is connected with most of the countries in west, south, and central Europe. These countries can also communicate with America through London. In America the service has been extended to all parts of Canada and to Mexico. The hours of service have been extended and a new radio channel has been utilised. A new submarine cable of the latest design connecting England with France has been brought into service during the year, thus bringing additional circuits of high efficiency to Paris within reach of telephone subscribers in Great Britain and giving them good communication facilities with towns in the south of France. The number of local calls made in 1928 was seven per cent greater than in 1927. The average number of trunk calls passing through the London Trunk Exchange was 8 per cent in excess of the preceding year. Attention is directed to the damage done by the fire in the Thames Embankment subway and by the recent explosion in Holborn. The former destroyed 200 main trunk and telegraph cables, and the latter damaged about twenty trunk cables. In both cases partial working was resumed within a few hours and full operation within a week.

IN Great Britain, Parliament has laid down a uniform charge for the transmission of telegrams irrespective of distance and of the number of retransmissions. In January of last year the Hardman Lever Committee reported that the average price paid per telegram was 14·76*d*., while the costs amounted to 22·14*d*. Of the costs, 15·24*d*. was absorbed by administration and management, operating, delivery, etc. The Post Office engineers naturally hesitate to recommend the expenditure of additional capital in the circumstances. As there are sufficient channels to carry the traffic, even if they are not very satisfactory ones, they have been experimenting on novel methods of increasing their carrying capacity, and at the same time of diminishing the requisite number of officials. In a paper by W. Cruickshank on 'voice-frequency' telegraphs, read to the Institution of Electrical Engineers on Feb. 14, a system was described which has been developed since the War and has proved successful in other countries. In the system described by Mr. Cruickshank, the currents in the line are of the same order as those used in the telephonic transmission of speech. Full advantage is taken of the properties of the thermionic valve. Its entire freedom from electromagnetic inertia and its extreme sensitiveness to minute changes of voltage admirably qualify it as a telephone 'repeater.' The long distances between large towns on the American continent have fostered the telegraph habit. Elaborate terminal and intermediate apparatus form but a small fraction of the total capital cost. It pays, therefore, to superpose composite telegraph circuits on telephone 'pairs.' When a pair is reserved entirely for telegraphs, as many channels as possible are attached to it. Successful operation of twelve channels, each carrying a start-stop printing telegraph, has been achieved on many important routes. The Post Office in Great Britain is experimenting on similar methods, and hopes to increase the earning capacity of its plant.

THE third of the course of lectures on the early history of X-rays was delivered at the Royal Institution on Feb. 14 by Dr. Alex. Muller. Two years after

Röntgen's discovery in 1895, Wiechert was able to determine the velocity of cathode rays, and by measuring their deflection in a magnetic field he succeeded in evaluating the ratio between the electric charge and the mass of the cathode ray particles. In the Cavendish Laboratory, J. J. Thomson and his collaborators carried out a series of brilliant experiments, in which they proved the charge of ions in various gases to be a definite quantity independent of the nature of the gas. Within a few years of the discovery of X-rays, the existence of the electron was a well-established fact. Research on X-rays during this period had advanced comparatively little. All attempts to deflect these rays by prisms or lenses had failed. The laws of diffraction did not seem to hold for X-rays; and yet it seemed inconceivable that they should be corpuscular. The discovery that X-rays could be polarised was in favour of the wave theory, and later, direct attempts were made to estimate the wave-length of X-rays. It was not until 1913 that it was found that X-rays could be diffracted by crystals, but it showed definitely that X-rays can be regarded as trains of waves, of wave-length much smaller than that of visible light. Then came the revelation of the connexion between the frequency of X-rays and the energy of the cathode ray which made the X-ray or was made by it. This wonderful interchange would undoubtedly have taken years to discover if the old photoelectric effect had been the only means of approach. The relation between X-ray frequency and cathode ray energy involves a new universal constant, and introduces the quantum into the province of X-ray theory.

DR. BRADFORD HILL presented a paper on sickness in various industrial occupations before the Royal Statistical Society on Feb. 19. Using figures relating to printers, he showed that in short-period sickness influenza is the predominant cause, supplying a quarter of all the claims between ages sixteen and fifty, and approximately one-sixth of all the time lost through short periods of incapacity. Next in importance are the diseases of the respiratory system. In long-period illness the two predominant causes are phthisis and diseases of the nervous system. Illnesses of women weavers in Lancashire show that the serious excess of sickness known to exist amongst married women over that of single women is not largely due to illnesses associated with pregnancy. The cost of short-period illness is increasing year by year; in long-period illness there is a slackening rate of increase, but the final age group, 50-69, seems to be the slowest in reaching stability. A very much larger number of claims begin on the first days of the week than in the latter part of the week, while just above 50 per cent of 1400 claims ended on Saturday. This is open to two interpretations. Once a week has been broken into the worker tends to consider it not worth while to return to work. Alternatively, workers are loath to break into a second week's work, and therefore conclude their period of sickness at the end of a week whether they are fully recovered or not.

SINCE 1918 the important scientific researches carried out at the Universities of Prague and Brno have attracted some attention, although Czechoslovak men of science have hitherto been obliged to publish the results of their investigations in journals outside their own country. Consequently, many important memoirs have remained untranslated in the archives of the Czech learned societies, and it has been felt that this circumstance has not afforded the Czechs a real international reputation commensurate with their achievements. A new monthly journal, entitled the *Collection of Czechoslovak Chemical Communications*, has therefore been founded under the editorship of Prof. E. Votoček and Prof. J. Heyrovský. The *Collection* will contain original communications (in French or English) on pure chemistry which have not previously been published in any widely known language. In addition, there will be a bibliography of all the chemical publications in Czechoslovakia, and reviews of Czech scientific books will also be given. The first number has appeared and contains an article by Prof. J. Štěrba-Böhm and S. Škramovský on the complex oxalates of scandium, one by Prof. J. Heyrovský and S. Berezický on the deposition of radium and other alkaline earth metals at the dropping mercury cathode, and two papers by Prof. Votoček and his collaborators on rhamno-convolvulic acid and 3 : 12-dioxy-palmitic acid (which is derived from rhamno-convolvulic acid). It may be remarked that Prof. Štěrba-Böhm has made a life study of the chemistry of the rare element scandium and his present communication on its double oxalates is of particular interest. The authors and editors are to be congratulated upon the clarity and excellence of the language and upon the high quality of their first issue. The annual subscription for the *Collection* is 170 Kč or £1.

IN 1886 the late Duc d'Orleans was driven by law from France, where he had spent his childhood, and for forty years he lived an exile in England. He was a traveller and sportsman, and it was pleasing to learn that no sense of bitterness against the land of his fathers prevented him from bequeathing to the National History Museum of France his unique collection of trophies. That collection has now been successfully transported to Paris—no mean undertaking—and there has been arranged and thrown open to the public. All familiar with the Duc and his enthusiam for natural history, and with the steady development of his collection in the most advanced and spectacular mode of taxidermy, under the skilled guidance of Mr. Burlace, of Messrs. Rowland Ward, Ltd., will realise how greatly the addition must add to the popular attraction of the Paris Natural History Museum. Apart from rare and valuable specimens, such as the great panda from Tibet and the mountain bush-buck from East Africa, the collection includes an unrivalled series of pictorial groups ranging from the polar bears of the Arctic to many African scenes of bird and mammal life, and an Indian group of elephant and tiger. The scenes, which record incidents in the travels of the Duc d'Orleans, were built under his minute direction and are a standing credit to British taxidermy. A short illustrated account of the collection, by the Director of the Museum, Louis Mangin, appears in the *Revue générale des Sciences* for Jan. 15.

THE extraordinary extent of the repercussions of commerce upon living creatures has recently been illustrated by the appearance in Smithfield Market of a consignment of rare birds from the mountains of Central Asia. They were Altai snowcock, game-birds in form like overgrown black-grouse, but of a predominant grey colour. Little is known of the habits of the species, and few specimens existed even in the British Museum, so that opportunity was taken to replenish the collections there and at the Royal Scottish Museum. An interesting article on these birds and the habits of related species, written by N. B. Kinnear, appears in the *Natural History Magazine* for January. In summer the birds live on barren hill-sides, above the limit of forest growth to 17,500 feet, but in winter, snow drives them downwards as low as 7000 feet. As a rule they live in small coveys of six to seven, but occasionally they appear in larger flocks of thirty or so, always tame and easy to approach, yet generally guarded by an outpost perched on a boulder or some other position of advantage. We wonder how many of the frequenters of Smithfield Market who ate the birds dreamed of the story behind their capture and transport from the Altai mountains. The writer can vouch for their excellence as food, though it may be that romance added savour to the dish.

A REMARKABLE and instructive experiment in connexion with the education of the blind has been carried out by Mr. N. D. Cuthbertson, librarian in the Royal Scottish Museum. Following upon a series of Nature rambles arranged by him for Girl Guides, he was induced to conduct a similar series for blind members of the organisation belonging to the Royal Blind School. The rambles were mainly botanical, and while the march of the seasons was emphasised by concentration upon studies of foliage, flower, or fruit, attention was always focused upon significant structural characters. It was a happy thought to test the result of the teaching by getting the blind ramblers to write accounts of their experiences. Some of these essays have appeared in *The Teacher of the Blind*, and they show not only that the pupils thoroughly enjoyed the excursions and learned from them, but also that their tactual appreciation of fine differences in structure, such as the presence or absence of fine hairs on stems or leaves, was at least as efficient as the visual impressions of seeing pupils. An excellent essay written by an excursionist who was both blind and deaf, indicates the pitch which blind-deaf education has attained, and shows very clearly that a general extension of the Nature ramble movement to blind scholars and their seniors would add a new pleasure and mental stimulus to their existence.

DR. A. E. DUNSTAN delivered a lecture before the Junior Institution of Engineers on Feb. 8, on recent developments in the art of oil cracking. He said that cracking as applied to oil is of British and not American origin, as commonly supposed, having been first employed in 1862 in Scotland, where a plant working at 20-lb. pressure was used to turn gas oil into kerosene. The term 'cracking' is American, and was suggested by the noise made by oil inadvertently allowed to remain in an overheated still. Last year 30 per cent of the gasolene or petrol was obtained by cracking crude oil, and a further 20-30 per cent from cracked natural gasolene. Although the world's consumption of oil is very great, during the past seventy years only about two-thirds of a cubic mile has been taken out of the earth. The researches of the chemist, aided by improvements in plant, have resulted only this year in the ability completely to break down the constituents of oils and gases and the reassembly of these components in forms which at the moment may be more profitable commercially. There are three essentials in oil distillation over which rigid control must be possible, namely, temperature, pressure, and time. An increase of 10° C. in temperature reduces by one-half the time required. The choking up of a pipe-still system by coke residue has been eliminated by using a pulsating flow produced by an auxiliary pump.

IN the *Engineer* for Feb. 8, Mr. Haanel, Chief of the Division of Fuels and Fuel Testing, Ottawa, gives a description of the new fuel research laboratories erected for the study and investigation of Canadian fuels, solid, liquid, and gaseous. Beside the chemical laboratories, which contain the usual apparatus for making analyses, determining calorific values and examining physical properties of fuel, the station will include a commercial by-product recovery coke plant, an experimental domestic heating plant, a large scale powdered fuel steam-generating plant, a commercial scale briquetting plant, and a large-scale coal-washing plant. The burning of solid fuels in the pulverised form has assumed great importance in recent years, one of the advantages of the system being the possibility of utilising low-grade coals which cannot be satisfactorily burned by hand firing or on any mechanical stoker. Another important feature of the work of the new laboratories will be the study of low-temperature carbonisation processes as applied to Canadian coals, and, as occasion arises, it is proposed to test out the most promising processes, while other matters to which attention will be paid are oil cracking and refining and the production of motor oils, lubricating oils, waxes, etc., and the distillation of oil shales such as those found in the provinces of Nova Scotia, New Brunswick, and elsewhere. The new station is designed to carry out experiments in the interests of the development of the coal resources of the whole Dominion.

THE Report of the Director of the Institute of Biological Research at the Johns Hopkins University indicates robust vitality and a vigorous tackling of many biological problems of first-rate importance. The work falls into two broad groups, general biology and human biology. Amongst the former are included statistical studies upon the growth of experimental populations, the duration of life, the factors influencing the rate of reproduction in *Drosophila*, individual growth, and the relation of organic (constitutional) pattern to life processes. The human

investigations deal with the factors influencing longevity, senescence, and senility, the influence of alcohol upon health and longevity, the constitutional factor in disease, biometrical studies on cancer, analysis of population growth, and human genetics. The programme seems greater than could reasonably be tackled, but the organisation of the Institute has now been completed according to the original plans, so that the staff of eighteen scientific workers, including the Director, Dr. Raymond Pearl, has been able to settle down to the undisturbed prosecution of the plan of research. In addition, however, the Director has found time to take a large part in the formation of an International Union for the Scientific Investigation of Population Problems, and to found a new journal, *Human Biology : A Record of Research*, a quarterly.

A PUBLICATION of the National Museum of Wales has just been issued which will be of great interest and value to geologists all over the world. It is by Dr. F. J. North, the Keeper of the Department of Geology, and is entitled "Geological Maps: their History and Development, with special reference to Wales." Written in scholarly fashion, and illustrated with a wealth of plates and text-figures, it is, at the modest price of one shilling, at once the cheapest and best book on its subject. The first part deals with the evolution of geological maps in general: the birth of the idea, the development of practical methods, the law of superposition, and the period of achievement, culminating in the work of William Smith. The next section is devoted to geological mapping in Wales, but so much of the pioneer work was carried out in Wales, that the history of Welsh geology is closely bound up with the history of geological progress in general. The heroic period of Sedgwick and Murchison, for example, receives full and sympathetic treatment. A feature particularly valuable to field workers is a classified list occupying 34 pages, giving details of all the maps that have appeared officially, in scientific journals, and in separate works during the past twelve decades. Finally, there is a bibliography and index.

THE growth in Britain of a desire to preserve the beauty of the countryside from destruction and disfiguration and to encourage walking on the moorlands and mountains is well exemplified in the excellent little Handbook of the Ramblers' Federation of Manchester and District. The book contains a record of many movements, of which some were successful, to preserve footpath rights and access to wild country. There are also interesting articles on the vegetation of the Peak district, the ancient monuments of Lancashire, national parks and reserves, and other subjects. The growth of the Federation is a healthy sign of the appreciation of open-air life and a welcome check to the ugliness of urban growth in many parts of the country.

A DISCUSSION on "Ultra-Microscopic Viruses infecting Animals and Plants," to be opened by Sir Charles Martin, will be held at the Royal Society on Thursday, Feb. 28, at 4.30 P.M.

ON Saturday afternoon (Mar. 2) at three o'clock, Sir Ernest Rutherford delivers the first of four lectures at the Royal Institution on molecular motions in rarefied gases. On Tuesday (Mar. 12) Dr. Stanley Kemp will commence a course of two lectures on Antarctic whaling investigations. The Friday evening discourse on Mar. 1 will be delivered by Sir Robert Robertson on infra-red spectra, and on Mar. 8 by Prof. T. F. Tout on the place of women in later medieval civilisation.

THE Ministry of Health has issued a Memorandum (Memo. 131 A/T.) on the treatment of tuberculosis, containing an analysis of work done during the year 1927 under the schemes of local authorities. Authorities concerned should find the memorandum of value in considering whether their schemes for the treatment of tuberculosis need revision in any respects in order to secure the most efficient arrangements and the best return for the money expended for the purpose.

THE report of the map publications and office work of the Survey of India for the year 1927–28 shows that steady progress is being made in the publication of modern maps. Considerable parts of the Punjab, peninsular India, the Ganges valley, Bengal, Assam, Lower Burma, and some other parts of the Indian Empire are now published on both the half-inch and one-inch scales. The quarter-inch scale is also making progress, and practically the whole of India and countries lying to the immediate west are now available on the one-million scale. The report contains keys to all the maps of India that are on sale.

THE eighth Annual Report of the Scientific and Industrial Research Council of Alberta, covering work to December 1927, has been issued from the University of Alberta, Edmonton. The report indicates that the province is energetically developing its resources in a scientific manner. The main part, dealing with fuels, contains data on the coals and lignites of Alberta. It was shown that good coke could be made from the coal, while the lignite could be briquetted. The geological section has been extending its study of the mineral resources of the State, while the engineering section has shown that an improvement of the gravel roads could be made by the application of bitumen (preferably emulsified) obtained from the local tar sands.

Two bulky volumes, Parts 1 and 2, constitute the thirteenth and fourteenth Reports of the Director of Veterinary Education and Research, Department of Agriculture, Union of South Africa (Pretoria, 1928). Some forty papers are included, dealing for the most part with diseases of animals. Sir Arnold Theiler and Dr. Robinson have investigated outbreaks of a somewhat mysterious disease occurring in mules and characterised by paralysis of the locomotor system. They find that it is a form of botulism due to the ingestion of the toxin of *Bacillus botulinus*, the exact 'type' of which has yet to be determined. The poisoning was derived from the consumption of infected fodder. The existence of equine botulism in South Africa is of interest, because about a year ago

Sir Arnold Theiler and his collaborators showed that 'lamsiekte,' an important disease of cattle, is also a form of botulism (see NATURE, June 18, 1927, p. 904).

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A second assistant chemist in the Hull Corporation Laboratories —The City Analyst, 40 Lowgate, Hull (Feb. 28). A city analyst for the City of Birmingham—The Town Clerk, Town Clerk's Office, Birmingham (Mar. 1). A junior assistant in the photometry division of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (Mar. 2). An assistant master qualified in mathematics, at the Technical Institute, Gillingham—R. L. Wills, 15 New Road Avenue, Chatham (Mar. 2). An assistant in the Building Department of the Northern Polytechnic, Holloway—The Clerk, Northern Polytechnic, Holloway (Mar. 2). A lecturer in chemistry at the Cheltenham Technical School—The Principal, The Technical School, Cheltenham (Mar. 4). A temporary chemical assistant in the Public Health Department, L.C.C. —The Medical Officer of Health, County Hall, Westminster Bridge, S.E.1 (Mar. 4). A (male) junior assistant under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A chemist at the Test House, Kidbrooke, of the Air Ministry Aeronautical Inspection Directorate—The Secretary (I.G.), Air Ministry, W.C.2. A male technical assistant in chemistry under the Chemical Warfare Research Department of the War Office—The Chief Superintendent, Chemical Warfare Research Department, War Office, 14 Grosvenor Gardens, S.W.1. A laboratory assistant in the Naval Ordnance Inspection Laboratory, Holton Heath, Dorset—The Head Chemist, Naval Ordnance Inspection Laboratory, Holton Heath, Dorset. A chief building trade instructor at the Army Vocational Training Centre, Aldershot—The Commandant, Army Vocational Training Centre, Aldershot. A male technical assistant in the Chemical Warfare Research Department of the War Office, and a male laboratory assistant at the Experimental Station, Porton—The Chief Superintendent, Chemical Warfare Research Department, 14 Grosvenor Gardens, S.W.1.

Our Astronomical Column.

THE PROPOSED FIXED EASTER.—The measure relating to this subject that was passed by Parliament last year postponed the date when it should come into operation until there was general agreement on the subject among the principal Christian bodies. A step in this direction was taken on Feb. 14, when the Upper House of the Convocation of Canterbury unanimously passed a resolution in favour of Easter being kept on the Sunday after the second Saturday in April. It was noted by the Bishop of Truro, who proposed the resolution, that the chief difficulty would probably lie with the eastern bodies collectively known as the Greek Church. Their conservatism was well known, as evidenced by the fact that they had held aloof from the Gregorian reform of the calendar for three and a half centuries ; but the fact that they had now come into line with the West on this point gave hope that they might admit further change. In this connexion it has been noted as a hopeful omen that practically the whole of Christendom will keep Easter on the same date this year. The rule now adopted in Greece does not bring this about every year, since they follow the true moon, while the West follows the 'ecclesiastical moon,' as given by the tables of Clavius.

As regards the largest Christian community, that which owns allegiance to the Pope, there have been reports during the present pontificate that the Vatican Council, which closed abruptly in 1870 owing to political events, might resume its session, in which case there is little doubt that this question of a fixed Easter would come up for discussion. It is unlikely that any insuperable obstacle to the change would be found on doctrinal grounds ; but there is not unanimity on the question, and it is by no means certain that a favourable decision would be reached.

AN EARLY OBSERVATION OF FORBES'S COMET.—Mr. M. Yamasaki, of the Misusawa Latitude Observatory, Japan, informs us that he detected this comet with a 7-inch reflector on a date that he gives as Oct. 27·81 U.T. Unfortunately, he did not communicate the discovery to anyone until Nov. 10, when he wrote to the Tokyo Observatory ; had he announced it at once by telegraph, the arc over which the comet was observed would have been considerably extended. He gives the position on Oct. 27·81 as: R.A. $11^h\ 1^m\ 23^s$; N. Decl. 8° 32·2′. A calculation made from the latest orbit of Mr. H. E. Wood, which includes observations from Nov. 21 to Dec. 20, and is certainly very near the truth, shows that the comet was very close to the position given by Mr. Yamasaki on Oct. 26·81 U.T., but was 100′ away from it on Oct. 27·81 ; so either Mr. Yamasaki has given the wrong day for his observation or else the wrong position ; the former supposition is by far the more probable, as it gives agreement both in R.A. and Declination.

If Mr. Forbes had not found the comet, it is very doubtful whether it would have been recovered from Mr. Yamasaki's announcement ; for by the time he wrote to Tokyo it was some twenty degrees distant from its position when he saw it, and no clue was given as to the direction or rate of its motion. Promptness in the announcement of cometary discoveries is highly desirable.

THE PARALLAX OF ALPHA CENTAURI.—The parallax of this interesting star, so long regarded as our nearest stellar neighbour, has been investigated photographically by Dr. H. L. Alden, at the Johannesburg Station of Yale University Observatory. The results are given in the *Astr. Jour.*, No. 913. It is the first time that this parallax has been determined by modern photographic methods, and it is satisfactory to find that the result is in perfect agreement with that of Gill and Elkin from the Cape heliometer : that was $0{\cdot}758'' \pm 0{\cdot}010''$, while Alden's is $0{\cdot}757'' \pm 0{\cdot}006''$. The parallax of Proxima Centauri, the distant companion that Dr. Innes found at a distance of 2° 11′ from the bright star, was also measured and found to be $0{\cdot}785'' \pm 0{\cdot}005''$. The weighted mean of the previous results of Voûte and Innes was $0{\cdot}765'' \pm 0{\cdot}021''$. Alden adopts the combined result $0{\cdot}783'' \pm 0{\cdot}005''$. This star is therefore nearer to us than Alpha Centauri by one-seventh of a light year. Its photographic absolute magnitude is 18·5, the visual being 16·5 ; its linear distance from Alpha is about 14,000 astronomical units.

The paper also contains a discussion of the relative masses of the two components of Alpha. The brighter star is found to have a mass 1·06 times the sun's, and the fainter 0·92 times. It is pointed out that the period 1945–1952 will be specially favourable for determining the relative masses, as the curvature of their relative motion will then be great.

Research Items.

GEBEL HARAZA.—In *Sudan Notes and Records*, vol. 10, Mr. H. A. Macmichael contributes some notes on the inhabitants and antiquities of the range of hills in the Sudan known by this name. The nomenclature of the peaks—each has its own name—is generally non-Arabic, and the proportion roughly represents the relative proportion of Arabic and non-Arabic blood. The present inhabitants are a mixture of Rekâbia and some other race. The Rekâbia migrated from Mundera on the Nile in the eighteenth century and expelled most of the previous inhabitants, intermarrying with the women who remained. They are particularly able and acute. The other inhabitants call them Nuba or Shaberga and they sometimes admit relationship with the Nuba of Kordofan. They say their fathers found a still earlier and alien civilisation at El Haraza, and as a matter of fact the earlier inhabitants were far more advanced in civilisation, working in stone, making, for example, rings of stone (granite, flint and sandstone) and hollow conical ornaments of unknown purpose, now used as amulets. Ironworks are still to be seen with back walls ranging in tiers, all with a number of concavities, presumably each intended for a single worker. Cylinders of hard burnt clay for use with the bellows lie about in large numbers. These earlier tribes produced rock pictures which are to be seen in three spots; some are in a red pigment and some in a white. At Kurkeila they are chipped roughly and indistinctly on the rock surface. The appearance of the camel suggests they may be fairly modern. The pictures at Shalashi are on the roof of a cave formed by a fallen boulder. They are beautifully proportioned and represent men on horseback, the horses being of the type of the Egyptian paintings, while the men have broad chests and narrow hips like the Egyptian figures.

SOLUTREAN SCULPTURE.—M. Henri Martin, who for many years has been engaged in excavating sites in the valley of the Roc (Charente), brought to light in 1927 a remarkable series of five sculptures, perhaps the finest ever discovered together, in a rock shelter situated on the slope of a cliff on the right bank of the river. These have now been deposited in the St. Germains Museum, and, with other features of the site, are described and very fully illustrated in Mem. 5 of the *Archives de l'Institut de Paléontologie humaine* of Paris. The area constituting the site contained two cave stations and two shelters, but the talus yielded a considerable amount of material. In one of the shelters three skeletons of Chancelade type were discovered. The other had evidently been used as a workshop. More than two thousand implements, flakes, ornaments, etc., were recovered from it. Traces of a hearth were also found. At the back of the shelter were large blocks of rock which had fallen either before or early in the occupation of the shelter, and on these were the five sculptures forming a frieze. They are executed in high relief and depict Bovidæ or pseudo-Bovidæ, horses, and men. Certain remarkable features are to be noted. In the first place, as regards situation, these sculptures are in full sunlight and not in the darkness of a cave like Magdalenian art. Secondly, while the human figures are poorly and conventionally represented, the animals are represented with the greatest fidelity. This is to be seen especially in the accurate swell of the joints and the play of muscle. The cloven hoof of the bulls is always shown. Thirdly, the horses are pregnant. While, therefore, the situation differentiates these drawings from the Magdalenian, to which a magical purpose is attributed, their fidelity and truth suggest a delight in creation for its own sake. Yet the pregnancy of the horses, as well as one human figure, possibly masked and dancing, suggest a religious motive in relation to fertility.

TUBERCULOSIS IN WILD ANIMALS.—The existence of tuberculosis in wild animals living under natural conditions is practically unknown; a few instances have been recorded in ground squirrels in California. Messrs. R. Paine and G. Martinaglia, of the South African Veterinary Service, now report cases among wild buck in the Albany District of Cape Province (*Journ. S.A. Veter. Med. Assoc.*, vol. 1, No. 2, 1928, p. 87). Five cases were met with in the kudu antelope (*Strepsiceros strepsiceros*) and one in a duiker ewe (*Sylvicapra grimmi*). Five out of the six cases were fully investigated and yielded the bovine strain of the tubercle bacillus.

LIFE CYCLE OF *ECHINOBOTHRIUM*.—J. S. Ruszkowski (*Bull. Int. Acad. Polonaise Sc. Lettres*, 7 B; 1928) describes a new species of *Echinobothrium* (*E. benedeni*) from the intestine of two species of skate (*Raia asterias* and *punctata*) taken at Roscoff. By examining the undigested food in the stomach of the skate as soon as possible after capture, he found three samples of the prawn *Hippolyte varians*, in which altogether were four larvæ of *Echinobothrium*. The larvæ of *E. benedeni* and probably those of other species have numerous well-developed crotchets on the head, but none on the cephalic peduncle. There is probably only one intermediate host in the life cycle of the Echinobothriidæ in general and of *E. benedeni* in particular, an important difference from the Bothriocephalidæ, in which two intermediate hosts are necessary.

SALMON OF THE RIVER CONON.—Mr. W. J. M. Menzies, Assistant Inspector of Salmon Fisheries for Scotland, describes the results of his examination of the salmon of the River Conon in 1927 (Fishery Board for Scotland, Salmon Fisheries, 1928, No. 8). This river, with its attendant lochs, is a difficult one for salmon, as most of these lochs are barred by impassable falls and the tributary streams are in consequence inaccessible. Ascending salmon have a hard life and a rough passage, the scarcity of food in the upper waters due to high ground, lack of lochs, and rough, rocky bottom making life none too easy for the parr. The result is that these parr grow slowly, and consequently a high average age of migrating smolts is shown. The author has examined more than 1100 sets of scales, forming a good representative proportion of the catches. In 1927 the largest fish caught in the nets weighed 35½ lb., whilst one barely half a pound heavier was caught in 1928. The largest caught by a rod in recent years weighed 30½ lb. and was 41·25 inches long. The salmon in the Conon are predominantly of the younger age groups and return after spending a minimum of time in the sea. The catch of the early season is composed almost entirely of small spring fish which have spent nearly two complete years in the sea. In May these are intermingled with small summer fish in about the proportion of two to one, in June small summer fish with grilse in the proportion of about two to one, and in July and to the end of the season grilse predominate. Out of 67 fish that had previously spawned, only 3 had spawned more than once, two came up as grilse and then spawned in two successive years, and one, after appearing for the first time as a small

spring fish, spawned twice, but spent a complete year in the sea between each visit to fresh water. This fish must have been nine years old when captured, and weighed 20·5 lb. The average age for smolts in the Conon is very high, 42 per cent being two years, 53 per cent three years, 4 per cent four years and a few five years of age at migration. Their calculated lengths are low. They had a specially vigorous growth in the sea. The average size of the grilse and summer fish is large and the grilse are exceptionally fat.

MORPHOLOGY OF THE SKULL OF GNATHOSTOMATOUS FISHES.—Mr. E. Phelps Allis (*Jour. Anat.*, vol. 63, pt. 1, 1928) gives a detailed review of the present position regarding the morphology of the skull in gnathostome fishes, with special reference to the origin and homologies of the pituitary fossa, the myodome and the trigemino-facialis chamber. He first of all gives a connected and detailed statement of his own theory, based on his work on *Ceratodus*. This is followed by a chronological review of the more important work on the subject from Gegenbaur in 1872 to de Beer in 1927. The author then discusses the evidence derived from this work and its bearing on his own theory, particularly in the light of the criticisms of de Beer. He concludes by re-affirming in all its essentials his interpretation of the morphology of the gnathostome fish skull first published in 1914. His paper is a valuable and critical statement of the present position of the matter and a notable contribution to vertebrate morphology.

STUDIES OF CHLOROSIS IN FRUIT TREES.—Mr. T. Wallace presents the results of further studies of this subject (see NATURE, Oct. 13, 1928, p. 587) in the *Journal of Pomology and Horticultural Science*, **7**, pp. 172-183 and 184-198, December 1928. In the case of lime-induced chlorosis, he shows again, by a chemical examination of leaves, wood, and bark of the current season's shoots, that whilst in the chlorotic leaves, in this case of pear, plum, and raspberry, the ash content on dry matter is high, the relative proportions of potassium and calcium are different from those obtaining in the green leaves, potassium increasing and calcium falling in the chlorotic leaf. These characteristics of ash distribution hold also for the bark, but not for the wood of the chlorotic shoots. On the other hand, in the case of a chlorosis of plums, due to deficiency of potassium, this element was poorly represented in the ash of the leaves of the chlorotic plants, which also had a low ash content on dry weight. In the case of this type of chlorosis, which occurred on soils where leaf scorch trouble might also be anticipated, spraying with ferrous sulphate was ineffective as a control, whilst potash manuring was a successful remedial measure.

ROOT INFECTION OF TEA PLANTS.—As a result of a visit to Nyasaland in February and March 1927, Dr. E. J. Butler has written a "Report on some Diseases of Tea and Tobacco in Nyasaland (issued by the Department of Agriculture, Nyasaland, Zomba, July 1928), which gives a general account of the diseases of these crops met with on his tour, which should be of considerable interest to all growers of tea and tobacco. An interesting feature in the report on tea diseases is the proportionately large space that has to be devoted to infectious diseases that appear to spread via the root systems. *Armillaria mellea* is of course one of the most striking of these parasites, and a very clear account is given of the appearance of trees which have fallen victims to this pest. But stumps also appear to be rotted by *Ustulina zonata*, which has elsewhere proved a parasite to rubber (*Hevea*), whilst an internal root-rot *Botryodiplodia theobromæ*, when present, seems to be an even more deadly foe than either of these other parasites in the light of the planters' observations. Dr. Butler discusses the symptoms and manner of spread of an obscure root disease, often attributed to this last fungus, but concludes that the identity of the pathogen in this case must remain an open question for the present. Root diseases are probably all the more prevalent from two cultural practices. When ground is cleared, removal of the plant cover causes rapid washing out and impoverishment of the soil. As a result, root growth is poor and the root system more susceptible. Then, on the other hand, tree stumps are not cleared out after felling, and, from his wide experience, Dr. Butler describes in an interesting manner the prevalence of centres of root infection which radiate from rotting stumps, and from stumps of some species of trees more frequently than others.

FOSSIL FRESHWATER MUSSELS FROM PERU.—W. B. Marshall describes (*Proc. U.S. Nat. Mus.*, vol. 74, art. 3) some fossil pearly freshwater mussels from deposits at the head-waters of the Upper Amazon, Peru. The exact geological horizon from which they were obtained has not been definitely settled, but Conrad considered that they could scarcely be later than Tertiary. Brackish water forms are associated with these mussels, which must have been swept down from higher levels by floods. Five new species are defined, for which the author creates two new genera: *Prodiplodon* and *Eodiplodon*.

COLORATION OF MOLLUSCAN SHELLS.—E. W. Bennett records some observations on New Zealand Mollusca in *Records of the Canterbury Museum* (vol. iii. p. 185, November 1928), and concludes that in most shelled mollusca the degree of pigmentation is in proportion to the degree of exposure to light in the natural habitat of the species in question. He regards the pigment as a protection, probably against ultra-violet rays. Although pigment, "unfortunately," as Mr. Bennett says, usually has disappeared from fossils, still its occasional recorded presence may throw some light on the habitat of the extinct species.

ANALCITE ROCKS OF AYRSHIRE.—Dr. G. W. Tyrrell has published an important contribution to the petrology of analcite-bearing rocks (*Quart. Jour. Geol. Soc.*, pp. 540-567; 1928). The rocks of the Ayrshire province are generally thoroughly basic, ranging from crinanite and teschenite through picrite to peridotite. It is therefore particularly interesting to find more felsic rocks—analcite-syenites—occurring in differentiated sills of crinanite as bands, schlieren, and veins. The occurrences described, of which that at Howford Bridge, Mauchline, is the most important, are all of late Carboniferous or Permian age. Variation within the sills is ascribed to crystallisation-differentiation aided by the settling of heavy titanaugite-ilmenite intergrowths. Several continuous and discontinuous reaction series have been traced, and it is clearly shown that a certain amount of lime must thereby have been restored to the residual magmatic liquor, along with the usual alkalis, silica and volatiles, leading to the final crystallisation of analcite, soda-lime zeolites, and prehnite. It is noted that the great development of analcite-syenite within the Howford Bridge sill is concomitant with the impoverishment of the associated crinanite in analcite. In the other sills, the crinanites are richer in analcite, and analcite-syenite is correspondingly sparse.

TAJIMA (JAPAN) EARTHQUAKE OF 1925.—This destructive earthquake occurred at 11 h. 10 m. 49 s.

(2 h. 10 m. 49 s., G.M.T.) on May 23, 1925, in the boundary district of the provinces of Tajima and Tango. It was followed, on Mar. 7, 1927, by the much stronger Tango earthquake with its epicentre only 11 miles farther east (NATURE, vol. 122, p. 36). The Tajima earthquake is the subject of valuable memoirs by Prof. B. Koto (*Tokyo Imp. Univ., Fac. of Sci. Journ.*, vol. 2, 1926, pp. 1-75), by Prof. A. Imamura (*Imp. Earthq. Inv. Com. Bull.*, vol. 10, 1928, pp. 71-107), and by Prof. N. Yamasaki (*Ibid.*, pp. 109-113). The epicentre lies to the east of Tuiyama Cove and close to the village of Tai. The focus must have been of considerable size in the vertical direction. From a study of the intensity distribution, Imamura concludes that its depth was about 6 miles, while Dr. K. Wadati, from the transmission curves of the $\overline{P}$ and P phases, estimates it at 20 miles. On the top of a hill near Tai, two faults were formed, each about a mile long, running north-east and south-west, roughly parallel to one another and to the old steep fault-scarps facing Tuiyama Cove. The greatest vertical throw was about 3 ft. 3 in., and the horizontal shift (of the west side towards the north) between 2 and 3 inches. The Tajima and Tango earthquakes occurred on the north side of the island, in what is known as the inner seismic zone, and within four years after the great Kwanto earthquake of 1923. Prof. Imamura notices that several other great movements in the east or outer seismic zone (in 1676, 1854, 1894, and 1896) were followed within a few months by others in the inner zone.

AN UPPER LIMIT TO ENERGY DENSITY.—In the September issue of the *Proceedings of the Physico-Mathematical Society of Japan*, Prof. S. Suzuki puts forward the hypothesis that there is a limit to the energy which can be concentrated in a given volume, just as on the theory of relativity there is a limit to the velocity a body can have. It would follow from such a hypothesis that as the energy density in an enclosure is proportional to the fourth power of the absolute temperature of the enclosure, there is an upper limit to temperature. Planck's radiation formula would require an additional term which becomes important for long waves and high temperatures. The frequency of a light quantum could not increase indefinitely, and the Compton increased frequency effect could not be produced when an extremely rapid electron struck a quantum of extremely high frequency.

ELECTRIC STARTERS FOR MOTOR-CARS.—Owners of motor-cars are chary of using their self-starters too often as they fear that the battery may lose too much of its charge. They will be interested, therefore, in a paper by Dr. Smith-Rose and Mr. Spilsbury on tests of electric starters for motor-cars, which is published in the *Journal of the Institution of Electrical Engineers* for January. The instantaneous values of the currents during starting were found by an oscillograph. The first car experimented on had a nominal 12 horse-power, 4 cylinder engine with a 12-volt battery. It was started by means of a dynamotor unit permanently connected to the engine shaft by a chain drive. The tests were made with the engines both hot and cold. Each of the other two cars had a separate starter motor unit, the driving pinion of which was only engaged with the engine fly wheel during the actual starting operation. In car No. 1, when the starter switch was first closed the current jumped up to a value of 195 amperes, the battery pressure rapidly falling from 12·4 to 9·3 volts; and then rising. In car No. 2, the current rushed up first to a peak value of 154 amperes and then to a second peak value of 228 amperes. With the third car they found a peak current of 260 amperes at the instant when the pinion and flywheel engaged. These large currents are of importance in practice, as they doubtless damage the battery by displacing paste from the plates. It seems likely that their value determines the life of the battery. It is satisfactory to find, however, that although the currents are so large the total quantity of electricity discharged from the battery during a normal starting operation is very small. The tests show that the engines started up from their cold condition in times varying from 0·39 to 0·75 of a second after pressing the switch. This corresponds to a total discharge varying from 63 to 128 coulombs. With the engines warm, they started in about half the time and used half the coulombs. It is concluded, therefore, that with a normal car there is little risk of the battery becoming discharged owing to frequent use of the starter.

CARBON SULPHIDOSELENIDE.—A new method of preparation of carbon sulphidoselenide, CSSe, together with an account of its properties, is described by H. V. A. Briscoe, J. B. Peel, and P. L. Robinson in the *Journal of the Chemical Society* for January. This compound was previously prepared by Stock and Willfroth by striking an arc between carbon poles containing selenium, under carbon disulphide, but the new method consists in passing carbon disulphide vapour over heated ferrous selenide, when a partial replacement of sulphur by selenium occurs. Carbon sulphidoselenide is a deep yellow liquid boiling at nearly 84° and having a density of 1·9874 at 20°. Its constitution, as deduced from surface tension measurements, appears to be Se = C = S, but it is less stable than carbon disulphide. Carbon sulphidoselenide has an unpleasant odour and is non-inflammable; its vapour is lachrymatory. It is immiscible with water, but soluble in most organic solvents. With phyenlhydrazine and aniline, carbon sulphidoselenide reacts in a manner analogous to carbon disulphide.

PHYSICO-CHEMICAL INVESTIGATIONS UPON RADIUM.—The increased demand for radium preparations for use in the cure of certain diseases has caused attention to be directed to the supplies available from the Belgian Congo. It has apparently been overlooked that the element was first discovered by Prof. and Mme. Curie in the pitchblende deposits of Jáchymov (St. Joachimsthal) in north-west Bohemia, where the isolation of radium products has been resumed since 1920. In the *Collection of Czechoslovak Chemical Communications* (January 1929), Prof. J. Heyrovský and S. Berezický describe the application of the dropping mercury cathode methods for determining the deposition potential of radium, which is found to be 1·718 volts. The deposition potential of the element in the presence of barium and other salts was also studied, using preparations containing amounts ranging from 14·6 per cent of radium to a preparation containing 97·3 per cent of radium chloride. It is found that the difference in the deposition potentials of the alkaline earth metals are great enough to permit of the deposition of each of them being followed in their mixtures. Traces of radium are noticeable in any amounts of calcium or strontium solutions, even in the presence of alkali metals. The deposition of radium becomes indistinguishable, however, when the ratio of barium to radium exceeds 10 : 1. Traces of barium are discernible in solutions of all the alkalis and alkaline earths. The application of the polarographic method with the dropping mercury cathode to the determination of the solubilities of sparingly soluble salts has also been found to give concordant and satisfactory results.

The British Industries Fair.

THE London section of the British Industries Fair, organised by the Department of Overseas Trade, was opened at the White City on Feb. 18; the Birmingham section, which was organised by the Chamber of Commerce under the auspices and with the support of the Department of Overseas Trade, being simultaneously opened at Castle Bromwich. Both sections will be open from Feb. 18 until Mar. 1 inclusive. Only British manufacturing firms were permitted to exhibit, and no exhibitor might exhibit articles other than those of his own manufacture.

The primary appeal of the Fair is to trade buyers, and in order to attract them a special advance overseas edition of the catalogue of the London section was issued early in January to 10,000 business men in Europe, North America, South Africa, and the eastern coast of South America, in time to enable buyers in cities so far apart as Constantinople, Cape Town, and Vancouver to receive a copy before commencing their voyage to England. The catalogue contains descriptions, though in little more than bare enumeration, of the exhibits of more than 1200 British manufactures, and embodies a complete classification of all those exhibits by trades, as well as indexes in nine languages, thus enabling foreign buyers easily to trace the goods in which they are particularly interested. As catalogues go, it is as clear as its conciseness will allow, but the authorities responsible for its publication might realise that its format, by the mere growth of its pages, is now become awkward. There are 400 pages constituting the body of the catalogue, with more than 260 pages of advertisements in addition. The size of the page being relatively small, the result is a paper-backed volume an inch thick which has to be so tightly pasted that it is difficult to open the catalogue widely enough to enable the beginning of the line to be read with ease.

No less than 39 trades (several of them being really groups of trades) are represented in the London section, from perambulators to pianofortes; but readers of NATURE will naturally be more interested in the scientific industries. An outstanding exhibit is that of the Imperial Chemical Industries, Ltd., that 'rationalised'—to use a term currently fashionable—embodiment of more than forty subsidiary and associated companies, operating throughout the British Empire and the world. This exhibit comprises heavy chemicals, explosives and ammunition, dyestuffs, metals and fertilisers, all of which are shown on a large site having for its central feature a cinema hall. Here films are shown continuously illustrating the manufacture of heavy chemicals, the making of dyestuffs, the use of blasting explosives (depicting the fall of 30,000 tons of limestone); and a film showing by examples the uses of fertilisers and their benefit to agriculture.

British optical and scientific instruments and photographic goods occupy nearly 8000 square feet. This section was inaugurated only in 1926, when there were 22 exhibitors, occupying 1700 square feet. This year there are 60 exhibitors occupying no less than 7662 square feet—a significant testimony to the rapid growth of these important branches of British industry. In view of the growing use of optical and scientific instruments for purposes of research, control, and test, in an ever widening and varied field of industrial processes, the exhibits in this section should grow more rapidly still if the manufacturers concerned realise the value of the opportunities that the Fair provides. A glance through the optical section shows that many of the leading British optical manufacturers, some of whom have deservedly a world-wide reputation, are represented, though there are also some not less notable omissions. It may be that for optical instrument manufacturers and also for the manufacturers of scientific instruments, in the stricter sense, the annual exhibition of the Physical and Optical Societies, held usually in January at the Imperial College of Science, South Kensington, provides a better *milieu* for appeal to the experts who can best judge of the value of such productions.

This view may account, in part at least, for the list of exhibitors in the optical and scientific instrument section of the British Industries Fair being less comprehensively representative than it might be. One can readily understand that the expenditure of time, energy, and money needed for the preparation of exhibits may easily constitute a serious financial burden on any firm, and more particularly on the comparatively small industrial units engaged in the optical and scientific instrument industries, if there should be an undesirable increase in exhibitions. But the British Industries Fair, with its wide range of appeal to trade buyers from the four corners of the earth, should provide a very suitable opportunity for display complementary to that provided by the annual exhibition of the Physical and Optical Societies.

The pre-eminence of British optical and scientific instruments in certain lines is unquestioned; but there are certain types of optical and instrument products in which the legend still lingers that particular foreign products are the best, even though recent improvements in the corresponding British productions may have falsified the legend. The British Scientific Instrument Research Association, for example, has recently published the results of a prolonged investigation into the characteristics of some typical British and foreign ammeters and voltmeters of the switchboard pattern. One upshot of that investigation is the definite conclusion that "the best-known British instruments of the kind dealt with are quite equal to the best-known corresponding products of foreign origin, in the suitability of their design for the purpose to be served, in the consistency of their indications, and in the general lines and details of their construction."

Among the conspicuous features of the exhibits of British optical and scientific instruments and photographic goods, the following may be mentioned: Ultra-violet ray equipment, embodying automatic control of the time of exposure; daylight lamps which, it is claimed, give the same effective results as before with the use of considerably less current; compasses suitable for fast motor-boats and a depth-sounding device for use at full speed; inter-communication telephones for use on aeroplanes or ships where noise makes the use of ordinary instruments impossible; a new splinter-proof glass for spectacles; the colour 'snap shot'—the special film which makes it possible to take colour 'snap shots' with an ordinary camera; a roll-film reflex camera for speeds up to 1/5000th of a second; and a photographic plate with a speed of '2000 *H* and *D*,' to use the appropriate technical term—four times as rapid, it is said, as any plate previously produced.

Scientific exhibitors, actual or potential, should also realise that, apart from the direct benefits in the shape of trade orders that are likely to accrue from the exhibition, the display of a representative and fairly comprehensive collection of optical and scientific instrument exhibits in a Fair organised by a department of Government may also have its indirect benefit in assisting Government to realise the value and importance, from a national viewpoint, of these particular industries.

The Paulin Aneroid.

THE Swedish engineer, G. Paulin, has recently applied the null reading principle to the aneroid barometer. The action of the instrument will readily be understood from the illustration (Fig. 1). The diaphragm *a*, the total range of motion of which is restricted by means of stops to about $\frac{1}{10}$ mm., actuates the frame *j*, to the upper ends of which are attached phosphor bronze strips, bent at an angle and fastened at their lower ends to the base. To the angles of the

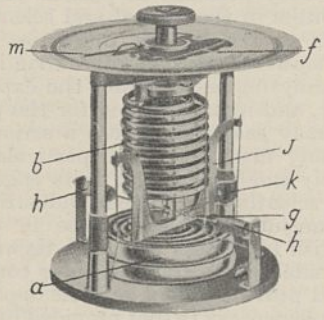

FIG. 1.

latter strips are attached two horizontal strips *k*, which are pinned above and below a transverse torsion strip *g*, held by springs *h*, and carrying the *null* pointer *f*. It will be seen that a rise or fall of the diaphragm alters the angles of the bent strips and imparts a twist to the torsion strip *g* through the horizontal strips *k*.

The *scale* pointer *m* is carried by a central threaded spindle, passing through a nut attached to the upper end of the spiral spring *b*. The lower end of this spring is coupled to the diaphragm. Varying air pressure on the diaphragm is thus equilibrated, and the diaphragm thereby restored to its null position by the measured rotation of the central spindle.

The writer has recently had an opportunity of testing this type of barometer on an experimental survey in the Eastern Highlands of Scotland, in the course of which checks on the aneroid readings were obtained at frequent intervals by means of trigonometrically fixed heights. Normal surveying practice was followed by reading a stationary barometer at intervals during the field traverses to allow for diurnal and weather changes of pressure, and the effect of varying temperature of the air column was allowed for, on the usual isothermal assumption, in reducing the field readings.

The makers claim that friction errors are eliminated, and this claim would appear to be substantiated. The reading is always consistently definite and is not affected by tapping.

The extent of the first climb in the early morning was invariably *exaggerated* by the instrument to the order of 1½ per cent. This error is not due to hysteresis, since it is in the wrong sense. Neither is it due to want of sympathy between the makers' graduation formula and the local meteorological and geographical conditions, for an independent computation from the International formula reveals no greater difference on this score than 0·1 per cent. The only alternative which suggests itself is faulty temperature compensation of the particular instruments under trial. Temperature fell considerably during the climb, and it is likely that insufficient time was allowed before starting to enable the traverse barometer to take up the outdoor temperature. It is indeed difficult to see how the mechanism described in the makers' catalogue can be compensated. On the other hand, the writer has been shown the results of National Physical Laboratory tests on other barometers of this type, which indicate remarkably good temperature compensation. Possibly the difficulty has been overcome in later models, at any rate in selected specimens.

Minor variations in altitude were recorded to within one or two feet of truth, and in all cases where the temperature remained sensibly constant the traverse closed to within two or three feet, even after a sudden drop of a thousand feet.

This instrument would appear to mark a step forward in the design of surveying barometers, although more extended field trials are necessary before this can be stated with assurance. M. H.

Isostasy.

By GEORGE R. PUTNAM, U.S. Department of Commerce, Washington, D.C.

THE condition of equilibrium in the crust of the earth is maintained by under-surface compensation of some sort, between the extremes of no compensation (a rigid crust) and complete local compensation (a plastic crust). Common knowledge shows that the materials of the crust are too weak for rigid support of the relief, and are too strong for complete local isostasy. What, then, is the most probable arrangement of the actual isostatic compensation ?

Gravity measurements furnish the principal evidence. Of the methods for their discussion, the reductions of Bouguer and Hayford correspond to the above two extremes. The large Bouguer anomalies prove that the crust is not rigid. In papers printed in the May 1928 issue of the *Proceedings of the National Academy of Sciences*, I have shown that the Hayford hypothesis of complete local compensation is untenable, and leads to significant error.

The Hayford method assumes that the isostatic compensation is "complete under every separate portion of the earth's surface," however small. This hypothesis was not claimed to be completely true, but this notable work has been built around local compensation, as complete as mathematically practicable. Hayford and Bowie allude to any error due to this assumption as a negligible matter. The Hayford reduction divides the area about the station into very small compartments, and assumes complete local compensation for each. The first zone is a cylindrical column 2 metres in radius and extending downward 113,700 metres (71 miles), and this column is assumed to be in perfect equilibrium, free to move without resistance from surrounding materials. This cannot represent a condition possible in Nature. Such compensation could be true only with materials wholly plastic, and no remaining surface relief.

The errors in the Hayford residuals show as over-compensation for stations above the average level, and as under-compensation for stations below ; they are appreciable or large for mountainous stations, but negligible in fairly level regions. They are similar to the 'free air' reduction errors, although much smaller. The proofs given depend mainly on comparisons of pairs of adjacent gravity stations differing materially in elevation. The evidence shows that regional compensation cannot be ignored in gravity reductions.

I also used this strong method by pairs, for a measure of the horizontal extent of regional compensation, and find evidence that this is appreciable to about 160 kilometres (100 miles) from the station.

Another basic hypothesis of the Hayford reduction is that the densities so vary with the elevation that the mass in a unit column is constant. This cannot be true even approximately, in mountainous regions, for small unit areas. The correct conception is that of limited regional compensation horizontally, which is the same as incomplete compensation vertically, or partial lack of local compensation, for features of moderate extent.

All this affects the discussion of the so-called Airy and Pratt theories. With regional isostasy there will be horizontally extended compensation beneath mountains, instead of individual downward protuberances. Probably the depth of compensation varies appreciably, and the topographic relief must be explained by more than one kind and direction of force.

To bring the gravity measurements within the possibility of mathematical treatment general assumptions cannot be avoided, but these must be physically reasonable, and be such as to result in minimum residuals.

In the papers to which reference has been made, two regional isostatic methods of reduction of gravity observations are given. One, a more accurate method now first proposed, uses a practicable regional system of reduction by averaging the elevation for moderate areas about the station, thus avoiding the local compensation error. It yields results nearer the truth than the Hayford method, and requires less labour. A more correct, but less readily computable, conception, would substitute a warped surface for a levelled area about the station.

The second method, the 'average elevation isostatic reduction,' was devised and used by me in 1895; it averages the surface elevation within 100 miles of the station, and applies a compensation for this average elevation. This is a simple method, although approximate, as it neglects curvature. On a reasonable conception of isostasy, it eliminates or greatly reduces the extreme residuals in mountainous regions. This method is of special significance in the general problem, as it proves isostasy without using the Hayford assumptions. It is not based on any assumption as to the thickness or vertical density arrangement of the compensation, providing it is at a considerable depth, and hence an unlimited number of combinations of these elements will satisfy the condition of isostasy. This reduction is a regional treatment of compensation, and the area used conforms well to that found, by more exact methods, to be regionally compensated. It confirms the previous conclusion that regional isostasy cannot be ignored.

In 1894, gravity measurements across North America were made by me for the Coast and Geodetic Survey, at stations which had been carefully selected to test the condition of the earth's crust. I applied this average elevation reduction to these and other determinations, representing extreme and diversified conditions. This work, on a basis of isostasy, eliminated the larger residuals which all preceding methods had failed to do, and it was the first consistent proof of isostasy.

The first observational evidence of crustal equilibrium came from British trigonometric and gravimetric surveys in India. The first definite proposal of this theory was made by Airy seventy-three years ago, and English scientists have continued to make valuable contributions to the theory of isostasy.

University and Educational Intelligence.

CAMBRIDGE.—The governing body of Emmanuel College offers to a research student commencing residence at the University in October next, a studentship of the annual value of £150, tenable for two years. Preference will be given to a candidate who has already completed at least one but not more than two years of research. Applications should reach the Master of Emmanuel (The Master's Lodge, Emmanuel College, Cambridge, England) not later than June 30.

THE Geological Department of the University of Melbourne has been provided with a new building at the cost of £21,000, by a grant from the Government of Victoria. On the occasion of the opening of the new building by Lord Somers, the Governor of Victoria, a pamphlet has been issued summarising the history of the Department and giving a list of positions obtained by its graduates, and of the 123 papers issued in connexion with the School during the past twenty-three years. The pamphlet refers to the early history of the school under its founder, Sir Frederick McCoy, from 1854 until 1899, Prof. Gregory during the next five years, and Prof. Skeats since 1904. It has been conducted in recent years in a joint building with metallurgy erected in 1905. The growth in the number of students has rendered necessary the provision of the present large and well-equipped building. The staff of the Department includes Dr. Summers as associate professor and Mr. Frederick Chapman, of the Victorian National Museum and now acting as Palæontologist to the Australian Federal Government, as lecturer in palæontology.

STUDLEY COLLEGE, Warwickshire, is appealing to the public, and especially to those having agricultural interests, for £20,000 to enable it to continue its work of providing courses of instruction for women in horticulture, agriculture, dairying, and poultry-husbandry. Originating as a hostel at Reading in 1898, the College moved in 1903 to Warwickshire, where it became a teaching centre for gardening and dairying. It now provides a three-years' diploma course in horticulture; two-years' courses in horticulture, in agriculture, in dairying, and in poultry-husbandry; one-year and shorter courses in the above subjects and instruction in carpentry, bee-keeping, fruit-bottling, and floral decoration. The fees for tuition and residence amount to 110 guineas and upwards per annum. The College is always full, and the demand made upon it for trained workers is greater than it can supply with its present accommodation, which is limited to sixty resident students. Of the twelve hundred women who have passed out from it, many are now managing their own land or earning salaries not only in Great Britain but also in Australia, New Zealand, Uganda, Kenya, South Africa, Canada, India, and Ceylon, where they are growing crops of all kinds, including cotton, lemons, oranges, coffee, and tobacco. In 1911 the College obtained a lease of Studley Castle estate, comprising the castle, farm buildings (now needing repair and enlargement), and 340 acres of land. This lease is now drawing to a close and £15,000 must be raised before July 1 to complete the purchase of the freehold. Towards this the Treasury has promised a grant of £5000, former students have pledged themselves to find £1000, and the present students and staff are contributing £300. The College is recognised by the Ministry of Agriculture and Fisheries, from which it receives an annual grant of £1000. The appeal is signed by the Marchioness of Londonderry as president. Donations may be sent to the honorary treasurer, Mr. H. Keeling, 26 Eccleston Street, London, S.W.1.

Calendar of Patent Records.

February 26, 1781.—The pigment known as 'Turner's Yellow' or 'Patent Yellow' was the subject of a patent granted to James Turner on Feb. 26, 1781, and was at one time extensively used. The validity of the patent was twice upheld in the courts and its life was extended by Act of Parliament (32 Geo. 3, c. 73) on the ground that "the colour was made from British materials, and that the invention has not only in a great measure superseded the necessity of importing the colour from abroad, but it is now exported in considerable quantities to most parts of Europe, the East and West Indies, and America, . . . and by the great consumption of common salt necessarily used in preparing the same the said invention will afford an increase to the public revenue." Like most lead paints, however, 'Turner's Yellow' is affected by long exposure to a sulphurous atmosphere, and the introduction of the chrome colours has rendered it obsolete.

February 27, 1802.—The closed kitchen cooking-range was first patented by George Bodley, of Quay Foundry, Exeter, on Feb. 27, 1802. The patent was for a stove constructed with an oven on one side and a boiler on the other, the flue gases passing from the upper part of the stove round three sides of the oven, under and up one side of the boiler, and then into the chimney; the whole being covered with a plate upon which vessels could be warmed.

February 28, 1799.—The so-called American type of windmill, in which instead of the small number of sails of large size, common to the mills of Europe, there is a large number of small blades arranged in wheel formation, was included in an English patent granted to George Medhurst on Feb. 28, 1799.

February 29, 1612.—The patent granted to Simon Sturtevant on Feb. 29, 1612, for the use of coal in all metallurgical operations, including iron production, was surrendered the following year, and it is chiefly of interest now because in it Sturtevant foreshadowed with remarkable accuracy the procedure, adopted officially much later, of filing provisional and complete specifications in connexion with patent applications. Sturtevant not only annexed to his petition for a patent a statement describing "in some measure" his invention and the method of carrying it out, but he declared also that the invention would be "more fully, amply, and particularly demonstrated, specified, described, and contained, in a large treatise which shall be put in print and published before the last day of Easter term next," and the treatise was in fact published by the date mentioned. The specification did not become a regular feature of the procedure of patent practice until more than a hundred years later, and the filing with the application of a provisional specification describing the nature of the invention was especially adopted by the Act of 1852.

March 1, 1651.—The official series of English and British patents which begins with the year 1617 and is being continued to-day, does not include any entries for the Commonwealth period, though several patents were granted during that regime. Some of these were in the usual way by Cromwell's Letters Patent, but others were granted direct by Act of Parliament and not under the Great Seal. One of these latter was to Jeremy Buck, of Minchinhampton, Glos., and dates from Mar. 1, 1651. Like Sturtevant's referred to above, it is one of the many unsuccessful patents dealing with the use of coal for smelting iron. The Act contains a proviso that, after seven years, Buck was to take apprentices and "teach them the knowledge and mystery of the new invention."

Societies and Academies.

LONDON.

Geological Society, Jan. 23.—J. K. Charlesworth: The South Wales end-moraine. The Irish Sea ice stood over Cardigan Bay at the period of the maximum advance of the Newer Drift period, and ponded back the natural drainage of northern Pembrokeshire and southern Cardiganshire to form a chain of extra-glacial lakes connected by marginal streams. The end-moraine of the Newer Drift passes across eastern and southern Wales. In northern Pembrokeshire and southern Cardiganshire it was laid down along the edge of the Irish Sea ice. Farther east, the moraine is practically continuous, and represents the marginal product of the local Welsh ice, which was centred in the mountains of Central Wales, the Carmarthenshire Vans, the Brecon Beacons, the Black Mountains, and the mountains of Radnor Forest. This ice flowed beyond the outlets of the great valleys of the east to form the valley-glaciers of the Severn and other rivers, and extended southwards on to the coastal plain of Glamorgan. The Newer Drift is of early Magdalenian age.—**A. Jowett and J. K. Charlesworth:** The glacial geology of the Derbyshire dome and the western slopes of the Southern Pennines. The Derbyshire Dome of the Southern Pennines was overridden at the period of maximum glaciation by ice from the north and north-west. This is shown by the occurrence of patches of true boulder clay, by the wide distribution of erratics of Lake District and Galloway rocks over the dome and along its valleys, and other evidence. The upper limit of the erratics from the north follows the outer flanks of the south-western Pennines at about 1250 feet above sea-level. The ice-recession from this position was associated with a copious marginal drainage, which eroded a well-developed suite of channels linking a number of big extra-glacial lakes in the valleys of the western Pennines.

Physical Society, Jan. 25.—C. Vernon Boys: A fused quartz pendulum rod for clocks. Possible causes of the progressively increasing losing-rate found in the going of the Shortt clock are discussed. A design is given for the free pendulum with rod of fused quartz; carbon steel and mild steel for the supporting springs and the bob respectively are suggested.—**G. W. Sutton:** A method for the determination of the equivalent resistance of air-condensers at high frequencies. The losses in air-condensers are divided into two portions: (*a*) those due to leakage through the solid dielectric, and (*b*) those due to terminal and plate resistance. A method is developed for measuring each, under conditions such that the other is negligibly small.—**L. Hartshorn:** The measurement of the anode circuit impedances and mutual conductances of thermionic valves. A Wheatstone bridge method with current of telephonic frequency is used. Although both anode circuit resistance and mutual conductance vary very considerably with the grid bias, the product of the two, which gives the voltage factor of the valve, is approximately constant. The increase in the effective values of the inter-electrode capacities is explained by the presence of the space charge, which also has the effects of making these capacities vary with the frequency and of giving them a comparatively high power factor, especially at low frequencies.

Linnean Society, Jan. 31.—Miss G. H. Faulkner: The anatomy and histology of bud-formation in the Serpulid, *Filograna implexa*. The genus *Salmacina* is synonymous with *Filograna*. The position of the plane of fission and the initial size of the bud are

variable, both being related to the length of abdomen of the stock. Internal histological changes accompany the formation of the external form of the bud. These result in a complete histolysis of the original tissues of the bud-segments and their replacement by embryonic cells.—**R. W. G. Hingston**: The natural history of the Oxford University Expedition to Greenland in 1928. Godthaab was selected as the place for investigations. Animal life is abundant, but the proportion of individuals to species is small. The birds are more prolific than the corresponding species in temperate regions and their development is more rapid. The Passerine birds laid on an average two more eggs in each clutch, and the fledgling periods were reduced by five or six days. The Polar wolf and hare do not change into a brown coat in summer, because in summer, owing to the superfluity of food, there is no struggle for existence in the ordinary sense, and therefore no necessity for such change.

PARIS.

Academy of Sciences, Jan. 21.—The president announced the deaths of M. Widal, member of the Section of Medicine and Surgery, and M. Riquier, *correspondant* of the Section of Geometry.—**A. Lacroix**: The chemical composition of the tectites, and in particular of those of Cambodia.—**Eduard Čech**: Projective deformation of plane networks.—**Paul Delens**: Systems of two circles and groups of spherical operations.—**L. Lusternik** and **L. Schnirelmann**: A topological principle in analysis.—**K. Kunugui**: The infinite and minimum type of dimension.—**Krawtchouk**: A theorem of Laguerre.—**Henri Cartan**: A new theorem of unicity relative to meromorph functions.—**J. Herbrand**: The non-contradiction of the arithmetical axioms.—**W. Margoulis**: The experimental determination of the tensions in the frames of aeroplanes.—**J. Haag**: The influence of the inertia of the spiral on the rate of chronometers.—**Joseph Pérès**: The action of an obstacle on a viscous fluid; a simple demonstration of the formulæ of Faxén.—**J. E. Verschaffelt**: The equation of van der Waals and thermodynamics. Discussion of a recent communication on the same subject by V. Karpen.—**C. Raveau**: The principle enunciated by Carnot: the theorem. The formulæ of the second domain of thermodynamics independent of any principle.—**B. Decaux**: The calibration of tuning-forks serving as a basis for the measurement of radiotelegraphic frequencies. The method described permits of an accuracy of 3 in 100,000.—**V. Dolejšek** and **Mlle. D. Engelmannová**: The spark doublets in the K series.—**J. Gilles**: The structure of the third order spectrum of sulphur.—**H. Volkringer**: The continuous spectrum of mercury vapour.—**Pierre Bricout**: A spectrograph objective possessing a focal distance constant to a thousandth approximately between 1850 A. and 7000 A. The elements of a quartz-fluorspar doublet are separated by a thin convergent meniscus of distilled water. This gives an objective remarkably achromatic over the range of spectra for which a quartz-fluorspar lens is commonly employed.—**R. Coustal**: The realisation of a phosphorometer by means of which measurements of the intensities of phosphorescence can be rapidly carried out.—**B. Bogitch**: A method for the electrolysis of nickel. A description of an industrial method for preparing nickel electrolytically of 99·9 per cent purity from a nickel containing 10 per cent of impurities. The electrolytic solution is a strong solution of nickel chloride heated to 65° C., the anode and cathode compartments are separated by a diaphragm, and fine nickel wires are used as the cathode.—**Mlle. Suzanne Veil**: The chromites and ferrites of nickel and cobalt.—**Octave Mengel**: The presence on the south slope of the Pyrenees of overthrust elements proceeding from a fold in the north.—**Robert Perret** and **Léon Moret**: The limits of the Bathonian in the Sixt Alps (Haute Savoie).—**H. Baulig**: The forms of relief in the central plateau of France and its Mediterranean border: general results.—**P. Mazé**: The determination of the temperature of the chloroleucites in maize plants exposed to the sun.—**A. Perrier**: The transformations of chlorophyll in a green alga.—**Max** and **Michel Polonovski**: The aminoxides of hydrastine and of narcotine. Hydrastine and narcotine oxidised with hydrogen peroxide give true N-oxides: these are unstable, and are easily transformed into compounds the nature of which is still under investigation.—**C. Vaney** and **A. Bonnet**: The phenomena of regeneration in *Spirographis Spallanzanii*.—**Aversenq**, **Jaloustre**, and **Maurin**: The action of thorium-X on the proportion of active principles of certain medicinal plants. Experiments are given showing that radioactivity is capable of producing a marked increase in the proportion of active principles of certain plants.—**J. André Thomas**: The rôle of the grouping of individuals in the perturbations of tropisms of *Convoluta Roscoffensis* by some alkaloids.—**L. Hugounenq** and **E. Couture**: The action exercised on the photographic plate by cholesterol extracted from cod-liver oil. Cholesterol extracted from bile calculi, or from ox brain, has no action, even after several days' exposure, on a sensitive photographic plate. Cholesterol extracted from cod-liver oil, on the other hand, exposed on the same plates under similar conditions, causes the appearance of well-marked black spots.—**S. Mutermilch** and **Mlle. E. Salamon**: The vaccination of the rabbit against cerebral tetanus.—**P. Descombey**: The antitetanus immunisation of the guinea-pig by the intracerebral injection of tetanus anatoxin.—**L. Normet**: The treatment of experimental hæmorrhage in the dog by an artificial serum containing citrates.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—**G. Fubini**: The transformations of Laplace, Lévy, and Moutard for hyper-surfaces.—**F. Zambonini** and **V. Caglioti**: The quantitative spectroscopic determination of small quantities of strontium, barium, and cæsium in minerals, rocks, natural waters, etc. The method long in use for the determination of lithium and consisting in ascertaining at what dilution the characteristic red line of the spectrum just disappears, is applied to strontium, barium, and cæsium. For the first two of these metals, the method requires absence of free acid from the solutions. The presence of barium does not influence the spectroscopic determination of strontium, but calcium in marked quantity renders the results less exact. Neither rubidium nor lithium affects the results obtained with cæsium, but if potassium is present in large proportion, the solution used for comparison should contain potassium in similar proportion. Under such conditions, the method gives approximately exact results with materials containing as much as 10 per cent of cæsium.—**G. Aliprandi**: The principal normals (according to Vitali) of a generic surface of Hilbertian space.—**Silvia Martis in Biddau**: The exponentials of matrices of the second order and their application to the theory of groups.—**G. Sansone**: The equation which satisfies the coefficient a of the congruence $x^3+ax+a\equiv 0 \pmod{p}$ with p prime.—**R. Calapso**: A new transformation of isothermal surfaces. With the help of the ready transformation of the R-surface of Tzitzéica into an isothermal

surface of a four-dimensional space, it was recently shown that the projective deformation of an R-surface is reducible to a transformation C_m. A new transformation of the isothermal surface, of which that of Darboux is a particular case, is now established.—**G. Colonnetti**: New contribution to the theory of elastic co-actions and its technical applications (3). The theorem enunciated and demonstrated in the two previous notes is applied to the solution of certain concrete problems of technical interest.—**H. Geppert**: Adiabatic invariants of a differential generic system (3). The differential systems of two dimensions having been considered in the earlier notes, the more general case of the generic system of n dimensions is now discussed.—**A. Masotti**: A form of the dynamic equations of a system of rectilinear vortices.—**A. Belluigi**: Gravity measurements and isostasy.—**A. Ferrari** and **M. Carugati**: The importance of the crystalline form in the formation of solid solutions (4). Thermal analysis of the anhydrous systems $MgCl_2 - FeCl_2$ and $CdCl_2 - FeCl_2$. As would be expected from the similarity in crystalline structure of their components, each of these two systems exhibits complete miscibility in the solid state.—**E. Pace**: Pinacones and pinacolines. It has been previously shown that the action of organo-magnesium compounds on γ-diketones gives rise to ditertiary glycols, which can be readily transformed into heterocyclic derivatives of tetrahydrofuran, tetrahydropyrrole, and tetrahydrothiophen. Similarly the α-diketone diacetyl reacts with two molecules of magnesium alkyl halide, yielding α-ditertiary alcohols (pinacones) which may be converted into the corresponding pinacolines by dehydration with dilute sulphuric acid and subsequent distillation in a current of steam. Acetylacetone, the most important of the β-diketones, fails, however, to react with magnesium alkyl halides, due perhaps to the existence of acetylacetone as an equilibrated mixture of desmotropic forms.—**L. Settimj**: Chemical composition of certain food pastes and the modifications effected by boiling in water. In materials of the macaroni type, the starch granules are mostly somewhat distorted and in some cases exhibit deep fissures, the central hilum being always shown as a point. After being boiled the granules are larger, the few that remain intact presenting undulating contours; the interior of the granules shows stratification and the central hilum resembles a vacuole. The boiled substance contains about 20 per cent of soluble starch and 6 per cent of reducing sugars, and shows a marked diminution in the proportion of soluble nitrogenous materials.—**P. Di Mattei** and **F. Dulzetto**: Histochemical demonstration of glutathione and its distribution in certain organs. To detect glutathione, the organs are reduced to small fragments and immersed for at least thirty minutes in 20 per cent trichloroacetic acid solution immediately after removal from the animal. Sections 4-5 μ in thickness are cut by the freezing method, placed on microscope slides, and treated for 3-4 minutes with freshly prepared 5 per cent sodium nitroprusside solution. The excess of the reagent being removed by means of filter-paper, the slide is inverted over the open mouth of a bottle of concentrated ammonia solution. An amaranth red coloration, appearing at once, indicates the location of the glutathione.—**E. Caroli**: The microniscus phase of *Ione thoracica* (Montagu) obtained by culture on copepods.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 11, Nov. 15).—**Harlow Shapley**: Studies of the galactic centre. (1) The programme for Milky Way variable stars. Five years ago an observing programme was arranged at Harvard Observatory to provide material for the general study of faint variables as bearing on the Milky Way problem. The observations will be continued for another five or ten years and the results summarised under the above general title. The problem is largely one of the improvement and extension of existing standards of magnitude.—**Harlow Shapley** and **Henrietta H. Swope**: Studies of the galactic centre. (2) Preliminary indication of a massive galactic nucleus. Examination of the distribution with respect to median magnitude of twenty-six cluster type variables in the field to the north of Ophiuchus and Scorpio, suggests a nucleus at a distance of nearly fifty thousand light-years, which agrees with the distance of the galactic centre as determined from measurements of the globular clusters.—**Gustaf Strömberg**: The determination of absolute magnitude dispersion with application to giant M-stars.—**Arthur E. Kennelly**: Gudermannian complex angles. These functions have many applications in physics and electrical engineering. An outline table of complex gudermannians is given.—**Nicholas A. Milas**: New studies in polymerisation. (1) Polymerisation of styrene. Benzoperacid increases the rate of absorption of oxygen in the initial stages of the oxidation of styrene and also the rate of polymerisation. Anthracene inhibits polymerisation and also the oxidation of the benzaldehyde formed. Yet in the presence of anthracene, oxidation of styrene proceeds at a relatively high rate, indicating selective inhibition. Polymerisation seems to be effected by energy liberated by the initial products of oxidation reacting with unoxidised styrene molecules.—**John R. Bates**: The quenching of cadmium resonance radiation. Hydrogen quenches the resonance radiation, probably having its vibrational energy increased.—**H. C. Sherman** and **H. L. Campbell**: The influence of food upon longevity. Using two diets, one of which, as shown by rates of growth and reproduction, is adequate, but the other is better, it is shown that the average duration of life of rats on the latter diet was almost ten per cent greater than those on the former diet.—**Carl Barus**: The interferometer U-gauge with closed auxiliary reservoirs.—**F. S. Brackett**: Characteristic differentiation in the spectra of saturated hydrocarbons. The vibration spectra in the near infra-red were examined. These give data as to the relative binding forces exerted upon the hydrogens when attached to primary, secondary, and tertiary carbons.—**E. O. Wollan**: Are characteristic X-rays polarised? Using a method based on integrated intensity measurements, it is found that, within the limits of experimental error, the $K\alpha$ lines of molybdenum are not polarised.—**J. G. Winans** and **E. C. G. Stueckelberg**: The origin of the continuous spectrum of the hydrogen molecule. A theoretical discussion.—**E. U. Condon** and **H. D. Smyth**: The critical potentials of molecular hydrogen. An examination of the experimental data on the lines of the preceding paper.—**Jesse W. M. DuMond**: The structure of the Compton shifted line. Theory predicts that the shifted 'line' is a diffuse band. Using scattering angles of 170°-178°, good agreement between observed and calculated structure was observed for scattering by aluminium, but additional lines appear with beryllium.—**Stanley Smith**: Some multiplets of doubly ionised lead.—**Benedict Cassen**: Spectral intensities of radiation from non-harmonic and aperiodic systems.—**Joseph Kaplan**: The aurora red line. In experiments on the excitation of the auroral green line when oxygen is mixed with active nitrogen, a red line is observed. This 'line' seems to be a

band belonging to the first positive group of nitrogen.—**Ernest Merritt and William E. Bostwick**: A visual method of observing the influence of atmospheric conditions on radio reception. Partial separation of the effects of the direct and the 'reflected' waves is achieved by using two balanced receivers, one with its plane vertical and directed towards the sending station, and the other in the vertical plane and at right angles to this direction. The coils are coupled with a local oscillator and made to actuate a cathode ray oscilloscope. The vertical and horizontal movements of the oscilloscope spot correspond in amplitude and phase with the oscillations received by the two coils.—**Francis D. Murnaghan**: On the energy of deformation of an elastic solid.—**Raymond R. Willoughby**: The survival of intelligence.

Official Publications Received.

BRITISH.

Royal Society of Arts, John Street, Adelphi, London, W.C.2. Cantor Lectures on Fatigue Phenomena, with Special Reference to Single Crystals: delivered before the Royal Society of Arts during February 1928. By Dr. Herbert John Gough. Pp. 108. (London.) 3s.

Indian Journal of Physics, Vol. 3, Part 2; and Proceedings of the Indian Association for the Cultivation of Science, Vol. 12, Part 2. Conducted by Prof. C. V. Raman. Pp. 151-305. (Calcutta.) 3 rupees; 4s.

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 4, December 29. Pp. 289-382. (Cambridge: Printed at the University Press.)

Canterbury College (University of New Zealand.) Records of the Canterbury Museum. Vol. 3, No. 3. Pp. 151-229+plates 24-37. (Christchurch, N.Z.)

Journal of the Indian Institute of Science. Vol. 11A, Part 12: A Biochemical Study of some Soil Fungi with Special Reference to Ammonia Production. By A. K. Thakur and Roland V. Norris. Pp. 141-160. 1 rupee. Vol. 11A, Part 13: The Atomic Weight of Antimony from different Sources. By K. R. Krishnaswami. Pp. 161-172. 1 rupee. (Bangalore.)

Proceedings of the University of Durham Philosophical Society. Vol. 8, Part 1, 1927-1928. Pp. iv+69+xi. (Durham.) 5s.

Calalogue of the Nineteenth Annual Exhibition of Electrical, Optical and other Physical Apparatus, January 8, 9 and 10, 1929. Pp. 142+xxvi. (London: Imperial College of Science.)

Transactions of the Mining and Geological Institute of India. Vol. 23, Part 1, November. Pp. 90+vi. (Calcutta.) To Members, 2.8 rupees; to non-Members, 4 rupees.

Transactions of the Norfolk and Norwich Naturalists' Society. Presented to Members for 1927-28. Vol. 12, Part 4. Pp. xvi+383-526. (Norwich.) 10s.

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. The Effect of Nitrate of Soda on the Yield and Chemical Composition of a simple Seeds Mixture in the First Harvest Year. By T. W. Fagan, W. E. J. Milton and Dr. A. L. Provan. (Series H, No. 9, Seasons 1926-1927.) Pp. 27+10 Tables. (Aberystwyth.) 3s. 6d.

Proceedings of the Liverpool Geological Society. Session the Sixty-ninth, 1927-1928. Edited by C. B. Travis. Part 1, Vol. 15. Pp. xvi+109. (Liverpool.)

The Bulletin of the Hill Museum: a Magazine of Lepidopterology. Issued at the Hill Museum, Wormley, Witley, Surrey. Vol. 2, No. 1, February 8th. Pp. 100+1 plate. 15s. Vol. 2, No. 2, June 18th. Pp. 101-182+22+4 plates. 15s. Vol. 2, No. 3, November 17th. Pp. 183-270+23-44+3 plates. 15s. Vol. 2, No. 4, Index. Pp. 271-296+vii. (London: John Bale, Sons and Danielsson, Ltd.)

The Ramblers' Federation Handbook: being the Official Year-Book of the Ramblers' Federation (Manchester and District) for 1929. Pp. 80+9 plates. (Manchester.) 1s. net.

Transactions of the Optical Society. Vol. 29, No. 5, 1927-28. Pp. 197-260+xv. (London.) 10s.

Torquay Natural History Society. Transactions and Proceedings for the Year 1927-8. Vol. 5, Part 2. Pp. 81-174. (Torquay.)

The Marine Biological Station at Port Erin: being the Forty-second Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 30. (Liverpool.) 1s. 6d. net.

Proceedings of the Royal Society of Victoria. Vol. 41 (New Series), Part 1. Pp. iv+62+11 plates. (Melbourne.)

Board of Trade. Second Report of National Fuel and Power Committee. (Cmd. 3252.) Pp. 46. (London: H.M. Stationery Office.) 9d. net.

The Oxford Preservation Trust. Second Annual Report, 1927-1928. Pp. 28. (London.)

FOREIGN.

University of Illinois Engineering Experiment Station. Bulletin No. 187: The Surface Tension of Molten Metals. Part 2: A Determination of the Capillary Constant of Silver. By Earl E. Libman. Pp. 22. (Urbana, Ill.) 15 cents.

Société des Nations: Institut international de Cooperation intellectuelle. Bulletin des relations scientifiques. 3e année, No. 4, décembre. Pp. iv+167-224. 8 francs. Index pour les années 1926 et 1927 (Nos. 1-6). Pp. 28. Index pour l'année 1928 (Nos. 7-10). Pp. 18. (Paris: Les Presses universitaires de France.)

The China Foundation for the Promotion of Education and Culture: Social Research Department. Second Annual Report. Pp. 8. (Peiping.)

Proceedings of the Imperial Academy. Vol. 4, No. 9, November. Pp. xxxi-xxxii+513-568. (Tokyo.)

China Foundation for the Promotion of Education and Culture. Factory Workers in Tangku. By Sung-Ho Lin. Pp. xi+128+8 plates. (Peiping.) 1 dollar.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 22: A Retirement Plan for Colorado Public Schools; a Study made at the Request of the Colorado Education Association and the State Department of Public Instruction. By Howard J. Savage and Edmund S. Cogswell. Pp. x+72. (New York City.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 81: Seasonal Variation in Salinity of Nile Water in the Aswân Reservoir and at Rodah (Giza). By R. Aladjem. Pp. 14+5 plates. (Cairo: Government Publications Office.) 5 P.T.

Department of the Interior: U.S. Geological Survey. Bulletin 806-A: The Pumpkin Buttes Coal Field, Wyoming. By C. H. Wedgemann, R. W. Howell and C. E. Dobbin. (Contributions to Economic Geology, 1928, Part 2.) Pp. ii+14+5 plates. 10 cents. Water-Supply Paper 591: Surface Water Supply of the United States, 1924. Part 11: Pacific Slope Basins in California. Pp. viii+448. 50 cents. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 81, No. 3: Morphology and Evolution of the Insect Head and its Appendages. By R. E. Snodgrass. (Publication 2971.) Pp. 158. Vol. 81, No. 6: A Study of Body Radiation. By L. B. Aldrich. (Publication 2980.) Pp. 54. (Washington, D.C.: Smithsonian Institution.)

Actes de la Société Helvétique des Sciences naturelles. 109e Session annuelle du 30 août au 2e septembre 1928 à Lausanne. Pp. 133+295+54. (Aarau: H.-R. Sauerländer et Cie.)

Conseil Permanent International pour l'Exploration de la Mer: Rapports et Procès-verbaux des Réunions. Vol. 52: Report of the Committee appointed by the Council to consider the Question of the Closure of the Moray Firth to Trawling. Pp. xviii+238. (Copenhague: Andr. Fred. Høst et fils.)

CATALOGUES.

Bulletin des publications nouvelles. 3e trimestre 1928. Pp. 32. (Paris: Gauthier-Villars et Cie.)

Notes on Books. No. 254, January, Vol. 13. Pp. 99-126. (London: Longmans, Green and Co., Ltd.)

Watsons' Microscope Record. No. 16, January. Pp. 32. (London: W. Watson and Sons, Ltd.)

Old and Modern Books: English Literature, Australasia, Canada, Ireland. (No. 24.) Pp. 54. (Newcastle-upon-Tyne: William H. Robinson.)

Catalogue of Accessories for the Petrological Microscope and Mineralogical and Crystallographic Apparatus. (Petrac 29.) Pp. 20. (London: James Swift and Son, Ltd.)

Catalogue of Science and Technology, No. 3: Annotated and Classified List of Rare and Standard Works on Exact and Applied Science. Part 9, including 13: Engineering (Section 1). Pp. 929-1016. (London: Henry Sotheran and Co.)

Vitamin Therapy: a Concise Résumé of our Present-day Knowledge done in a form suitable for the busy Practitioner. Pp. 16. (London: The British Drug Houses, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press. Pp. xv+292. (London: Cambridge University Press.)

The "Salex" Book of Lens Bargains. Pp. 48. (London: The City Sale and Exchange, Ltd.)

Taylors Bee Supplies, 1929. Pp. 44. (Welwyn, Herts.: E. H. Taylor, Ltd.)

Captain James Cook, 1728-1928. Pp. 16. (London: Francis Edwards, Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 22.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. F. A. Freeth: The Qualifications of an Industrial Chemist.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Dr. G. Slot: A Clinical Method of Estimating Cardiac Efficiency in Children, and the Work of a Rheumatism Supervisory Centre.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—Prof. C. H. Lees: The Free Periods of a Composite Elastic Column or Composite Stretched Wire.—Dr. A. Ferguson and J. A. Hakes: A Capillary Tube Method for the Simultaneous Determination of Surface Tension and of Density.—Demonstration of a Standard Electrostatic Voltmeter and Wattmeter, used for Measurements of Alternating Currents at Power Frequencies at the National Physical Laboratory, by Dr. E. H. Rayner.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5.30.—A. S. Grunspan: Specification Notes and Good Practice relating to Concrete and Reinforced Concrete Work.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Relations between the Properties of Engineering Materials and their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (jointly with Institutions of Civil and Mechanical Engineers), at 6.15.—W. Ford: Standardisation.

ROYAL AERONAUTICAL SOCIETY (Students' Section), at 6.30.—L. T. Brown: The Napier Lion Engine.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—G. H. Taylor: Reduction of Weight in Rolling Stock.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.—F. H. Terleski and others: Discussion on The Manufacture of Toilet Soap and Glycerin.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—G. Baker: Electrical Precipitation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. C. Weston: Enlarging.
WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—Dr. W. H. Hatfield: The Response of Steels at Elevated Temperatures.
BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—W. A. Walsh: Some Recent Improvements in Textile Machinery (Lecture).
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Calderwood: The Application of the Heavy Oil Engine to Yachts and Small Craft.
INSTITUTION OF PRODUCTION ENGINEERS (at 83 Pall Mall), at 7.30.—The Story of a Sparking Plug.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Surg.-Comdr. S. F. Dudley: Human Adaptation to the Parasitic Environment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. F. A. Bather: Lily-Stars of the Sea: How they fit their Surroundings.
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).
TODMORDEN TEXTILE SOCIETY.—S. Taylor: Winding and Warping (Lecture).

SATURDAY, FEBRUARY 23.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—F. E. Smyth: Diamond Boring Applied to Tapping Drowned Areas Underground.—H. C. Pawson: Land Drainage.—R. G. Lunnon: The Laws of Motion of Particles in a Fluid. —*Paper open for discussion*:—Roof Control on Longwall Faces, J. F. C. Friend.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (III.).
HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—K. G. Tidd: Marine Refrigeration.

MONDAY, FEBRUARY 25.

INSTITUTE OF ACTUARIES, at 5.—J. Bacon: An Experience of Assured Lives in the State of Mysore.—L. S. Vaidyanathan: Mortality of Indian Assured Lives.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. W. Gregory: Electric Supply to the Rural Districts of England.
ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas M. Legge: Thirty Years' Experience of Industrial Maladies (Shaw Lectures) (II.).
MEDICAL SOCIETY OF LONDON, at 8.—Prof. A. H. Burgess and C. H. S. Frankau: Acute Intestinal Obstruction.
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. K. Fry: Fractures of the Mandible in, and Posterior to, the Molar Region.
CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School), at 8.45.—Dr. A. E. Barclay: Where Science and Medicine meet.

TUESDAY, FEBRUARY 26.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Prof. K. Hansen: The Psychical and Allergic Factors in Asthma.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (I.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (V.).
INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—J. H. R. Nixon: Motor Converters.
INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—R. A. Chattock: The Modern Use of Pulverised Fuel in Power Stations.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. K. Tallent: A Simplified Method of Screen Negative Making.—R. E. Owen: Physical Development and the Nature of the Latent Image.
INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof. C. H. Desch: The Deformation of Metals.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.
ROYAL AERONAUTICAL SOCIETY (Leeds Branch).—N. S. Norway: Control of Rigid Airships.
MANCHESTER ATHENÆUM TEXTILE SOCIETY.—H. Broadbent: The Law of Contracts (Lecture).

WEDNESDAY, FEBRUARY 27.

LIVERPOOL ENGINEERING SOCIETY (at The Temple, Liverpool), at 6.30.—Mr. Woolnough: Valves for Reciprocating Steam Engines.
INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—H. Kerr Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (jointly with Midland Centres of Institutions of Civil and Mechanical Engineers) (at Midland Institute, Birmingham), at 7.—Capt. J. M. Donaldson (Power Systems), J. G. Hines (Telephone Systems), and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plant.
INSTITUTION OF WELDING ENGINEERS (at Birmingham Chamber of Commerce), at 7.—C. S. Milne: Welding and Cutting Practice with Low Pressure Plant.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.15.—Dr. F. S. Sinnatt: A Fuel Research Subject.
HALIFAX TEXTILE SOCIETY (at White Swan Hotel, Halifax), at 7.30.—Dr. S. G. Barker: Alkaline Standards for Scouring and Effect upon Dyed Goods, etc. (Lecture).
ROYAL SOCIETY OF ARTS, at 8.—A. F. Suter: Resins.
EUGENICS SOCIETY (at Royal Society).
SOCIETY OF CHEMICAL INDUSTRY (Newcastle-on-Tyne Section) (at Armstrong College).—S. A. Wikner: Tar Distillation (IV.).

THURSDAY, FEBRUARY 28.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District) (at Town Hall, Southall), at 10.45 A.M.
ROYAL SOCIETY, at 4.30.—Sir Charles Martin and others: Discussion on Ultra-Microscopic Viruses infecting Animals and Plants.
LINNEAN SOCIETY, at 5.—Symposium on the Occurrence of Natural Hybrids:—Dr. A. W. Hill: Hybridisation in the New Zealand Flora, with Special Reference to *Gaultheria*.—E. M. Marsden-Jones and Dr. W. B. Turrill: Hybridisation in Certain Genera of the British Flora.—Prof. C. E. Moss: Some Natural Hybrids of *Clematis*, *Anemone*, and *Gerbera* from the Transvaal.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (II.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. O. Rankine: Physics in Relation to Oil Finding (II.).
BIOCHEMICAL SOCIETY, BIRMINGHAM UNIVERSITY, at 5.30.—A. G. Norman: Immunity.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Ll. B. Atkinson: How Electricity Does Things (Faraday Lecture).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—R. A. Fraser: The Flutter of Aeroplane Wings.
INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffs Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—W. A. Benton: Metallurgy and the Evolution of the Balance.
INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—H. Page: The Distribution of Compounding Ingredients in Rubber Mixings.—W. H. Reece: Chemical Reactions in Rubber Compounds (I.): Litharge and Pine Tar.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Royal Hotel, Luton), at 7.30.—G. Baston: Some Notes on Gear-box Design.
INSTITUTE OF BREWING (Yorkshire and North-Eastern Section) (at Queen's Hotel, Leeds).—R. Seligman: Applications of the Plate Heat Exchanger to Brewery Purposes.

FRIDAY, MARCH 1.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7. Informal Meeting.
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Prof. T. P. Hilditch: Recent Advances in our Knowledge of the Structure of the More Common Fats.
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—W. Lawson: The Rotor Bearings of Electricity Meters.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—Sir Joseph Isherwood, Bart., and others: Do the Rules of Classification Societies tend to improve Shipbuilding and Engineering in this Country?
GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. E. Hollingworth: Evolution of the Eden Drainage in the South and West.—M. Chatterjee: The Accessory Minerals in the Bodmin Moor Granite.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—L. S. Atkinson: The Control of Electric Lifts.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 51 West Regent Street, Glasgow), at 8.—E. C. Philbrow: Inspection.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Robert Robertson: Infra-Red Spectra.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (Birmingham Conference on Chromium Plating).

SATURDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (I.).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 22.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Air Transport and the Disintegration of Economic Barriers.
UNIVERSITY COLLEGE, at 5.30.—Dr. J. H. Jones: Hygiene of the Mercantile Marine. (Succeeding Lectures on Mar. 1 and 8.)

SATURDAY, FEBRUARY 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. Bernard Smith: Zermatt and its Glaciers.

MONDAY, FEBRUARY 25.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—J. Bailey: Preservation of the Countryside.
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—T. Hacking: The Law in Regard to the Sale of Milk.

WEDNESDAY, FEBRUARY 27.

UNIVERSITY COLLEGE, at 5.—Dr. J. H. Burn: The Properties of, and Methods of Estimating, some Therapeutic Agents. (Succeeding Lectures on Feb. 28 and Mar. 1.)—At 5.30.—J. A. Wilks: Special Library Collections at University College.

THURSDAY, FEBRUARY 28.

BEDFORD COLLEGE, at 5.15.—A. E. Henderson: Byzantine Architecture.
UNIVERSITY COLLEGE, at 6.—W. G. Tarrant: Estate Development and its Relation to Town Planning.

SATURDAY, MARCH 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davis: English Food, Past and Present.