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## Ethnographical Studies and Colonial Administration.

IN a recently published work by a resident in East Africa of many years' standing, it is stated that the native regards with profound mistrust all white men excepting only British officials and missionaries. This observation, perhaps a little too sweeping and perhaps too flattering to our vanity if assumed to be of universal application, lends support to the view, with which we have been made familiar since the British Empire became self-conscious, that members of the British race are pre-eminently successful as settlers and administrators in strange lands. In so far as this is borne out by the facts, it is in large part due to a certain ability to handle a backward people with a degree of sympathetic understanding. Although it is true that the British record in this matter has not been spotless in the past, and even now is not always above reproach, yet judged by results our methods may perhaps bear comparison, not entirely to their disadvantage, with those of other nationalities.

Lest such a comparison may appear invidious, it is possible to appeal for justification to facts which were forced on the attention of British officers in the former German colonies in Africa after the War. In the official reports, reference is frequently made to behaviour on the part of the natives which certainly seemed to indicate that their former rulers had inspired them with anything but confidence in the white man.

There is, however, less reason for diffidence on our part in instituting such a comparison now that in France, the power with a stake in tropical Africa second only to that of Britain, an appeal has been made to British methods to explain and justify action which has recently been taken by the University of Paris.

The pre-eminence of France in the study of prehistoric man and his handiwork has to a certain extent overshadowed the achievements of those of her men of science who have devoted themselves to other branches of anthropological investigation. To say this is not to ignore the claims of the distinguished human anatomists who have done so much to systematise the study of physical anthropology; or of the distinguished sociological group, with the late E. Durkheim at its head, which founded and carried on *L'Année Sociologique*, now happily revived after an intermission of some years owing to the War. Perhaps only those who follow specialist publications are aware of the extent to which ethnographical investigation has been carried on in the French colonies. Of the results, comparatively little has appeared in the more widely read publications devoted to the study of anthropology. A conspicuous example is the work which has appeared

in the valuable and scholarly publications of the École d'Extrême Orient, dealing with the cultures and peoples of the French possessions in Further Asia. It ought, perhaps, to be unnecessary to emphasise the value of much of the work which has been done in Madagascar and the colonies of North and West Africa.

On more than one occasion in these columns, stress has been laid on the practical value of anthropological training in the administration of the affairs of backward races, or, to use the more general term, of peoples of non-European culture. It has been of interest to those who take this view to note that in the courses of lectures on ethnology and other departments of anthropology which were advertised at the opening of last winter's session of the University of Paris, there was a distinct bias in the direction of the possible practical application of the instruction to be given. Even courses of a general character in the study of religion and social anthropology frequently had special reference to the native races of some or all of the French colonial possessions. The study of Moslem custom and religion was naturally capable of more directly utilitarian treatment; while a large number of courses in linguistics covered many of the more important native languages under French jurisdiction.

A more significant development, however, is the foundation within the University of Paris of an Institute of Ethnology. The object of the Institute is, in the first place, to create a body of professional ethnologists and to give to any residents or intending residents in the French colonies who have an inclination for linguistic or ethnological studies, such instruction as will enable them to carry on these studies intelligently and in accordance with methods which will render the material collected of scientific and practical value. Secondly, to direct attention to recently discovered facts or newly developed methods with the view of their verification, and the testing in the field of any hypothesis under discussion. Thirdly, to publish ethnographical works which, owing either to their length or the amount of illustration they require, cannot be published in the usual periodicals. Fourthly, in conjunction with the colonial authorities, to send expeditions into the field and not to leave to foreigners the exploitation of the ethnography of the French colonies, as has happened in the past.

The idea of such an Institute was first put forward by M. Marcel Mauss in 1914; but its realisation has only recently been attained, the project having been revived in 1924. As a teaching body the Institute will in no way conflict with any existing interests. On the contrary, its primary function will be to act as a co-ordinating body for the courses already provided, or to be provided, at the University, the Collège de France, the Museum, the École des Hautes Études, the École Coloniale, and the École des Langues Orientales Vivantes. It will provide, in addition, in courses such as cannot be obtained elsewhere, a small number of lessons in technical matters with the view of giving an orientation to the future ethnologist. The Institute will grant a diploma in anthropology and, if or when the necessary ministerial permission has been obtained, a certificate of Licencié ès Lettres.

It is not without interest to note that Prof. Lévy-Bruhl, in an account of the Institut d'Ethnologie and its organisation and objects, which appears in the *Revue d'Ethnographie et des Traditions Populaires*, 4me trimestre, 1925, Nos. 23-24, indicates to what an extent the founders have been influenced by British methods in defining the scope and methods of the Institut. He opens with a reference of some length to Capt. Rattray's book on Ashanti, pointing to the incident of the 'Golden Stool' there related as an example of the way in which a serious conflict with the natives, and very possibly a punitive expedition, were averted by the advice based on expert knowledge which the newly constituted anthropological service was able to place at the disposal of the administration. Had it not been for the official anthropologist's knowledge of native customs and ways of thought, action in connexion with the Stool which it had been decided to take, without thought of its possible effect on the religious susceptibilities of the native in view of the sacred character of the Stool, would almost certainly have caused a serious uprising. Prof. Lévy-Bruhl goes on to express the hope that a similar anthropological service may one day be instituted in the French colonies. It will then be the aim of the Institut d'Ethnologie to turn out officers competent to man it, not necessarily highly trained ethnologists, but men with a sufficient knowledge of anthropological method to enable them to collect material of both scientific value and practical utility. He pertinently adds that in the study of the resources of the French colonies which is necessarily a preceding condition of their full development, the greatest asset of all, the native population, should not be overlooked.

However flattered we may feel at the compliment implied in Prof. Lévy-Bruhl's reference to the work of Capt. Rattray and his department, British anthropologists have still to regret that the principle that all administrative officials in British dependencies with backward peoples under their jurisdiction should be trained in anthropological methods is an ideal which has yet to be officially adopted in practice. An argument which is applicable to the case of the French colonies should, it is permissible to say, apply with immensely greater cogency to that of the British Empire.

## Man at Great Altitudes.

*The Respiratory Function of the Blood.* By Joseph Barcroft. Part 1: *Lessons from High Altitudes.* Pp. x+207. (Cambridge: At the University Press, 1925.) 12*s.* 6*d.* net.

WHOEVER reads this book—and every physiologist who deals at all with the hæmato-respiratory functions must read it—will gain one certain result: he will conceive a sincere liking for the author, as the ideal companion under low barometric pressure. In a style intimate, as between comrades in adventure, Prof. Barcroft here sets forth his experiences in his various invasions of the regions of low oxygen, the Peak of Teneriffe, the Capanna Margherita on the summit of Monte Rosa, Cerro de Pasco in the Andes, and last but not least the glass chamber in his laboratory where for six days he breathed the oxygen down, and himself thus virtually up, to the physiological equivalent of an altitude which proved too much of a strain even for his bold and cheerful spirit.

Prof. Barcroft reminds us that the modern sport of mountaineering originated in such essentially scientific expeditions to the upper regions as those of de Saussure on Mont Blanc. It is quite proper, therefore, that the scientific treatment of the physiological effects of low oxygen, mountain sickness, and acclimatisation should retain something of the zest of a noble sport. In this field the investigator is himself the subject observed, and in his own person suffers discomfort and overcomes hardships as great as any explorer of a new country. Yet it is also in this field that physiology has most nearly emulated the precision of physics and chemistry. It requires literary art to bring out the sporting aspects of oxy-hæmoglobin dissociation curves. Prof. Barcroft imparts 'human interest' (to use the journalistic term) even to the gas laws.

As it happens, although mountaineering is not a competitive sport, the physiology of altitude is just now almost as competitive as football or rowing between two of the universities of England. It was shown by Paul Bert in France in the last century by means of a low-pressure chamber, and by the late Prof. Zuntz of Berlin by his expeditions to the Alps, that the one essential factor in the decrease of barometric pressure at great altitudes is the lower partial pressure of oxygen in the lungs and in the blood. The condition induced is essentially asphyxia.

During the first decade of this century, Haldane and his co-workers at Oxford carried out experiments which were so fundamental and so illuminating that they may be said to have created the physiology of respiration. To follow up the principles of vital regulation thus revealed, the next step was the study of the adjustment which respiration may make to the decreased oxygen pressure at high altitudes. Accordingly, Haldane and Douglas from Oxford, accompanied by Henderson and Schneider of Yale, spent five weeks during the summer of 1911 on the summit of Pike's Peak, Colorado, altitude 14,100 feet. Their observations were supplemented by Miss M. P. FitzGerald, who determined the alveolar carbon dioxide and the hæmoglobin of people resident at various altitudes between sea-level and 11,000 feet. The fundamental principle was thus established that the adjustment of respiration in states of complete acclimatisation is strictly quantitative. The basic controlling factor is the partial pressure of oxygen in the lungs. To this factor (*a*), the alveolar carbon dioxide (*b*) and the blood alkali (*c*) come gradually at every altitude into the relation $a : b : c = 100 : 40 : 60$ (for example, 50 : 20 : 30 at about 17,000 feet, bar. 390 mm.); and the volume of breathing during rest is the reciprocal of the alveolar carbon dioxide.

In addition to this law, Haldane postulated an active secretion of oxygen by the tissues of the lungs, so as to raise the pressure of oxygen in the blood above that in the air in the lungs: a process analogous to that by which the kidney may produce urine of higher concentration in respect to salts than in the blood from which the salts are drawn.

At this point Barcroft takes up the story; and the book before us is in the main an account of the investigations of the Cambridge-Harvard expedition to the Andes which he organised and led. On the basis of the results obtained by that expedition, Barcroft accepts in the main the first part of the conclusions of the Pike's Peak expedition; but he rejects now absolutely the hypothesis of oxygen secretion in the lungs. It must, indeed, be admitted that the direct determinations of the pressure of oxygen in the arterial blood in relation to that in the air of the lungs, which he and his co-workers achieved, afford strong evidence that the former never exceeds, indeed never quite equals, the latter. Thus the passage of oxygen from the atmosphere into the blood must be dependent, according to the view of Prof. Barcroft and his co-workers, wholly upon the physical process of diffusion. The adjustments constituting acclimatisation do not then include oxygen secretion.

How great a problem is thus presented to physiology is evident from the fact which Prof. Barcroft points out that healthy men who go in a day, even by railway and with no exertion in comfortable, well-heated cars, from sea-level up to 14,000 feet in the Andes, are rendered acutely ill. Men who ascend direct from sea-level to 23,000 feet in a balloon lose consciousness and

die. Yet a large population in the Andes and Tibet spend their entire lives at 14,000 or 15,000 feet, and the members of the two expeditions above referred to were quite comfortable and well when acclimatised at Cerro de Pasco and on Pike's Peak. Furthermore, the members of the Mount Everest expeditions became acclimatised to 23,000 feet, and in some cases ascended even to 26,000 feet without mountain sickness, as is described in an appendix in this book by Major R. W. G. Hingston, Medical Officer to the Everest expedition of 1924.

The utmost value attaches, therefore, to Prof. Barcroft's observations and discussions bearing upon different aspects of the problem of accounting for so extraordinary a power of adjustment in the living organism. Prof. Barcroft would himself be the first to recognise that if oxygen secretion is ruled out (and Dr. Haldane is still to be heard in reply at the meeting of the British Association at Oxford next August) the problem of acclimatisation stands out only the more imperatively. Thus, if the reviewer may be allowed to instance facts which the conception here presented seems scarcely as yet adequate to cover in detail, attention may be called to the rapidity with which a person acutely mountain-sick may develop a comfortable degree of acclimatisation. Such cases of rapid acclimatisation were easily explained on the theory of oxygen secretion. They still require much study to show how they are possible as results of the comparatively slowly developing changes in the blood. Indeed, the shift of the oxy-hæmoglobin dissociation curve to the left which Prof. Barcroft now postulates was not found in any previous investigation, either by the Pike's Peak expedition (using Barcroft's method) or by himself at Teneriffe. It affords one of the strongest grounds for seconding Prof. Barcroft's expressed hope that others may carry further the study of altitude at Cerro and on Pike's Peak.

Attention may also be directed to the proven efficiency of inhalation of dilute carbon dioxide in overcoming the ill effects (which are essentially mountain sickness) following carbon monoxide asphyxia, and following anæsthesia. Such beneficial effects are presumably due to an adjustment of the blood of the same general character as that which Prof. Barcroft postulates in acclimatisation; but in this case probably the shift is to the right.

It is especially to be hoped that the unique opportunities of observing acclimatisation between 15,000 and 25,000 feet afforded by expeditions to Mount Everest will hereafter be utilised to the full. In future expeditions to Tibet it should be possible to combine this object without impairing the chances of attainment to the highest point in the world. For science the value of this accessory service would certainly equal the primary object of expeditions to Mount Everest.

In closing, a few words may be permitted on the general importance of the problem of asphyxia to the solution of which Barcroft and Haldane in their friendly controversy are making fundamental contributions.

The most universal and characteristic process of life lies in the exchange of oxygen, combustion in living cells or, as physiology terms it, respiration. When we understand asphyxia and the adjustments which the living body makes to combat it, we shall have solved a problem which is the reciprocal of that of the nature of life. We may fairly hope that, at least to a considerable extent, mere inversion of the terms in which the solution of the problem of asphyxia will be stated, will afford a solution of the inner nature of respiration, and thus far of life itself.

YANDELL HENDERSON.

## The Geology of West Lothian.

*The Rocks of West Lothian: an Account of the Geological and Mining History of the West Lothian District.* By Henry M. Cadell. Pp. xvi + 390 + 32 plates + 2 maps. (Edinburgh and London: Oliver and Boyd, 1925.) 18*s*. net.

THE county of West Lothian is of exceptional interest in Scottish geology, as it forms the connecting link between the two ends of the Midland Valley, and affords the most trustworthy evidence for the correlation of the dissimilar Carboniferous sequences in the western and eastern basins. The county is also of interest as the seat of the Scottish oil shale industry.

The geological and physiographic history of the county has been summarised by Mr. H. M. Cadell in an interesting and beautifully illustrated volume. Mr. Cadell knows the county intimately; he understands its relations to the rest of Scotland from knowledge gained during his service on the Scottish Geological Survey; and he brings to the interpretation of its rocks observations made during world-wide travels. Many of the illustrations are drawn from his foreign experiences, such as below a reproduction of von Humboldt's famous view of Jorullo in 1803, his own sketch taken from the same point of view in 1906. Much of the information in the volume has been previously published in technical journals, but it has been re-written in a simpler and more popular form.

The book is most concerned with the Scottish Carboniferous system; it gives an excellent account of the geology and economics of oil shale, and of some of the associated rocks such as the Houston marls, which the author shows are not of volcanic origin. He records

the result of the bore at West Calder, 4000 ft. deep, put down in the search for mineral oil; instead of finding oil, it passed through an unexpected thickening of the volcanic rocks below the Burdiehouse limestone. The chapters on the Lower Carboniferous rocks describe their successive limestones and volcanic phenomena, which in this district are exceptionally well displayed, partly in surface outcrops, and partly in the evidence as to the deep-seated structure of some ancient volcanoes revealed by bores put down during mining prospecting. During the Carboniferous, according to the author, the country was broken across by an east-to-west rift valley, between the Ochiltree fault on the north and the Calder and Middleton Hall faults on the south; he illustrates this valley by one of his graphic reconstructions of the scenery, due to his combination of geological insight and artistic skill.

Mr. Cadell was one of the first Scottish geologists to recognise the importance and significance of the buried river channels that lie deep below the present sea-level; he brings the knowledge of those in West Lothian up-to-date in chapters dealing with the development of the present topography during the Kainozoic era, of which the only local evidence is physiographic.

The last three chapters are devoted to the history of mining in the county from that at Carriden about 1165 by the monks of Holyrood; he describes the condition of coal mining in the seventeenth century during the wars of the Commonwealth, gives an account of the early Scottish salt industry, and tells the story of the Hilderston silver mine, which was worked early in the seventeenth century and was unsuccessfully re-opened in 1873 and 1896. The author, owing to his descent from the founder of the Carron Co., has been able to draw on unpublished records in his interesting account of the mining and iron industry of the Bo'ness district since 1760.

## Nematode Parasites of Vertebrates.

*The Nematode Parasites of Vertebrates.* By Prof. Warrington Yorke and Dr. P. A. Maplestone. Pp. xi+536. (London: J. and A. Churchill, 1926.) 36*s.* net.

THE outstanding spirit of the early study of helminthology was the search for knowledge for its own sake; whereas the motive underlying the activities of workers of more recent years has been, partly unconsciously perhaps, its potentiality for human and animal welfare. The literary output on the subject of the structure and relationships of the Nematoda during the last hundred years was enormous, and the position would doubtless have been chaotic had not Diesing, in 1866, summarised the knowledge of that time in his "Revision der Nematoden," and Stiles and Hassall, in 1919, provided the materials for a similar revision in the invaluable subject-index on the roundworms, in their "Index Catalogue of Medical and Veterinary Zoology." During the past ten years the labours of Railliet, Skrjabin, and Travassos have resulted in a classification of the parasitic nematodes which has met with considerable acceptance, though of course, in points of detail, there remains room for adjustment. The volume issued by Yorke and Maplestone is therefore to be welcomed as marking the present position of the classification of the Nematoda in the same significant way as did that of Diesing half a century ago.

The authors have handled the vast mass of material in a masterly manner. Accepting Railliet's classification in the main, they have provided a series of definitions and keys which should enable those acquainted with the structure of the Nematoda to place many, if not all, of the known species in their proper genera. Each genus is illustrated and defined, the definition being based largely upon the type species; other species which in the authors' view can be reasonably allocated to the genus are listed alphabetically.

As generic definitions based too closely upon the type frequently contain characters of specific value only, this method is likely to entrap the unwary. Moreover, those who prefer to rely upon text-books rather than consult the original publications, should note that many of the older and probably legitimate species have been omitted, and there is a distinct danger that these may be recorded again as new species. It is perhaps regrettable that some provision, such as the compromise recently suggested by Stiles, has not been adopted whereby collective group names, *e.g.* Fusaria, Sclerostoma, and so on, would have been given some taxonomic place to species which, although probably valid, have not yet been sufficiently fully investigated to admit them to modern and more restricted genera.

With each species the 'type host' in which it has been found is listed, but no indication is given of the almost equally important 'type locality,' although the subject of geographical distribution is one which is likely to interest many of those who turn to this work for information. The same may be said of intermediate hosts. In these days, when the bionomics of animals is attracting more and more attention, the omission of all reference to the life-history in a book with such a comprehensive title is, to say the least, unfortunate.

In the course of their revision the authors have found it necessary to create a number of new genera, many of which are based on new species, of which brief descriptions are given in the form of footnotes.

More than three hundred genera are illustrated in the text, and in most cases the type species has been used. Many of these are original, but the goodwill of other workers has been relied on for this purpose to a surprising degree.

In spite of these criticisms, the authors are to be congratulated not only on having produced a work which is likely to become a standard book of reference, but on having also made a definite contribution to the classification of the order Eunematoda.

## The Composition of Milk.

*Variations in the Composition of Milk: a Study of the Results of Analysis of Six Hundred and Seventy-six Samples of Milk (each Sample being the Milk of one Cow) from Cows of various Breeds throughout Scotland in 1921–22.* By Dr. J. F. Tocher. Pp. 195. (Edinburgh and London: H.M. Stationery Office, 1925.) 21*s.* net.

THE Inter-departmental Committee appointed to report on the regulations, etc., governing the sale of milk in Scotland arranged for a large number of samples of milk taken at random from individual cows to be analysed. No particular breed was selected, nor was any account paid to the period of lactation, feeding, age of animal, etc., the only consideration being to ensure proper and thorough milking and the taking of a representative sample. In all, 676 samples of milk were dealt with, the samples being both from morning and evening milkings, with a small proportion of midday samples (the latter, however, not included in the statistical analysis). The examination of the samples covered the usual determinations of specific gravity, fat, solids not fat, and in addition the estimation of nitrogen, lactose, ash, refractive index and freezing-point.

The report which Dr. Tocher has drawn up gives a very exhaustive account of the manner in which the inquiry was conducted, the results of the determinations, the statistical analyses of the results and the conclusions which may be drawn from them.

Whilst the object of the inquiry was to collect data upon which legislation could be based, the information which has been gained is of considerable scientific interest, and some important facts concerning the composition of milk and the extent to which the constituents vary in the case of individual cows has been brought to light. The milk of single cows is shown to vary widely, in the case of butter fat from 1·7 per cent. to 7·5 per cent., whilst the solids not fat may be from 6·9 per cent. to 10·6 per cent. In the case of composite samples there were found to be wide differences according to the number of cows from which the milk sample was taken. Thus herds of five cows fell below the present standard for solids not fat (8·5 per cent.) in the proportion of six groups out of a hundred, whilst larger herds of twenty cows only fell below the standard in one group out of a thousand.

On the practical side of the subject, Dr. Tocher advocates that milk should be supplied from a large number of cows so as to reduce the variations; that good cows should be selected and that the inheritance of butter-fat yield should be completely studied. Some other matters of interest in the report are the lactose content and freezing-point of milk, the influence of the lactation period and the effect which this may have upon the interpretation of the results of feeding trials.

## Our Bookshelf.

*Handbuch der Arbeitsmethoden in der anorganischen Chemie.* Gegründet von Arthur Stähler. Fortgeführt von Prof. Erich Tiede und Friedrich Richter. Zweiter Band: *Physikalische und chemische Operationen.* Zweite Halfte: *Physikalische und chemische Operationen besonderer Art.* Herausgegeben von Prof. Erich Tiede und Friedrich Richter. Pp. x+655+1648. 54 gold marks. Vierter Band: *Ausgewählte Kapitel der präparativen Chemie.* Zweite Hälfte. Pp. x+315-572. 14·50 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1925 and 1926.)

THE special operations described in the second part of the second volume of this work include microchemical methods, membrane-filtration, electrometric analysis and electrolytic purification, decomposition with a silent electric discharge and in the arc, the use of radio-elements as indicators, identification of crystals and X-ray analysis, the use of high vacua and of high pressures, mass-spectrography, the use of liquid ammonia, sulphur dioxide, hydrogen chloride and hydrogen sulphide as solvents, and the general operations of photochemistry. The technique of these diverse operations has been described by fifteen authors, in a volume of about 1000 pages. It will form a most valuable work of reference for those who may have occasion from time to time to make use of one or other of the special methods with which it deals.

The first part of the fourth volume had already appeared when the present editors took charge of the "Handbuch." They did not regard it as necessary to carry to completion the original plan for the volume on preparative chemistry, but have concluded their work by adding to Part 1 of vol. 4 an abbreviated Part 2, dealing with thermite-reactions, phosphorescent materials, mineral synthesis and the growing of crystals. They have also included a very interesting catalogue of some hundreds of substances which can be prepared in a state of great purity (*e.g.*, as required for determinations of atomic weight), with references to the original papers in which the methods of preparation of these pure elements and compounds are described.

*The Engineer and the Prevention of Malaria.* By Henry Home. Pp. x+176+14 plates. (London: Chapman and Hall, Ltd., 1926.) 13*s.* 6*d.* net.

THE object of this book, as mentioned by the author in the introductory note, is to help engineers engaged on anti-malarial works to obtain the necessary information without reference to numerous publications on public health, entomology, and parasitology which is otherwise essential. It is furthermore believed that medical officers will find material of value within its pages.

The book deals with the various engineering problems which so frequently arise in malaria prevention in a clear and concise manner. There are fourteen plates and numerous text figures which contribute to the value of the work. The first three chapters are devoted to the economic aspect of the disease, the malarial mosquito, and to anti-malarial schemes. The eight following chapters deal with the varied aspects of lowland drainage, hill drainage, details of construction, oiling, larvicides, vegetation, natural enemies, the question of housing, and possible biological methods of control.

There are four appendices, the first of which, by Lieut.-Colonel MacArthur, deals with mosquito netting from the point of view of the right determination of the apertures and the gauge of wire or the size of cotton thread used by the manufacturers; Dr. P. A. Buxton contributes the next two appendices dealing with applied entomology as regards anophelines and the house fly. The final appendix contains an account of the hydrogen-ion concentration of waters and methods of estimation.

The engineer and the sanitarian are, or at least should be, frequently associated in endeavours to combat disease, and this is especially the case in anti-malarial schemes. To formulate a successful campaign on sound practical lines demands a close co-operation between the two services. In this little book both should find much of common interest, and its study will undoubtedly tend to foster that spirit of co-operation with and sympathy in the work of the two which is essential in so many of the efforts directed to the control of disease. G. E. F. STAMMERS.

*Rothamsted Experimental Station Library.* Catalogue of the Printed Books on Agriculture published between 1471 and 1840; with Notes on the Authors by Mary S. Aslin. Pp. 331+22 plates. (Harpenden, Herts: Rothamsted Experimental Station, 1926.) Paper, 10*s.*; cloth, 12*s.*

NOT the least notable feature of the Rothamsted Experimental Station is the library, containing as it does probably the most complete collection in existence of ancient and modern books (in all languages) on agriculture. The number of ancient books, in particular, is remarkable, including, it may be noted, copies of such treasures as Crescentius' "Liber ruralium commodorum," the first printed book on agriculture. Of this the library possesses a fine illuminated folio, bearing the insignia of Sigismund II. of Poland, and a unique early edition of Fitzherbert (*circa* 1523).

As the director, Sir John Russell, points out, the dates 1471 and 1840 are both significant in relation to the history of agriculture; the first marks the appearance of Crescentius, and the latter the definite break with empiricism which followed the foundation of the Rothamsted Station by Lawes. The catalogue, therefore (relating to 1500 books published between these dates), may be said to record the empirical stage of agriculture, and it speaks much for the enterprise and, may we add, the culture of the governors of Rothamsted and their director, that such a collection—largely of bibliographic interest—should have been added to the institution. Their interests in the art, which it is their mission to inspire with science, are conceivably more limited, but, as the director, in the words of Comte, aptly says: "No idea can be properly understood apart from its history."

*Volumetric Iodate Methods.* By Dr. George S. Jamieson. (New York: The Chemical Catalog Co., Inc., 1926.) 2 dollars.

THE "iodate method," first proposed by L. W. Andrews in 1903, depends on the formation of iodine monochloride, and the disappearance of the iodine colour imparted to an immiscible solvent such as chloroform or carbon tetrachloride. Since the last traces of free iodine are collected in a small volume of immiscible solvent, the sharpness of the end-point is remarkable; and when a titration has been completed, there is no return of the iodine-colour even after keeping the solutions for a day. These factors, together with the great stability of the solutions of potassium iodate and the absence of interference by many kinds of organic matter, make the use of this method very advantageous in many forms of analysis. The author has therefore put together a description of a dozen different determinations (*e.g.* of Sb, Cu, Hg, Mo, Sn, Mn, $N_2H_4$, $H_2O_2$, $PbO_2$, etc.) in which the method can be employed with advantage. He has further increased the value of the book by giving details of the application of the method to the analysis of arsenic and copper in insecticides, of antimony, copper and tin in alloys, etc. The book should be of considerable value in giving publicity to a new and valuable method of analysis, as well as in providing precise directions for applying it.

*Wellenlangenmessungen des Lichtes im sichtbaren und unsichtbaren Spektralbereich.* Von Prof. Dr. Paul Eversheim. (Sammlung Vieweg, Heft 82.) Pp. v+111. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 7 gold marks.

THE object of this book is to give a concise survey of the present state of our knowledge concerning the exact determination of standard wave-lengths. The author first gives a short general description of early measurements, together with Rowland's normal system, and refers to the necessity for its revision. He then deals with the more recent methods of determination, briefly referring to Millikan's work, and considering in detail the measurements of Benoît, Fabry and Perot. Succeeding chapters discuss the establishment of international standard wave-lengths, and many tables of standard lines in the visible region are given, attention being paid to the results of individual workers in order to indicate the accuracy of the standard data.

The ultra-violet and infra-red portions of the spectrum are treated in separate sections, due reference being made to the work of Lyman and Millikan. In the final chapter on X-rays, the work of the Braggs, of

Siegbahn and of others is described, and two clear diagrams of modern X-ray tubes for spectroscopic purposes are given.

The book may be thoroughly recommended to all interested in the matters with which it deals.

*Adventures of Exploration.* Book 4: *Africa.* By Sir John Scott Keltie and Samuel Carter Gilmour. Pp. iv+180. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.; n.d.) 2*s*.

THIS volume is the most recently published of a series of six supplementary readers designed to quicken interest in geography by stories of adventurous travel. They do not claim to give a coherent history of exploration, but serve to direct attention to the great steps and prominent names in the story of discovery. In this respect they form valuable supplements to the orthodox geographical text-book. After a general chapter on early voyages the story begins with Bruce at the Blue Nile, moves to Mungo Park and the Niger, and after a chapter on the seekers for Timbuktu, takes the reader to the great lakes, the Nile sources, with chapters on the work of Burton, Speke, Baker, Thomson, Livingstone, Stanley, and others, and finishes with some of Selous' adventures and Hassenein Bey's recent journey. The stories are admirably told, and well illustrated with maps and pictures. The series deserves to be widely used. R. N. R. B.

*Macmillan's Secondary School Atlas.* With an Introduction by T. Alford Smith. Pp. iv+64+8. (London: Macmillan and Co., Ltd., 1926.) 5*s*.

THE 64 pages of coloured maps in this atlas include physical and political maps of every part of the world, with enlarged maps of Europe and the more important parts of other continents. There are also January and July temperature maps and annual rainfall maps of all continents and the British Isles, geological maps of the British Isles and Europe, and a number of distributional maps of the world. The physical maps are particularly good, and not overcrowded with names. On all maps the projection is given. Although the scales vary a good deal, an attempt has been made to use simple multiples of the scales of the maps of Great Britain. An index of some two thousand names gives reference by latitude and longitude. The world-pressure maps would be improved by southward extension to show the Antarctic high-pressure area, and in the current and vegetation maps some revision is required on the coasts of Greenland. Murmansk, and not Alexandrovsk, is the terminus of the Murman railway.

*The Story of Minerals.* By Herbert P. Whitlock. (The American Museum of Natural History, Handbook Series No. 12.) Pp. 144. (New York: American Museum of Natural History, 1925.) n.p.

IN this book the author has aimed at a popular exposition of the elements of mineralogy, his declared intention being "to answer questions rather than to rehearse facts." In preparing it, he has taken advantage of his experience as Curator of Mineralogy in the American Museum of Natural History, and has fashioned the book to answer questions usually put by visitors to the Museum. About a third of the book is given to the principles of mineralogy, including chapters on "Nature's mathematics" (crystallography), "the mimicry of minerals," "water as a maker of minerals," and "change and decay in minerals." The remaining chapters describe some of the commoner minerals and groups of minerals. The book is very well illustrated, and should prove interesting as well as useful to those numerous visitors to the Museum who have not previously studied the science of mineralogy.

*Introduction to the Study of Organic Chemistry: a Theoretical and Practical Text-book for Students in the Universities and Technical Schools.* By Dr. John Wade. Revised by Dr. Henry Stephen. New and enlarged edition, with an Appendix containing Supplementary Practical Detail, forming with the text an Illustrative Laboratory Course. Pp. xx+646. (London: George Allen and Unwin, Ltd., 1925.) 8*s*. 6*d*. net.

WADE'S "Organic Chemistry" is a book which has enjoyed a deserved popularity for some years. It is therefore only necessary to say that the new edition appears to have been carefully prepared, and that the appendix of laboratory experiments, occupying 65 pages, makes the volume a self-contained guide for students preparing for honours degrees. Dr. Stephen has added a new chapter on derivatives of pyrone, chromone and xanthone, and some new matter at the ends of various chapters. The price of the book brings it within the reach of students, and it may be warmly commended.

*Gems and Gem Materials.* By Prof. E. H. Kraus and Dr. E. F. Holden. Pp. vii+222. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s*. net.

THIS is a well-illustrated account of gem minerals, in two parts. The authors remark in a brief introduction that the study of gem minerals has been named "gemmology," but it is a great relief to have their assurance that this term is not widely used. Part 1 (pp. 9-104) deals with the general properties of minerals, including chapters on the genesis, cutting and polishing, naming and manufacture of gem stones. Part 2 (pp. 107-213) gives descriptions of the various minerals used as gems, and includes numerous tables in which gem minerals are classified according to their properties. The last of these tables gives a summary of the properties of gem minerals described in the text, the arrangement of the minerals being alphabetical. The book concludes with a useful index.

*Le mouvement scientifique contemporain en France.* 3: *Les sciences physico-chimiques*; 4: *les sciences mathématiques.* Par Dr. Georges Matisse. (Collection Payot.) Pp. 320. (Paris: Libr. Payot, 1925.) 10 francs.

THIS volume constitutes a small guide-book which indicates the main contributions of French chemists, mathematicians, and physicists to modern scientific knowledge. Since the work of about thirty scientific workers is summarised, that of any individual worker is only outlined in a very brief manner.

## Letters to the Editor.

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

### On the Magnetic Properties of Single Crystals of Iron.

FORMERLY the preparation of single crystals of iron has been made by Goldschmidt's method, by which means crystals ranging from one to two centimetres in linear dimensions can be obtained; but the production of larger crystals by the same method is almost impossible. In 1924, however, Prof. C. A. Edwards obtained large crystals of iron by using Prof. Carpenter's method of preparing single crystals of aluminium, and thus opened to us an important route for the investigation of the true nature of the metal. Hitherto we have been able to measure only the mean of the properties differing in various orientations of the crystal, but we are now in a position to study the property of an individual crystal in different directions relative to its orientation.

Since the beginning of last year the present writers have used this method and obtained crystals of iron, for which the magnetic properties have been measured. The first communication of ours dealing with this investigation was published at the autumn meeting of the Denki Gakkai, Tokyo (Institute of Electrical Engineering), on Oct. 24, 1925. The present note contains the results of the investigations we have made during last year.

The magnetisation was measured with a rod of a

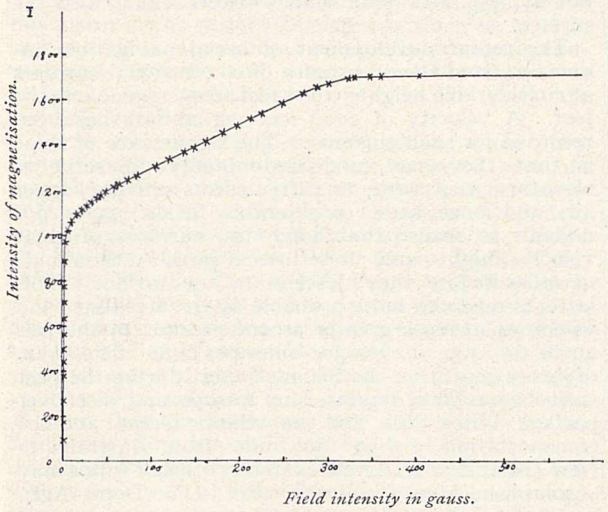


FIG. 1.—Magnetisation curve of a single crystal of iron.

single crystal of iron of the dimensions, 68·1 × 2·4 × 1·81 mm.³, the axis of the rod being inclined at angles of 21° 10′ and 70° 10′ to the tetragonal axis of the crystal. The ballistic method was used for the measurement of magnetisation. The curve of magnetisation plotted against the effective field is given in Fig. 1.

The characteristic features of the magnetisation curve are as follows:

(*a*) The curve is almost straight up to an intensity of magnetisation of 1000 c.g.s. units.

(*b*) Then the curve shows two sharp breaks or bendings.

(*c*) The saturation of magnetisation is much more easily attained than in the case of polycrystals, its value being 1710.

The hysteresis loss of a single crystal of iron is very small, amounting only to one-tenth of that of ordinary sheet iron containing silicon. It increases very rapidly with the numbers of grains or crystals in a specimen, as is shown in Fig. 2. It is therefore to be concluded that the hysteresis is considerably affected by an irregular distribution of molecular magnets at the grain boundaries.

The initial and maximum permeabilities also

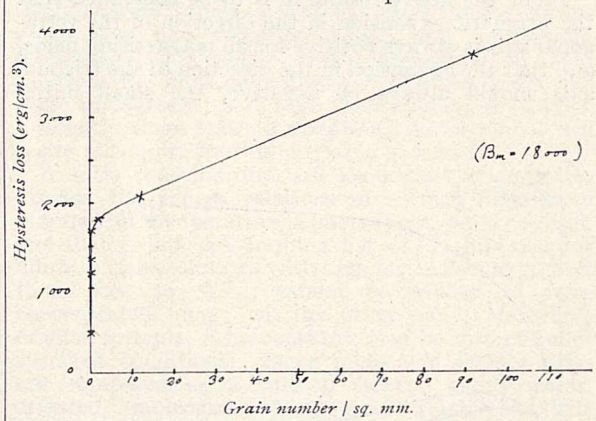


FIG. 2.—Curve showing the relation of hysteresis loss to number of grains or crystals in the specimens.

decrease with the number of grains. The following table contains the numerical results of our observations in this direction:

| Grain Number per mm.². | Initial Permeability. | Max. Permeability. | Hysteresis Loss. | Demagnetising Force. |
|---|---|---|---|---|
| | | | Ergs. | Gauss. |
| 92 | 600 | 3400 | 3730 | 0·604 |
| 12·1 | 900 | 3740 | 2070 | 0·325 |
| 1·9 | 980 | 3700 | 1840 | 0·273 |
| 0·15 | 1000 | .. | 1325 | 0·168 |
| 0·092 | 1500 | 4430 | 1170 | 0·147 |
| 0·0067 | 1700 | 4300 | 460 | 0·063 |

Five rods of single crystals and of dimensions 2 × 2 × 40 mm.³, of which three had their axes approximately lying in plane (100) and other two in plane (110), were next prepared; their axes had the following orientations with respect to the principal axis of the crystals:

| Specimen. | Orientation. | |
|---|---|---|
| No. 1 | 14° | nearly in plane (100), |
| ,, 2 | 25° | |
| ,, 3 | 33° | |
| ,, 4 | 27° | nearly in plane (110). |
| ,, 5 | 41° | |

With these rods the magnetic expansion was measured up to an effective field of 500 gauss by the method usually employed in our institute (*Sci. Rep.*, 9, 1920). The results of measurement are graphically given in Fig. 3 and may be summarised in the following terms:

1. The magnetic expansion of single crystals of iron is generally very large as compared with that observable in ordinary iron, its magnitude being about ten times greater than that in the latter iron.

2. In specimen No. 1, the axis of which subtends a small angle with the tetragonal, the magnetic expansion rapidly increases in weak fields and then slowly, tending to an asymptotic value, as the field increases (Fig. 3, *a*).

3. In specimen No. 5 the axis subtends a small angle with the trigonal. A very small magnetic expansion is observable in weak fields; above a field of 50 it is always negative, the amount steadily increasing with the field (Fig. 3, *c*).

4. In specimen No. 3, subtending a small angle with the digonal axis, the course of the curve is similar to that in specimen No. 5; the maximum elongation and the inversion field are a little greater, but the contraction in strong fields is about $\frac{1}{3}$ of that in specimen No. 5 (Fig. 3, *b*).

From the above results it is to be concluded that the magnetic expansion in the direction of the tetragonal axis is always positive for all magnetising fields, and that the expansion in the direction of the trigonal axis should always be negative, the small initial

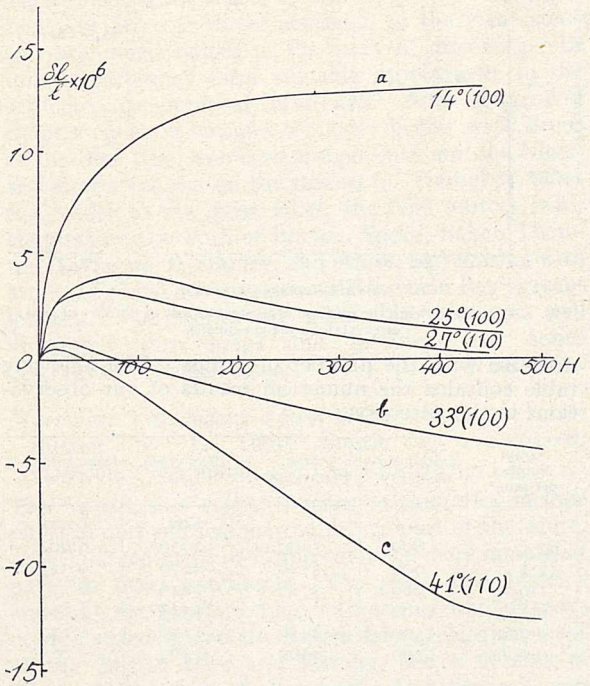


FIG. 3.—Curve showing magnetic expansion of single crystals of iron differently oriented with regard to the principal axis of the crystals.

expansion actually observed being due to the deviation of the axis of the specimen from the trigonal axis. The expansion curves in specimens Nos. 2, 3, 4 may be considered as the combined effect of the above two. The magnetic expansion in ordinary iron consisting of microcrystals is a differential effect of the expansion and contraction above referred to, the crystal axes being distributed at random. The smallness of the magnetic expansion of ordinary iron as compared with that of the single crystal, as well as the course of the expansion-curve, are all explained on the above view.

The result obtained for the magnetic expansion agrees with that obtained by Heap (*Phy. Rev.*, 24, 1924) in the case of magnetite. The sharp breaks in the magnetisation curve can be expected from the theory of crystal magnetisation put forward by Dr. J. Okubo and one of the present writers (*Sci. Rep.*, 5, 1916) ten years ago. This theoretical part, together with new interesting facts, will be dealt with in a further communication.

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## The Physical Basis of Insect Drift.

THE writer in the issue of NATURE for September 5, 1925, summarised available data in regard to insect drift and only incidentally alluded to the meteorological phases. Very recently the occurrence of hundreds of thousands or even millions of black aphids, *Dilachnus piceæ* Panz., and a flower fly, *Syrphus ribesii* Linn. (C. S. Elton, *Trans. Ent. Soc. Lond.*, pp. 289-299, 1925), on the ice-covered wastes of North-East Land, Spitsbergen Islands, north latitude 80°, has renewed interest in the subject, particularly as these insects must have drifted more than 800 miles near the extreme north. This could scarcely have been a movement in response to some strong instinct, and the same is very probably true of the Coccinellids recorded very recently from the crater of Vesuvius (*Ent. Record and Journ.*, Variation 37, 143, 1925).

There are physical explanations for these movements and many others noted in our earlier cited paper. A moderately strong favourable wind is all that is necessary to account for widespread transportation of insects capable of sustaining themselves in the air. The latter may or may not be correlated with what we know as a strong flight. It is well known that ordinarily air currents near the surface of the earth, during the milder season when insects are abroad, are usually more or less unstable, and therefore we do not expect extensive drifts in this manner, and the general tendency has been to explain any widespread movement as a migration, that is, a somewhat determinate or purposive movement by hosts of insects. This attitude is due in part to our very limited knowledge as to the movements of the upper air currents, and secondly to the assumption, based largely upon lack of data, that insects remain near the surface.

The recent development of aerial navigation has demonstrated the occurrence of convectional currents at considerable heights, 1000 feet to even 3000 or 4500 feet. A velocity of 2000 feet per minute has been recorded for such currents. The significance of these is that they may, and undoubtedly do, serve as elevators, as it were, to carry insects into the upper air, and once at a considerable height, it is not difficult to realise that horizontal currents of great velocity might carry these insects possibly thousands of miles before they descend to the surface. This latter is rendered more probable by the fact that wind velocities increase greatly as one ascends in the free air to 100, 200, or even 300 miles per hour. The $5\frac{1}{2}$ in. of dust swept from the Sahara Desert during the past thirty years and deposited in Europe and also over parts of Africa, Asia, and the Atlantic Ocean, and the transportation of dust 1500 miles from Australia to New Zealand, are concrete examples of what winds may accomplish (*Monthly Weather Rev.*, U.S. Dept. Agr., 50, 301, 1922).

It is well known that there is a somewhat definite circulation of warm air from the tropical or subtropical regions toward the cooler sections of the north. Such a movement of warm air means a return near or at the surface of the earth of cooler air. We readily see what is in the latter, because it is within easy vision. We know nothing about the upper air except the extremely few observations made by airmen in balloons, dirigibles, or aeroplanes, at a time when they are concerned mostly with problems of navigation and can give only incidental attention to such minor matters as birds, insects, and other forms of life.

The large desert areas in Arabia and northern Africa are undoubtedly sources of convectional currents

which ascend to considerable heights and move northward, carrying with them, presumably, any light objects which might be in the air, including wandering insects, and possibly millions from nearby localities producing enormous broods. It is easy to see how hosts of the thistle butterfly, *Vanessa cardui* Linn., might be picked up by such convectional currents, carried to considerable heights, drift northward at such elevations, and thus supply all Europe north of a line through the middle of France and south Germany or Switzerland with these insects, a movement suggested by Mr. C. B. Williams, some being carried (we believe this is drift rather than flight) even to northern Scotland, Scandinavia, the Shetland Islands, and distant Iceland.

Such a drift would suggest that the warm air currents might extend even nearer to the Pole, and the record of plant lice and flower flies which are given above is conclusive evidence that such must be the case, to a limited extent at least. It is quite possible that other insects are carried into remote northern areas, sometimes in considerable numbers. The mere fact that there are no records counts for little, owing to the impossibility of obtaining from such sections anything which might be considered approximately complete data.

Turning to the western hemisphere, there are several records of enormous swarms of this butterfly, *Vanessa cardui*, being observed in apparent migration in southern California in 1924 and 1926, the movement being from the south-east to the north-west. One of the observers suggests that the source or the origin was either the foothills of the Sierras or the Sierras proper. There is a possibility that these swarms originated at a considerably greater distance. They may have been carried into the upper air in regions bordering desert areas considerably farther south or south-east, in much the same way as suggested for this insect in the eastern hemisphere, since we have in both extensive desert areas constantly producing convectional currents, and after a certain altitude is attained, the probabilities of extensive drift are certainly excellent.

There are interesting records which, while they undoubtedly represent extremes for wind currents near the surface of the earth, may be taken as reasonably suggestive of conditions at some elevation where air movements are not hindered by friction. These are the notable gales at Point Reyes Light, Calif. (*Monthly Weather Review*, U.S. Dept. Agr., May 1903, p. 227), in May 1902 and 1903, the first lasting six consecutive days, with an average velocity of 50 miles an hour and an extreme velocity of 120 miles an hour, and the second of nine days' duration, with an average velocity of 54 miles an hour and an extreme velocity of more than 90 miles per hour. There can be no doubt regarding the ability of the winds to transport insects and other drifting objects long distances, and with a multitude of areas favourable for the development of convectional currents of moderate to considerable intensity, it seems quite probable that many insects are raised to somewhat high altitudes and carried long distances, some species in large numbers, and presumably many are represented only by scattered specimens, owing to their seldom breeding locally in great abundance.

It is believed that a recognition of these forces and an understanding of the agencies involved will assist materially in solving problems in connexion with the extensive movements of flying or drifting insects.

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## The 'Gas Laws' in Surface Solutions.

IN a letter to NATURE (April 3, p. 484), Messrs. Adam and Jessop disagree with the findings of MM. Marcelin (*Ann. de Physique*, November-December, 459) and Delaplace (*C.R.*, **180**, 2020), concerning the relation between the pressure, $(F)$, of the surface films of oleic acid and the area per molecule, $(A)$. The latter investigators find the relation $FA = kT$, while the former find $A$ largely independent of $F$. It should be noted that Langmuir (*J. Am. Chem. Soc.*, **39**, 1868) obtained two types of $FA$-curves: when the films were formed on distilled water the $FA$-curves were steep like those of Adam, and represented *irreversible* conditions; when expanded on acid solutions the films gave flatter $FA$-curves, more like those of Marcelin, and were (presumably) reversible. Evidently there exists a disturbing factor and it will repay to inquire into its probable nature.

A little consideration will show that attempts to express the energy relations of surface films as a function of temperature alone cannot be successful, and that Delaplace's formula $FA = kT$, while true for dilute surface solutions with area per molecule greater than 5000 sq. Å.U., cannot be applied to more concentrated films; on the other hand, Marcelin's original formula, $FA =$ constant, may be correct under specified conditions. Since molecular surface films are composed as a rule of heavy, highly polar, oriented, molecules which have relatively little freedom of movement, changes in their energy content will not involve changes in heat energy to any large extent. In fact, it has been shown by Einstein (*Ann. der Physik*, **4**, 543), and by Harkins (*J. Am. Chem. Soc.*, **39**, 354), that the relation between the specific heat of surface $(S)$ and the free surface energy, or surface tension $(\gamma)$ is $S = -T\, d^2\gamma/dT^2$, and when $d\gamma/dT$ is linear, which is generally the case, *the surface contains no heat, its energy being in potential form*. This is only what may be expected, seeing that heat energy is closely connected with volume and with free movement in three dimensions, and that oriented molecules, in a two-dimensional continuum, can possess but little energy of translation.

It seems much more rational to express energy relations of films in terms of surface $(A)$, of surface pressure $(F)$, and of $(E)$, the *potential of the surface energy*,—these three variables corresponding to the familiar $p$, $v$, $T$, of thermodynamics. Unfortunately, we know very little about the real nature of the potential $E$. It is probably an electro-chemical potential depending on the chemical nature of the film and on the electrical potential. We do know that in disperse systems certain ions have great influence on the degree of dispersion, and therefore on the surface energy; we know that there is a close connexion between potential difference and surface tension (Lippmann-Helmholtz equation); that the surface tension of mercury may be calculated, with certain assumptions, from the energy of the double layer formed by the positively charged atomic nuclei and the negatively charged electrons (Frenkel, *Phil. Mag.*, **33**, 6, 297); and the writer has shown that electrical energy may be changed into surface energy ("Electrical Dispersion of Liquids," *J. Phys. Chem.*, **29**, 1289). Consequently the area of the molecular surface film may be expected to be a function of an electro-chemical potential $(E)$, just as the volume of gases is a function of the heat potential $(T)$. By analogy we should expect a 'law' of the form $AF = kE$ (or $kE^2$, if the potential is to be expressed in units of ordinary electrical potential). Below a certain value of the potential $E$ the molecular surface film will behave like a 'liquid' and steep $FA$-curves, like

those of Adam, will be obtained; above that value, the film will behave like a gas above its critical temperature, giving *FA*-curves like those obtained by Marcelin and by Langmuir. The fact that experiments were carried out sometimes under (electrically) adiabatic conditions and sometimes under 'isoelectric' (corresponding to isothermal) conditions, possibly explains the 'hysteresis' of the curves obtained by Langmuir with films on water, and the (presumable) reversibility when acidified water was used.

Naturally, only 'ideal' cases follow the relation $FA = kE$. One may define an 'ideal film' or 'ideal colloid' as *a system all surface and no volume*, in the sense that *its energy is a function of the potential E only*. The 'ideal colloid' is, no doubt, as difficult to find as the 'perfect gas' is. Perhaps some of the body colloids come nearest to the ideal state, for we know, much to our discomfort, that they claim the temperature to be a constant, and a variation of a few degrees is as much as they will stand without 'giving up the ghost.' Yet the human organism is an extremely efficient machine, and its efficiency is due to the fact that it does not derive its energy from wasteful heat changes; more and more we come to consider it as an electro-chemical machine working under nearly reversible conditions. It is known, for example, that muscular action is accompanied by changes in the hydrogen-ion concentration (formation of lactic acid); if we had an ideal colloid composed, for the sake of simplicity, of closely packed molecular films of thickness, say, $1 \times 10^{-6}$ cm., a variation in their potential due to a change in the hydrogen-ion concentration would readily produce a difference of 10 dynes in their surface tension (as in some of Langmuir's experiments); that would enable each square centimetre of cross-section of the ideal colloid (in this instance, the muscle) to lift a weight of approximately 20 lb. To conclude: let us follow Nature's lead and, assuming the temperature to be a constant, determine the electro-dynamic laws which govern the energy relations of 'oriented' molecules. VICTOR COFMAN.

Research Department,
Armour and Company,
Chicago, Illinois, April 23.

### The Oxidation of Ammonia.

IT is regretted that there is an error in the second equation of those suggested in NATURE of April 24 which makes the scheme there given impossible. The writer still considers that nitrohydroxylamic acid is a possible intermediate product, as will be explained below, but it cannot be derived as previously given. Before giving alternative schemes it may be interesting to review briefly the facts to be explained.

A suitable scheme of reactions should explain some such set of data as the following, which is taken from records of experiments made for the Munitions Inventions Department during the period 1917–1919. These records have been in proof for two years but have not been published.

(1) The platinum catalyst, consisting of gauze of 0·1 mm. diameter wire with 80 meshes to the linear inch, through which the mixture of air (or oxygen) and ammonia is passed, exhibits an activity increasing from a very small value with unused metal to a maximum attained, in the case of a single gauze, after 14 hours running with an amount of ammonia oxidised of about 1 gram per sq. in. a minute. This is accompanied by a change in the appearance of the platinum from bright to grey, and has been shown by other experimenters (see Rideal and Taylor, "Catalysis," fig. 10) to be due to a remarkable efflorescence on the surface. This is similar to that observed by Newbery in experiments on overvoltage and seems to suggest that it is due to the expulsion of gases which have been dissolved in the platinum and have perhaps interacted there.

(2) The rate of oxidation is very great. With two gauzes and ammonia-air mixtures containing from 9·1 to 13·8 per cent. ammonia by volume, a time of contact of not more than 0·000155 sec. was sufficient to ensure an oxidation of 82·6 to 94·2 per cent. in various experiments. The results were practically the same (87·6 to 94·4 per cent.) with a time of contact of 0·00062 sec., whilst with a longer time of 0·00093 sec. there was some falling off in the yield (63·7 to 89·1 per cent.). The higher yields usually correspond with lower ammonia content of the initial gas. In the case of mixtures with oxygen and steam, with a time of contact of 0·000155 sec. the oxidation was 98·3 per cent. and the output greater than with air. With very slow rates, both in the case of air and oxygen, the yield fell below 70 per cent.

(3) The conversion was practically the same with mixtures in which the air varied from the amount required to form nitrogen trioxide, $N_2O_3$, to that required to form nitrogen pentoxide, $N_2O_5$, although the best working appeared to correspond with the former. Below $N_2O_3$ the yield is smaller, and it appears that more oxygen is required than for $4NH_3 + 5O_2 = 4NO + 6H_2O$, both with air and with oxygen and steam. In only two experiments yields of more than 90 per cent. were obtained with the nitric oxide ratio, but generally lower conversions were found with this ratio.

(4) In the experiments with pure oxygen (diluted with steam) the sole products of combustion appeared to be nitric oxide and water, since the gas coming from the converter could be completely condensed by cooling into liquid nitric acid. No nitrous oxide is formed and it is reasonable to assume that none is formed with air, although this was not tested.

A reaction scheme must therefore conform with the following conditions:

(*a*) Reactions of order higher than bimolecular are improbable.

(*b*) Hypothetical intermediate compounds should not be capable of rapid direct decomposition into nitrous oxide. This makes the formation of NOH improbable.

(*c*) Excess of oxygen above the amount to form nitric oxide, NO, seems necessary.

(*d*) Reactions between gases condensed on or dissolved in the platinum, or labile oxides of platinum and dissolved gases, seem not improbable.

The fact that unconverted ammonia, when it does not appear as such, is accounted for as free nitrogen, makes it possible that such substances as $NH_4NO_2$ can be formed.

The necessity for excess of oxygen seems to indicate that the primary product is one containing more oxygen than nitric oxide, and since the reaction becomes complete at the nitrogen trioxide ratio it may be that this, or $N(OH)_3$, or nitrous acid may be formed. It is also possible to assume the formation of nitric acid, since the decomposition of this could be a slower reaction after the catalyst. Very recent work on heterogeneous catalysis will also allow us to make use of atomic oxygen, and hence the following schemes are possible:

A. (1) $NH_3 + O_2 = NH(OH)_2$.
   (2) $NH(OH)_2 + O = N(OH)_3$.
   (3) $4N(OH)_3 = 4NO + 6H_2O + O_2$.

B. (1) $NH_3 = NH + H_2$.
   (2) $NH + O_2 = HNO_2$; etc.

C. (1) $NH_3 + O_2 = NH(OH)_2$.
   (2) $NH(OH)_2 + O_2 = HNO_3 + H_2O$; etc.

Schemes A and B also explain the formation of nitrogen, which would come from ammonium nitrite. A possible source of nitrogen in a gas rich in ammonia is combustion in the gaseous phase, possibly accompanied by flame, owing to local rise of temperature on the catalyst, as in the well-known lecture experiment.

It does not at the moment seem possible to connect the formation of nitrohydroxylamic acid with simpler reactions than those given. Although possible schemes are easily drawn up (*e.g.*, one involving the rapid reaction of $N(OH)_3$ and $NH_3$ followed by rapid oxidation of the product) they do not, in fact, appear very probable. J. R. PARTINGTON.

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### Seasonal Sunshine in Great Britain.

AN article on "Seasonal Sunshine in Great Britain" by Mr. Charles Harding appeared in NATURE of March 20. The results were based on the 35-years' mean, 1881–1915. Comparing south-east England with south-west England and south Wales, Mr. Harding says that "the average sunshine for the year in south-east England is 4·49 hours a day, and in south-west England and south Wales, including the so-called Cornish Riviera, it is 4·28 hours. In the winter, south-east England has an average daily sunshine of 1·92 hours, and in south-west England and south Wales the value is 1·91 hours a day; in spring the hours of sunshine for the two districts are respectively 5·50 and 5·36; in summer 6·88 and 6·41, and in autumn 3·46 and 3·31 hours."

An examination, however, of the Air Ministry figures, upon which these values are based, show that more sunshine is experienced in the south-west than in the south-east. The fact is hidden through the district being linked up with south Wales, which has different climatological characteristics. South-west England and south Wales have now been made separate districts by the Air Ministry for forecasting purposes, but the original larger areas are still retained for climatological investigation. The counties included in south-west England have an area of 6548 square miles, and those in south-east England 7224 square miles. As these districts are situated in approximately similar latitudes, there is but little difference between them for purposes of comparison of sunshine values. The addition of south Wales, however, with its additional 4762 square miles of country, brings the south-western district up to 11,310 square miles, and the lowering effect upon the sunshine values is apparent. The results for south-east and south-west England are as follows:

| | S.E. England. Hours. | S.W. England. Hours. |
|---|---|---|
| Spring | 5·50 | 5·66 |
| Summer | 6·88 | 6·75 |
| Autumn | 3·67 | 3·68 |
| Winter | 1·92 | 2·01 |
| Year | 4·49 | 4·53 |

The seasons are:—Spring: March, April, May; Summer: June, July, August; Autumn: September, October, November; Winter: December, January, February. J. B. PHILLIPS.

The Observatory, Falmouth,
April 24.

THE criticism by Mr. Phillips, Superintendent of the Falmouth Observatory, is more a matter for the Meteorological Office than for me. In my article it is stated clearly that the sunshine records are taken from the "Book of Normals," published by the Meteorological Office. Exception is taken by Mr. Phillips to the paragraph he quotes from the article, where it is stated that the values quoted are taken from a "Book of Normals" (M.O. 236, Section 2) giving seasonal normals for several districts; in this the Meteorological Office has combined south-west England and south Wales in one normal. I am not at all sure that I agree with Mr. Phillips in thinking that the Meteorological Office should have separated south-west England and south Wales. I agree practically in the results obtained if these two parts are separated, and I will accept Mr. Phillips' sunshine value 4·53 hours for the year for south-west England in which observations are taken for Newquay, Cullompton, Plymouth, and Falmouth. Taking all the stations as used by the Meteorological Office for the normal for south-east England, I obtain for the year 4·47 hours a day, in good agreement with 4·49 hours given by Mr. Phillips; this value is obtained from 9 stations. By omitting observations from Kew and Marlborough, and using the remaining 7 stations, the normal for south-east England is 4·62 hours, which is a greater duration than the normal for south-west England.

There is clearly keen competition for a premier record, and without doubt much can be done by the choice of a good position for the sunshine recorder. In my judgment, however the records are considered, certainly for a single station or two south-east England has a higher value of daily sunshine than any station in south-west England, which includes the so-called Cornish Riviera. CHAS. HARDING.

### The Original Home of the Banana.

I REGRET that in the notice of my recent discourse at the Royal Institution (NATURE, April 24, p. 597) it is stated that "the available evidence points to South America as the original home of the banana." Reference was made to the views that have been held by various authorities as to the original home of the edible banana, and it was pointed out that from all the evidence at present available the balance was in favour of Indo-Malaya as the probable home of the seedless forms now so widely cultivated.

These forms belong to the subgenus Eumusa, the species of which are all regarded as of Indo-Malayan origin.

There are ancient traditions that the banana existed in Central and South America before the arrival of the Spaniards, and edible bananas certainly existed in Sierra Leone in 1568, no doubt as introduced plants, as those alleged to exist in America may also have been.

Prof. Berry's recent discovery of fossil banana seeds in the Tertiary rocks of Colombia is of great interest, since they belong to a species of the subgenus Physocaulis, the species of which are nearly all African. This discovery proves, therefore, that the genus Musa was represented in South America in prehistoric times.

Whether, however, this fossil species, which is closely allied to *Musa Ensete*, from tropical Africa, is in any way related to the seedless bananas is very doubtful. Nor does it seem very likely that such a species as *M. Ensete* would give rise under cultivation to a form with edible fruits.

The seedless bananas have been so long in cultivation that it seems almost impossible to be certain of their place of origin, but the evidence I think on the whole inclines rather towards Asia than to America. ARTHUR W. HILL.

Royal Botanic Gardens,
Kew, Surrey,
April 29.

## The Present Position of the Transmutation Controversy.

IF the genius of John Dalton gave the chemist a freehold title to the atom, the work of Becquerel and the Curies may be said to have transferred the title to the physicist, or at least to have granted him an indeterminable repairing lease of the property. The physicist has made good use of his tenure: he has determined the structure and conditions of stability of the atom, and by embellishing its parts with attractive and repulsive signs, he has thrown light upon many things that were previously obscure, and revealed new avenues of research for the investigator. Except for some tentative efforts to formulate an electronic theory of valency, the chemist has, for the most part, been out of the picture; and even when Rutherford used $\alpha$-particles to disintegrate certain light atoms, the chemist was denied participation by the circumstance that the quantities of material involved were too minute to come within the range of his most delicate methods. In 1924, however, a vista of golden opportunity arose when Miethe and Stammreich announced that they had obtained from pure mercury gold in sufficient yield to be manipulated and determined by chemical means. The vista, although riddled by the barbed arrows of hostile criticism, is still above the horizon, and only the crucial test of further experimentation can decide its ultimate fate. Meanwhile, it may be of service to attempt a brief survey of recent happenings in this very interesting field of alleged transmutation.

It will be recalled that Miethe and Stammreich passed a strong current at 175 volts through a quartz mercury-vapour lamp containing, according to their statement, mercury free from gold, and that after working the lamp for 20-200 hours, gold to the amount of 0·1-0·001 mgm. was detected by chemical means in the mercury (*Naturwissenschaften*, August 1, 1924; NATURE, August 9, 1924). Afterwards, they found that the formation of gold was not bound up with any definite form of discharge, although a certain critical potential difference or electron velocity had to be exceeded; that the amount of gold produced was proportional to the current-strength and the time; and that the production was facilitated by a high pressure inside the apparatus. When they passed electric sparks between mercury poles in a paraffin dielectric, they found that gold was present in the mercury dispersed along the line of discharge, but not in the liquid mercury constituting the poles. Duhme and Lotz are reported to have observed the formation of gold when a sufficiently powerful current is passed between electrodes dipping into mercury; and investigators in the Siemens research laboratory to have produced gold by bombarding a mercury surface with electrons in a very high vacuum (*Naturwissenschaften*, July 17, 1925). In some of their experiments Miethe and Stammreich observed the production of a metal which resembled silver in its chemical properties. It is important to note that these authors have maintained throughout that the mercury they have experimented upon was in all cases proved to be free from gold by the very same tests which they used to prove its presence in the treated mercury.

In May 1925, Nagaoka reported in these columns that he and his co-workers had passed a discharge of P.D. about $15 \times 10^4$ volts/cm. for about 4 hours between terminals of tungsten and pure mercury, using paraffin oil as dielectric, and had detected gold in the resulting black mass of carbon, oil, mercury, etc., by the purple-of-Cassius test and by the formation of ruby glass. In a later communication (*Journal de Physique et le Radium*, 1925, **6**, 209) he stated that on passing a discharge through drops of mercury falling between iron electrodes, he observed, in addition to gold, the formation of a complex white metal consisting mainly of silver.

Early this year, in a preliminary announcement to NATURE (January 2, p. 13), Smits recorded the transmutation of lead into mercury and into thallium by means of a quartz lead-vapour lamp consuming 40 amp. at 80 volts. The initial purity of the lead and the subsequent presence of thallium and mercury were attested by the spectroscope. The method was varied by substituting sparks of high current-densities for a continuous current; using 60-100 amp. at make, all the lines of the mercury spectrum were visible after 9½ hours' sparking. Another method, in which sparks at 100,000 volts and 2 milliamp. were passed between electrodes of highly purified lead, immersed in a liquid dielectric, showed the transmutation of lead into mercury, the presence of which was proved by conversion into red mercuric iodide.

A priori objections to these experimental results are not difficult to conceive. It might be thought that heavy atoms, like those of lead and mercury, would be more unstable and therefore easier to disintegrate than light atoms, because their nuclei contain a greater excess of positive over negative charges; but Rutherford's experiments with $\alpha$-particles showed that the lighter atoms are the less stable. Most of the light elements which he decomposed have an odd atomic number; all, with the exception of nitrogen, have atomic weights that are multiples of that of helium plus 3 units; and none of them except boron exhibits isotopy. Now mercury and lead have each an even atomic number, their atomic weights do not follow the above-mentioned numerical rule, and both elements possess isotopes.

Aston, moreover, has advanced some weighty arguments against the probability of the alleged mercury-gold transmutations (NATURE, December 19, 1925). This transmutation might conceivably be effected by the addition of an electron to the mercury nucleus, or by the expulsion of a proton from it. The chance that an electron would hit a nucleus at which it was fired is remote; and if a mercury atom did absorb an electron its weight would not be sensibly increased. Hönigschmid, however, has determined the atomic weight of Miethe's gold and has found it to be 197·2 (the same as that of ordinary gold), a number which is appreciably different from the atomic weight of mercury. Theoretically, it is possible for a mercury isotope of atomic weight 197 to absorb an electron and so produce ordinary gold; but none of the six isotopes of mercury identified by Aston possesses this atomic weight. The alternative hypothesis, that the mercury nucleus may be disrupted with the ejection of a proton, is held by

Aston to be quite untenable, because the forces employed are "ludicrously inadequate" for the purpose. The components of a nucleus are bound together by forces of the order of millions of volts, and these are not yet available to the laboratory worker, except in the form of swiftly moving $\alpha$-particles from radium-C, as employed by Rutherford.

Possible explanations of the production of mercury and of thallium from lead have been considered recently in these columns by A. C. Davies and F. Horton (NATURE, January 30, 1926, p. 152), who think that investigators should attempt to determine if hydrogen or helium is evolved during the changes: their production would indicate a disruption of the nucleus, their absence would favour the hypothesis of electron absorption. Up to the present no one has observed the liberation of these gases during the reported transmutations.

Criticisms of the experimental findings of Miethe and Stammreich, and of Nagaoka, centre around the question of the purity of the mercury used by them; Was it really free from gold? The answer to this question must depend upon the analytical method employed and upon the 'personal equation' of the observers. The method used by Miethe and Stammreich was to dissolve the mercury in nitric acid (1 : 4), fuse the undissolved residue with borax (0·1 gm.), and to measure the resulting sphere of gold, if any, under the microscope. They state that the limiting concentration of the detectable gold in an amalgam is $1 : 10^7$ to $1 : 10^{12}$, and that the amounts of gold obtained by transmutation were within $10^3$–$10^4$ of these limits. In one of their experiments they distilled *in vacuo* 1 kilogram of purified mercury, which showed no trace of gold, with 0·5 mgm. of silver and 0·5 mgm. of gold, until only 1 gram of the mixture was left; in this residue they found *all* the silver and gold that had been put in (*Zeitschrift f. technische Physik*, 1925, **6**, 74, 76).

In spite of such evidence, it is freely contended that distillation is not a trustworthy method of separating metals of high boiling-point from mercury, and that all the mercury that has been used in transmutation experiments was auriferous. Stammreich has discussed (*loc. cit.*) the possible ways in which gold might be carried over during the distillation of a gold amalgam. (*a*) It might distil over in virtue of its own vapour pressure. The vapour above the amalgam would contain gold, if only in an infinitesimal amount, and this amount would not sensibly increase when the amalgam was boiled. In the above experiment the vapour pressure of the gold must have been very nearly zero, and any error due to gold distilling over in the vapour phase would be well within the limits of accuracy of the method employed for determining the gold. (*b*) The vapour pressure of a gold amalgam might be higher than that of pure mercury. Such a phenomenon would be against all experience. (*c*) Vapour or minute drops of the (auriferous) mercury used for the mercury-pump might be carried over into the distillate. Miethe and Stammreich state that the distilling apparatus used by them precluded the possibility of such an occurrence.

In support of possibility (*a*), the critics quote the work of G. A. Hulett (*Physical Review*, 1911, **33**, 307). This investigator submitted a mixture of 6·75 kgm. of thrice-distilled mercury and 45·5 gm. of electrolytically refined gold to two distillations *in vacuo*, and the second distillate was found by a colorimetric method due to T. K. Rose (*Chem. News*, 1892, **66**, 271) to contain nearly 2 mgm. of the noble metal. It will be noted that the concentration of gold in the initial mixture was more than 1300 times greater than that in the mixture used by Miethe and Stammreich (*v.s.*). These authors attribute Hulett's result to spirting or irregular ebullition of the amalgam during distillation.

More recently Riesefeld and Haase have distilled an amalgam containing about 1 part of gold in 10 million of mercury under very carefully controlled conditions, using distilling apparatus specially designed to prevent mercury vapour diffusing back from the mercury-pump, and to prevent gold being carried over mechanically (*Berichte*, 1925, **58**, 2828). The distillate was found to contain gold in determinable amount.

In their reply, Miethe and Stammreich adhere to their contention that gold enters the distillate either from the pump or as the result of irregular ebullition. They point out that the microbalance which Riesefeld and Haase used for weighing their gold had an error of 0·003 mgm. and that this was exactly the weight of the gold they extracted from the third distillate. They note that the isolated gold was not pure, and they reaffirm that the mercury used in their own transmutation experiments was always previously purified from gold, to which end only two or three distillations were required as a rule, although so many as fifteen distillations had on occasion to be performed (*Berichte*, 1926, **59**, 359).

In a discussion of this subject held at the third assembly of the Deutscher Physikertag in Danzig (September 1925), it was suggested that gold and mercury might distil over together as a constant-boiling mixture. Prof. Miethe replied that in all constant-boiling mixtures the boiling-points of the components are of the same order (mercury boils at 357° C. under atm. press., gold at above 2600° C.), and that the components are present in commensurable proportions; he had investigated the possibility and had concluded that such amalgams do not exist.

Another suggestion made was that the mercury used for the transmutations may have contained gold in a state unrecognisable by the chemical tests employed, *e.g.* in colloidal solution or as a chemical compound, and that these were afterwards broken down by the electric discharge. There is, however, no experimental basis for this explanation. Finally, it was suggested that a decisive answer could be obtained by collecting the mercury dispersed in the dielectric by the discharge (*v.s.*), purifying it from gold, and then resubmitting it to the discharge: if it was found that more gold was produced, transmutation would be established. The experimental difficulties of such a test would be very great; the highest gold-concentration hitherto obtained in the mercury-mud of the dielectric is 1 : 10,000.

This short sketch of the main issues of the controversy will leave the impression that the question is still *sub judice*. On one hand, we have the perfectly definite statements of Prof. Miethe, who is an experimenter of acknowledged ability, and has shown much skill in parrying the attacks of his critics. On the other

hand, the accounts of some of his experiments, notably in regard to the distillation apparatus he employs, are somewhat lacking in precise detail; several investigators have entirely failed to reproduce his results (*e.g.* Tiede, Schleede, and Goldschmidt; Sheldon and Estey, NATURE, November 28, 1925, 792; Piutti and Boggio-Lera, NATURE, April 24, 1926, p. 604); and the considerations put forward by Dr. Aston still await a reply. Claims to have effected 'the great work' of transmutation have been made at frequent intervals since alchemy fell into disrepute, and their ignoble fate must make us sceptical of more recent contentions; but if these are proved to be baseless, it will be admitted that modern research into the constitution of the atom gave them a rational basis of possibility such as was never dreamed of by the medieval alchemist, even in his most fantastic flights of imagination.

Since the above account was written, a lecture given by Prof. F. Haber to the Kaiser Wilhelm-Gesellschaft, in Berlin, has been published in the issue of *Die Naturwissenschaften* for May 7, in which he communicated the results of prolonged investigations on the alleged transformations of mercury into gold. These results, which appear quite convincing, show that the gold obtained by Nagaoka and by Miethe and Stammreich did not in all probability pre-exist in the mercury, but was derived from auriferous metal constituting the electrodes or other metallic parts of the apparatus employed.

Prof. Haber has worked out two chemical processes for separating and determining gold in the presence of a large excess of mercury, but in the experiments now recorded he used mercury which had been purified by extremely slow, repeated distillation. Nagaoka's experiment was repeated several times, using a less powerful discharge, which, however, was continued for fifty hours, and gold up to $1 \times 10^{-7}$ gram was obtained; but Miethe's experiment of passing a discharge through paraffin between mercury poles gave no gold whatever. The mercury-lamp method, when modified to give electrons with much greater velocity, gave small amounts of gold, which, however, did not increase when the period of the discharge was prolonged from four to fifty-six hours.

Using a kind of X-ray tube with a cathode of tungsten wire, an anticathode of strongly cooled mercury, and 30,000 volts, Prof. Haber also obtained gold; in one experiment so much as $1{\cdot}6 \times 10^{-6}$ gram. This led him to examine the metallic connexions of the tube, and he found that whereas the parts of these within the apparatus contained $2 \times 10^{-6}$ gram of gold before the experiment, only one-fortieth of this amount was present at the end, the difference corresponding approximately with the weight of gold found in the mercury. But the most important evidence he obtained was that gold was never found when he used electrodes completely free from that metal. He analysed electrolytic copper wire, nickel wire, steel screws and Swedish iron, and found them all to be auriferous; only thin tungsten wire contained no trace of gold. The silver obtained in transmutation experiments is believed to have a similar origin.

Prof. Haber does not propose to repeat Nagaoka's experiment with higher voltages, because he foresees little chance of success; voltages of the order of two million might lead to results, but at present one million volts is about the limit for laboratory work.

An interesting feature of the recent work on transmutation is the extraordinary delicacy of the tests now used for detecting gold. Prof. Haber relates that one of his young collaborators suddenly found traces of gold in a material he was analysing, but no one else could confirm the observation on other samples of the material. It turned out that the chemist was in the habit of removing his gold spectacles before he made an observation, and that on the occasion in question he had removed them and then grasped a strip of the purest lead to put into the crucible he was using in the analysis. On another occasion, some one in the laboratory was heating gold to a high temperature, and shortly afterwards a worker *in the next room* detected this metal in a substance which was known to have been previously quite free from it.

## High-Frequency or 'Ironless' Induction Furnaces.

THE emergence of the high-frequency induction furnace from the scientific worker's laboratory into the world of industrial production has aroused widespread interest. True, induction furnaces have long found successful application in the commercial world, but these have all been characterised by some form of iron core and have operated at relatively low frequencies. Although the possibilities of high-frequency inductive heating were demonstrated so far back as 1905 by Schneider, not much advance was made until 1919, when Northrup published an authoritative paper which renewed interest in the subject. How rapid has been the progress from that date may be judged from the fact that in 1925 high-frequency furnaces capable of handling 600-lb. charges of nickel alloys were in operation.

A high-frequency induction furnace, whether large or small, usually consists of a helix of copper tubing the turns of which are somewhat flattened and are separated from one another by a suitable electrical insulator. Electric currents (or oscillations) of the desired frequency are then passed through the furnace helix or inductor, which would speedily become hot were it not for a stream of cooling water passing through the interior of the copper tubing. Powerful eddy currents are induced in any conducting mass placed inside the helix, and a rapid rise of temperature of the material ensues provided conditions are suitable.

In practice, the charge (or metal to be heated) is contained in a crucible which is separated from the inductor coil by some refractory substance which acts both as a thermal and electrical insulator. The reader will in all probability have already surmised that the simple type of furnace (shown diagrammatically in Fig. 1) required for high-frequency inductive heating is not the most complicated part of the plant. Indeed the design of apparatus for the generation of oscillations of the desired frequency has made the greatest

demands on the ingenuity of those responsible for the development of methods of high-frequency inductive heating.

### ACCESSORY APPARATUS.

Northrup has produced a 'converter' or oscillation generator which consists essentially of two suitably insulated water-cooled electrodes projecting inside a closed vessel containing some mercury. Arrangements are provided for regulating the height of the electrodes in respect to the mercury level and for filling the upper part of the vessel with either hydrogen or alcohol vapour. Energy is delivered to the electrodes at, say, 50 cycles, and at a pressure of 6600 volts R.M.S. When this 'spark gap' is shunted with an oscillatory circuit comprising the furnace inductor coil and a bank of condensers, high-frequency currents are generated in the furnace circuit. The frequency of the oscillations

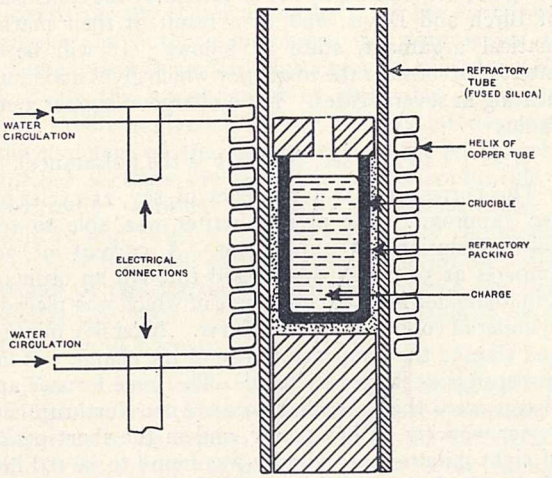


FIG. 1.—Diagrammatic representation of a high-frequency or 'ironless' induction furnace.

is determined chiefly by the inductance of the furnace coil and leads and the capacity of the condenser system. This form of 'converter' or oscillation generator seems particularly suitable for units of about 35-40 K.V.A. input, and units of this capacity are finding extensive industrial application at the present time.

The fact that the larger so-called high-frequency furnaces could be operated successfully at moderate frequencies has permitted the use of special alternators for supplying energy direct to the furnace coil. Brace has recently described an alternator which delivered 400 amperes at 250-300 volts at 5000 cycles, and gave an excellent mechanical and electrical performance when used in conjunction with a 225-lb. ferrous furnace. Even lower frequencies have been employed, for Campbell mentions 400 cycles and capacities of 600 lb.

While the mercury gap converter and the alternator as sources of high-frequency currents have been developed in America, France has not been idle, for the Compagnie Électro-Thermique, following the practice of Prof. Ribaud, has produced single-phase equipments involving open spark gaps. These interrupters, fitted with rapidly revolving studded armatures, are reminiscent of the early high-power wireless transmitters, and are probably very robust (a consideration for foundry use).

Both the Northrup converter and the Ribaud rotary gap equipment can, if desired, be modified for use with three-phase supply, thus approximately trebling the capacity of the furnace. Thermionic valves or vacuum tubes can be utilised as oscillation generators for small furnaces, but it will be realised that large valves and the accompanying electrical gear are scarcely proper inhabitants of the foundry. Poulsen arcs and Lepel discharge gaps can also be used as sources of high-frequency energy, but do not appear to have been developed commercially in connexion with high-frequency induction heating.

Although the expression 'high-frequency' inductive heating has often been applied to all induction methods which dispense with the iron linkage circuit, yet the large so-called high-frequency furnaces now operate at frequencies of 400-500 cycles per sec., frequencies which are no longer high, at least from the 'radio' point of view. Perhaps Northrup's expression 'ironless' induction would, if generally adopted, avoid all risk of confusion.

Birch and Ryland, who have attacked the subject from the mathematical aspect, rather suggest a distinction should be made according to whether the electric currents induced in the melt are substantially confined to the skin or flow through the whole volume of the material.

### APPLICATIONS IN LABORATORY AND WORKS.

High temperature research already owes a great deal to ironless inductive heating, for it is now possible to adopt refinements which are practically impossible with other types of furnaces. Except in special cases the heat is generated where required—namely, in the charge. Consequently induction furnaces are unique in that the charge is the hottest part of the whole furnace. This fact is all-important in considering the behaviour of refractories surrounding the melt. The inner lining of the crucible must, of course, be capable of resisting the action of the molten metal, but owing to the steep temperature gradient around the charge, a much less refractory material may be used to support the crucible if desired. Frequently the crucible and charge are contained in a tube of fused silica dimensioned so as to pass through the furnace coil (Fig. 1). The close proximity of the water-cooled furnace coil to the central portion of the fused silica tube prevents undue temperature rise, and by making suitable connexions at the ends of the tube, metal melting can be conducted at temperatures well over 2000° C. in a controlled atmosphere or *in vacuo*. As many metals react at high temperatures with air or ordinary furnace gases, the preparation of many high melting-point alloys of great purity has been made possible by the advent of the ironless induction furnace.

High temperatures can be attained so readily in small furnaces working at moderate powers that the chief difficulty of the research worker is to discover refractory material capable of withstanding the action of liquid or gaseous metals in these circumstances. Where exceedingly high temperatures are required, the crucible containing the material to be heated is placed inside a thin cylinder of graphite which is suitably lagged on the outside to prevent undue loss of heat.

Graphite becomes hot much more quickly than metals in the high-frequency or ironless induction furnace owing to its higher and more suitable electrical resistivity. There does not seem great difficulty in actually attaining temperatures in the neighbourhood of 3000° C., but certain inconveniences are apt to arise; vapours and sublimed material obstruct the sight hole, the graphite is apt to react with refractories and even the material in the crucible, and the quantity of gas evolved continuously from the furnace is enormous. Electrical non-conductors (such as glass) can sometimes be melted in ironless induction furnaces by surrounding the crucible with a graphite or metallic sleeve.

Perhaps the best-known application of ironless inductive heating in Great Britain is in the manufacture of the nickel-iron alloys (Mumetal), which possesses exceedingly high permeabilities at low magnetising forces. This alloy is used for 'loading' submarine telegraphic cables, which are thereby enabled to handle traffic at a much greater rate. No fewer than forty-two Ajax Northrup converter units (mercury gap) have been installed for one firm dealing with this alloy. The desirable magnetic properties of the nickel iron alloys diminish rapidly in the presence of impurities, especially carbon, consequently it is not difficult to understand why ironless inductive methods have found favour. Although the weight of melt per furnace (20 lb.) may appear small for some purposes, yet the exceedingly rapid rate of melting enables a considerable output to be maintained.

The cleanliness, ease of control and rapidity of melting have no doubt appealed to those concerned with precious metals, particularly metals with high melting points such as platinum. Further, the violent electrical stirring which is always present in the liquid metal so long as the furnace is in operation, assists in the preparation of the alloys, particularly when the alloying metals possess very different densities. Quite at the other end of the scale of dimensions are the 600 lb. brass, copper, or nickel silver melting furnaces, which may operate at frequencies so low as 400-500 cycles per second.

These ironless, medium-frequency induction furnaces, unlike the true iron-cored low-frequency furnaces, can be operated economically for short periods for alloys of varying compositions, and do not require rings of metal to be left in the furnaces at the conclusion of melting operations, so as to permit the starting up of the furnaces on a future occasion.

While ironless inductive heating finds its chief application in the melting operations, it has also been applied to the heat treatment and hot working of metals. A cold iron or steel bar inserted in a small furnace becomes red hot in a few seconds after the furnace has been put in operation, owing to the hysteresis losses in the magnetic material.

## Theoretical Considerations.

Those concerned with the practical applications of ironless inductive heating, and with no taste for mathematics, will find articles by Campbell and Gifford of interest. Prof. Ribaud has also given an excellent review of the subject, and he is perhaps unique in bringing together the practical and theoretical aspects of the subject by means of his simple but valuable experiments and conclusions. The accurate measurement of high-frequency resistances, or inductances of furnace and charge, is difficult, and this no doubt partly accounts for the fact that accumulated experience still plays the chief part in the design of new furnaces and plant. There is some ground for believing that the mathematical theories of ironless induction furnaces which have been propounded in the past are a little out of touch with reality.

The two outstanding mathematical accounts of ironless inductive heating are by Northrup and later by the joint authors Birch and Davis, and it is noteworthy that the latter take an exception to a rather fundamental statement of Northrup, namely—"That the effective ohmic resistance of the charge is equal to its reactance."

Again, the reader is apt to be misled by the conclusion of Birch and Davis, who, as a result of their mathematical argument, state as follows: It will be of interest to consider the frequency which gives maximum heating in several cases. For a charge of copper 3 cm. radius

$$p > 1{\cdot}5 \times 10^2 \text{ per sec. (where } p \text{ is the pulsatance).}$$

This corresponds to a frequency of, say, 25 cycles per sec. (approx.). The present writer was able to test this conclusion by experiment. A current of 200 amperes at 50 cycles was passed through an ordinary 4-in. diameter furnace coil, inside of which was placed a cylinder of copper 2 in. in diameter. After five minutes had elapsed the temperature rise of the charge was imperceptible as judged by hand. The same furnace and charge were then attached to an Ajax Northrup converter working on low power, and in the short period of eight minutes the cylinder was found to be red hot. Under the latter conditions, the frequency was in the neighbourhood of 25,000 cycles per second, and the value of current flowing in the furnace coil was known to be much less than 200 amperes.

These experiments would appear to indicate that this statement of Birch and Davis as to frequency requires modification. Generally speaking, exact mathematical prediction as to the behaviour of high-frequency or ironless induction furnaces has not been very successful, possibly owing to lack of complete knowledge concerning them. On the other hand, those engaged in the commercial exploitation of these furnaces in Great Britain have acquired extensive experience as to their various applications, and potential users can anticipate with confidence the performance of a high-frequency or ironless induction plant under definite conditions.

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## News and Views.

IN modern chemical literature, specially that which deals with the binding of atoms together to form molecules, the nomenclature has become very complex and is altogether bewildering for the student who has not the time for a detailed study of the question. He is left wondering what the difference is between valency, co-valency and electro-valency, and wherein the distinction lies between bonds which are polar, non-polar and semi-polar. In a discourse entitled "Electrons, Atoms and Molecules," published as a special supplement in this number of NATURE, Prof. T. M. Lowry presents some aspects of modern theoretical chemistry. He has succeeded in a few pages in giving a clear account of a few at least of the large number of theories which are at present on the chemical market. In the early paragraphs the author emphasises the debt which the chemist owes to modern physics for the methods which lead to the measurement of molecular dimensions. Due credit is given to X-ray analysis for the recent development of the stereochemistry of solids, while further sections are devoted to the application of electronic theories to specific problems, such as affinity and valency. In assuming that the modern 'child of five' will not hesitate to build up the correct lattice of the diamond when playing with his tetrahedral toy, Prof. Lowry shows the optimism of the true man of science.

THE twelfth annual report of the Carnegie United Kingdom Trust, dated March 12, 1926, contains, in addition to its report, a survey of the activities of the Trust during the past five years. Prof. Adams's report on the Borough Library service led, it is stated, to the Trust's County Library policy which has met with general acceptance throughout England, Scotland and Wales. New opportunities are now being provided thereby in the rural and semi-urban districts for intellectual development and recreative reading at a nominal cost. The County Library system, however, is linked up with the policy of the Central Loan Collections established in London, Dunfermline and Dublin. The future financial positions of these institutions are now under the consideration of the Committee on Public Libraries set up by the Board of Education. The cost of administering these Collections is not shown in the report, but it is known that the income of the Central Library for Students in London depends in part upon grants made by the Carnegie United Kingdom Trust and upon private generosity—sources which cannot be regarded as permanent. The subscriptions received by the Central Library from the borrowing libraries amounted in 1925 to 580*l.* only—in return for the issue of some 25,000 volumes.

THE financial position of the Central Loan Collections is therefore far from satisfactory. We suggest that State assistance might be limited to the free postal carriage of books, coupled with conditional access to the contents of the State libraries. This relief would justify a correspondingly larger contribution from the borrowing libraries, which at present pay the cost of carriage each way. This arrangement would involve a minimum of State interference with, or responsibility for, the administration of the Loan Collections. The taking over by the State of the Central Library for Students would not conduce to a healthy development of the County Library service. The County unit is being applied with good augury of success to other branches of the Trust's policy. Community Councils are linking up the voluntary associations for the promotion of adult education, music and the drama and social services, with the statutory authorities in the counties. Two new departures in the Trust's future activities are adumbrated: (1) a much-needed inquiry into the work of the local museums, and (2) an experimental erection at Sawston in Cambridgeshire of a building to be known as the "Village College," for which the County Authority is to provide the cost of the school while the Trust contributes the rooms for adult education. The experiment is a bold one, and the results obtained thereunder will be followed with interest.

THE problem of finding a permanent protective coating for iron is one of the most important in the whole field of applied science, but one which unceasing effort has so far been unable to solve. In a preliminary communication to the *Zeitschrift für angewandte Chemie* (May 6), Dr. A. V. Blom, of Berne, Switzerland, announces that he has discovered a lead pigment which when applied to iron produces a surface that will not rust. The pigment is made by melting lead in an electric furnace and starting the reaction by passing air and reducing gases through a thin layer of the molten metal. The resulting dross or scale is essentially a pyrosol of lead in yellow lead oxide, and, according to the operating conditions, it is either dense or voluminous; but it must have a particular structure if, after pulverising and mixing with specially prepared linseed oil, it is to be effective as a protective coating for iron.

DR. BLOM has not yet worked out a complete theory of the action of his pigment, but his present view is that the highly dispersed basic lead pigment saponifies the linseed oil, that the fatty acids liberated in this way, and also on drying, react with the lead oxide to produce very finely-divided particles of lead, which, in virtue of their special form and Brownian motion, penetrate the surface of the iron and thus cause a kind of cementation. In experimental tests with sheet iron that had been painted or sprayed with the new pigment, lead was found in the surface of the iron in every case; in one experiment the amount was 1·36 mgm. per 100 sq. cm. of surface four weeks after application. Tests on different kinds of iron ware, extending over several months, gave uniformly good results, and short, drastic tests with steam were most successful. The pigment is extraordinarily adhesive, and although its efficiency is mainly due to the lead particles which diffuse into the iron, the

coating itself plays a part in the protection. To realise the potential importance of Dr. Blom's discovery, it may be recalled that in 1922 Sir Robert Hadfield estimated that the world loss due to corrosion in 1920 was 29 million tons of iron, valued at 700 millions sterling.

THE demand for electrical energy has led to the construction of large generating stations and to the laying out of great networks of distributing lines. It is highly probable that these networks will be greatly increased in the immediate future. This will necessitate the adoption of very high pressures in order to keep the losses within economic limits. It will also make it necessary to have circuit breakers capable of dealing with enormous currents. The switch houses necessary to control the system will be much larger than the generating stations. This will make the direct control of the system very difficult. It is customary to control the switches from a separate room, in which a switchboard and the necessary instruments are provided. So far as the normal operation of the system is concerned this greatly simplifies the routine work of the attendants; but when anything abnormal has to be done, as, for example, when a generating set has to be switched from one section of the mains to another, there is a serious risk of damage being done to the machines or the network. To obviate this difficulty the Oerlikon Co. of Switzerland describes in its bulletin for January a device which makes errors in operation almost impossible. They provide a miniature "busbar" system where signalling devices indicate automatically which of the different switches and circuit-breakers are closed or open. Changes in connexions are first made and considered on the miniature board. When they are seen to be correct, the gear itself is operated in the switch house. The necessary switches are indicated by lighted lamps, so that there is practically no risk of a switching error. This system has been installed in the great Gennevilliers power station near Paris, which operates part of its network at 60,000 volts.

MR. J. E. SEARS, Jun., delivered the Friday evening discourse at the Royal Institution on May 21, taking as his subject "Some Recent Developments in the Art of Fine Measurement," and dealing particularly with the measurement of length. Modern end standards offer superior accuracy of definition to the actual reference standards at present current. Machines are available which are capable of measuring such standards to an accuracy of 0·000001 in. Gauges of this very accurate finish will 'wring' together. This action is due to the presence of minute traces of grease or moisture on their surfaces. The thickness of the wringing film is of the order of 0·0000005 in., the known minimum thickness of a free liquid film. The wave-length of light affords the possibility of a 'natural' standard of extremely high precision, whereas previously natural standards have proved unreliable. Interference methods are used. The direct determination is limited to a distance of about 4 in., but by the use of multiple reflections in white light greater lengths in simple integral numerical relations can be determined. Reference was also made to improved methods of measuring internal diameters, and a description given of a machine designed by the author for this purpose. The nature of the fit of plug and ring gauges under different conditions was shown; when well greased a plug will pass through a ring definitely smaller than itself, the ring expanding elastically by an amount which can be shown experimentally by measurement of its outside diameter. The method of optical projection is very useful for the accurate measurement of profiles.

AT the annual meeting of Messrs. Brunner. Mond and Co., Ltd., held on May 13, Sir Alfred Mond, who has succeeded Mr. Roscoe Brunner as chairman of the Company, announced an important development in the activities of the subsidiary undertaking, Synthetic Nitrates, Ltd., which is the only producer of synthetic ammonia in Great Britain. The plant of this Company is being greatly extended, and before the end of the year 1927 it is anticipated that the present output will be trebled. Among the projected new manufactures are ammonium nitrate, sodium nitrate, nitric acid, anhydrous ammonia, ammonium carbonate and bicarbonate. During the past year Synthetic Nitrates made a profit of 103,647*l.* after allowing for substantial depreciation, and much larger profits are expected in the future. In Sir Alfred Mond's opinion, recent developments in chemical engineering have opened up possibilities of progress the limits of which cannot be foreseen.

THE Prime Minister of the Commonwealth of Australia has announced the personnel of an executive committee the formation of which was recently recommended by Sir Frank Heath as the first step in the reorganisation of the Institute of Science and Industry. The chairman is Mr. G. A. Julius, a prominent engineer of Sydney and president of the Engineering Standards Association. The other two members are Mr. W. J. Newbigin, who is intimately associated with the commercial life of Australia, and Prof. A. C. D. Rivett, who recently succeeded Sir David Orme Masson in the chair of chemistry in the University of Melbourne. It is understood that the new body will possess extensive powers and, together with an advisory council and State advisory committees, will be charged with the organisation and development of national effort in scientific and industrial research.

THE Adelaide Correspondent of the *Times* in the issue of May 20 announces the departure for Oodnadatta of an expedition, financed by Mr. Donald Mackay of Sydney, to explore unknown country in the Northern Territory. The object of the expedition is to carry on research in geography, geology and anthropology. It is also intended to search for precious metals, of which the country west of Charlotte Waters, north of the boundary of Southern Australia and the Northern Territory, is said to contain an enormous wealth. The leader of the expedition is Mr. Herbert Basedow, Protector of the Aborigines, and the author of a recently published

book on the Australian aboriginal—a subject on which he is an acknowledged authority. Kinematograph and phonograph apparatus are to be carried, with the view of recording the ceremonies and songs of the almost unknown natives of these parts.

THE third edition of the Kew Hand List of Coniferæ, which includes in this case the Gnetaceæ as well as the Cycadaceæ, has recently been issued by the Royal Botanic Gardens (price 1*s*. 6*d*.). From the preface to this edition by the Director, Dr. A. W. Hill, it appears that a list of the Cycads in cultivation at Kew has not been published before, though it is believed that one or two of the fine specimens growing in the Palm House were brought from South Africa in the days of Sir Joseph Banks. The transference of the Gymnosperms from Museum I to Museum III at Kew has also necessitated the addition of a section to the hand list which deals with the economic properties of the Gymnosperms and serves as a guide to this museum collection. The heavy greasy deposit from the London smoke is very deleterious to the conifers, as to all evergreens. Recently the Forestry Commissioners have recognised this fact and a special collection under conditions more favourable to the growth of these trees is being built up at Bedgebury, near Tunbridge Wells, under the control of Kew in co-operation with the Forestry Commission. The Director repeats the statement that the deposits from the smoke block the stomata of the leaves and thus impair their vitality. If, however, recent American work is correct (J. B. Rhine, *Botanical Gazette*, vol. 78, pp. 226-232, 1924) the stomata of the leaves of such plants when grown in places quite free from atmospheric contamination are still found to be blocked by a waxy substance which is readily soluble in alcohol, so that this black deposit is a natural product of the leaf and has no connexion with smoke injury.

THE Field Museum, Chicago, is to be complimented on its decision to publish the results of its curatorial experience in a series of small publications under the heading "Museum Technique." It is fitting that the author of the first number, entitled "Herbarium Organisation," should be Dr. Millspaugh, to whose efforts and organising ability is due the high position of the fine herbarium. The various blanks, cards, tickets, index slips, loan forms, and catalogue pages reproduced in the pamphlet may provide useful suggestions to any commencing a large herbarium. Such forms look formidable, but when carefully drawn up, as here, save time in the end. The best cases are said to be those of steel, since they are the most dust-proof, do not warp, are more fire-proof, and take up less space. Each pigeon-hole is converted into a drawer by placing beneath its contents a straw-board slide, to the front of which is hinged a one-inch drop that serves as both drawer-pull and label-holder.

WE have recently received a copy of Heft 3 and 4 of a new genetical journal published in Zürich, the *Archiv der Jülius Klaus-Stiftung*. It is to appear in four parts per year at a subscription price of 40 Swiss francs. The journal is devoted to contributions on heredity, social anthropology and race hygiene, and the publishers are Art. Institute Orell Füssli, Zürich. The present number contains a short paper on the inheritance of myopia and hemeralopia in man by Dr. Gassler, and an extended account of genetical and cytological studies on certain Primula hybrids, by Drs. Ernst and Moser. Both *P. Auricula* and *P. hirsuta* and their hybrids are found to have 72 chromosomes (octoploid). These interesting hybrids have long been known as *P. pubescens* Jacq., and are the origin of garden Auriculas. The hybrids produce nearly as much pollen as the parent species, and some of the $F_1$ types resemble either parent. A coloured plate shows very well the nuances of colour in the flowers and leaves of various types. This journal will form a valuable addition to the numerous genetical publications already in existence.

THE seventh annual meeting of the American Geophysical Union was held in Washington, D.C., on April 29 and 30. The six sections met separately before the general meeting of the Union. At the latter there was a symposium on the constitution of the earth, introduced by brief summaries of various aspects of the subject. The sections relate to geodesy, seismology, meteorology, terrestrial magnetism, and electricity, oceanography, and volcanology. The section on meteorology held a discussion on questions involving international co-operation, including the co-operative measurement of the sun's general and ultra-violet radiation (and the estimation of the ozone content of the atmosphere), and on the best method of establishing a chain of meteorological stations along the border of the polar basin

SIR J. C BOSE delivered a lecture on May 20 before the Fondation Universitaire, Brussels, on his recent work on sensitivity in plants. His Majesty the King of Belgium and his Ministers were present at the lecture. In recognition of his work in advancing science, the decoration of commandeur, Ordre de Léopold, has been conferred on Sir J. C. Bose.

DR. ALDO CASTELLANI has just returned from America, where, at the invitation of the authorities of the Tulane University, New Orleans, he has established and organised a tropical medicine division in the Medical School. During his visit he had the honour of being invited to deliver the Gehrman Memorial Lecture series at the University of Illinois; and later at the annual convention of the American Medical Association and its Medical Exhibition on scientific subjects he was awarded the gold medal, the highest recognition which can be given by the Association. The award "was based on the excellent investigation in comparatively unexplored fields of Medicine and for the perfection of the display" of specimens.

THE one hundred and seventh annual meeting of the Swiss Society of Natural Sciences will be held at Fribourg on August 29-September 1. This will be the fifth occasion on which the Society has visited the little town with its comparatively young and vigorous

university. Seventeen sections are being organised, covering most branches of pure and applied science; and excursions in the neighbourhood of Fribourg are a feature of the programme. Lectures will be delivered by Prof. J. Reinke, of Kiel, on natural forces; by Prof. J. B. Senderens, of Toulouse, on catalysis in chemistry and biology; and by Prof. P. Debye, of Zurich, on molecular forces. All communications should be addressed to the president of the Society, Prof. Dr. S. Bays, Le Châtelet, Fribourg.

REFERRING to his article "Tests of Relativity Theory," NATURE, April 10, Prof. A. S. Eve now writes that a mistake occurs on p. 521, col. 2, line 29. In the sentence "The compromise of Silberstein that in *rotation* there is full drag, and that in *translation* there is a partial drag, will suit the experimental evidence in hand, but no one seriously supposes that such will be the ultimate result of further experiments," the words now italicised should be exchanged. On p. 383 in Silberstein's "Theory of Relativity" it is clearly pointed out that in the theory of the famous Chicago experiment "If there is a full drag, there should be no fringe shift at all," and this is otherwise obvious. Dr. Silberstein pointed out the error to Prof. Eve, and added the following interesting comment: "Nor is there actually a compromise'; absence of *spinning* (rotational) drag is well compatible with the presence of a partial (and even almost complete) *translational* drag."

MR. F. EDWARDS, 83a High Street, Marylebone, W.1, has issued a catalogue (No. 481) of upwards of 300 second-hand works on botany, general natural history and zoology, some rare. A number of herbals are included. The catalogue can be obtained free upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior lecturer in botany at the Royal Technical College, Glasgow—The Director (June 7). A junior engineer at the Forest Products Research Laboratory of the Department of Scientific and Industrial Research, South Farnborough—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 12). An assistant lecturer in zoology at the University College of North Wales, Bangor—The Secretary and Registrar (June 14). One or two assistant superintendents in the Geological Survey of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (June 26). A works chemist at a large firm of woollen manufacturers in the West Riding of Yorkshire—The Secretary, British Research Association, Torridon, Headingley, Leeds.

## Our Astronomical Column.

THE NOVA IN MESSIER 61.—Several additional observations have come to hand of this nova, the detection of which by Prof. M. Wolf and Dr. K. Reinmuth was announced in the issue of NATURE of May 15.

The discoverers note (*Beobach. Zirk.*, Nr. 20) that a plate taken on April 15 shows no trace of the nova, while on May 9 it was between mag. 13 and mag. 14, being slightly fainter than the 13th mag. star south preceding the nucleus at a distance of 2′·6. Lorenz gives the position of the nucleus of the nebula as R.A. $12^h\ 16^m\ 48^s{\cdot}58$, N. Decl. 5° 1′ 43″·5, equinox 1900·0.

The nova was observed at Greenwich both visually and photographically on May 15 and 16 by Messrs. Melotte, Merton, and Steavenson. The *Times* of May 21 also reports that it was observed at Harvard University Observatory. On the very doubtful assumption that the distance of the nebula is 10 million light years it is deduced that the nova is 10 million times brighter than the sun, which would make it the brightest nova on record except that in the Andromede nebula in 1885. But these estimates should not be quoted in the public press without a warning of their extreme uncertainty.

FIREBALL ON MAY 2.—Mr. W. F. Denning writes that "A magnificent fireball was observed on May 2 at $23^h\ 30^m$ G.M.T. from various places in the N.W. of Ireland. Reports have come from Co. Tyrone, Donegal, Londonderry, and other parts, but unfortunately they are not of the required character and give few details of utility for computing the real path of the object. The light it exhibited was astonishing, and some people describe it as of dazzling intensity. An observer at Ballybofey says his attention was attracted by a flash; then a more prolonged light illuminated the whole countryside, and on looking up he saw a large ball of fire which broke up into three or four pieces as it fell to near the N.W. horizon. Another spectator at Dunnamore describes the illumination as quite dimming the 12-volt lamps of the motor in which he was riding. He observed the meteor explode into four fragments. The observations of position are fairly consistent, and prove that the fireball was probably directed from a radiant near $\beta$ Libræ and that it pursued a path of about 92 miles at a velocity of about 15 miles per second. The height was from 64 to 47 miles, but it seems highly probable that the path was longer than this and that the height at disappearance was less than that given. Possibly the meteor may have descended to within about 30 miles at the termination of its luminous flight, but data of greater accuracy and consistency are needed.

COMETS.—*Astr. Nachr.* No. 5440 contains two reproductions of photographs of Ensor's Comet obtained at Bergedorf Observatory. That on March 16, by A. Schwassmann and J. Stobbe, has been already described in this column. The other was taken by the Director, R. Schorr, with the reflecting telescope on April 3, the exposure time being 30 minutes. The comet appears as a straight streak 35′ long in Position Angle 310°. There is no nucleus; the head has a diameter of 2′; the tail gradually widens, being 6′ broad at its extremity. The position angle increased by 60° between March 16 and April 3. Another exposure (not reproduced) was made on April 13, lasting 1 hour. The comet appeared as a very faint glimmer, magnitude 17, the tail being 30′ long and 5′ broad, position angle 0°.

Orkisz's Comet was photographed at Bergedorf on May 2, its magnitude being 16. It was under observation for an interval of 13 months, which will enable the orbit to be deduced with great precision.

## Research Items.

CALIFORNIAN ANTHROPOMETRY.—A valuable contribution to the physical anthropology of the American-Indian people is made in a comprehensive study of the available measurements on the living and on crania which is published by Mr. Edward Winslow Gifford as Part 2 of vol. 22 of the *University of California Publication in American Archæology and Ethnology*. The aborigines of California fall into two main groups, one low-faced, the other high-faced. The low-faced group constitutes the Yuki type, with high nasal index, relatively low cephalic index, and short stature. The high-faced group is variable in nasal and cephalic index and medium to tall in stature. This group is divided into a broad-headed sub-group of wide distribution—the Californian type, divisible into narrow-nosed, broad-nosed, and tall; and secondly, a narrow-headed, narrow-nosed sub-group, the Western Mono type. The cranial material is not so representative in distribution as the measurements from the living; but it affords seven types, of which three may be local specialisations of a fundamental type with medium facial, medium to high cephalic, and medium nasal indices. This fundamental type appears to have as its nearest living representative the Californian type. Unfortunately a comparison between living and cranial measurements is impossible, as the two classes of material do not coincide in distribution. In the case of the Yuki, where there is adequate material, there is practically no difference between living and dead. Nowhere is there any indication of stratification of types. In the matter of extra-Californian relations, Boas reports a type from the coast of British Columbia with cephalic index 77-81, which resembles the Yuki, while the Californian type suggests Boas's brachycephalic type, the Tinneh. His Kwakiutl and Shuswap suggest the narrow-nosed sub-type of the Californian. The Athabascans of California do not correspond to this type, such of them as the Wailaki and the Kato being of the Yuki type.

MANIFESTATIONS OF LIFE.—The editor of *Scientia*, Prof. E. Rignano, has written in the February issue and the four preceding issues of his journal a series of articles on "Les Manifestations finalistes de la Vie," in which he challenges the mechanistic position. He discusses among other subjects development and regeneration, adaptation, the behaviour of the lower organisms, reflexes and instincts. At the end of the article on the lower organisms he summarises the facts and considerations on their movements, and points out that no physico-chemical process in the inorganic world in the least resembles the avoiding reactions of these organisms, and that no non-living substance exhibits a behaviour influenced by past experiences. In the presence of these facts he writes: Should we not ask if we are not shutting our eyes to the most patent reality if we continue to say that the properties of matter suffice to explain the phenomena of life?

HERRINGS ON THE WELSH COAST.—Volume 1 of a new series of reports on work done in the Zoological Department, University College of Wales, Aberystwyth, issued in December last, has recently been received. The editor, Prof. R. Douglas Laurie, in an introduction gives a list of the researches at present in progress, and expresses a hope that reports will be issued annually. The current volume is largely devoted to an account by Mr. E. Emrys Watkin of some preliminary investigations upon the herring shoals visiting local waters in 1921 and 1922. During the autumn of 1922, thirteen samples comprising a total of 1989 fishes taken from commercial catches at Borth, Aberystwyth, and Newquay were examined, and data collected on length, sex, degree of maturity, number of rings to scale, and growth observations on the scale. Mr. Watkin concludes that fishes with 3 and 4 rings to the scale formed 68 per cent. of the fishery. A number of distinct schools of herrings visited the fishing-grounds, of which some came to spawn, but others to feed. It is to be noted that measurements of growth increments of the actual scale were directly compared, whereas it is usual first to calculate the length of *fish* which by theory corresponds to each of the winter rings on the scale, and then compare these lengths. It is to be hoped that in his future reports Mr. Watkin will adopt the customary practice.

A NEW NEMATODE FROM THE RAT.—Eloise B. Cram describes (*Proc. U.S. Nat. Mus.*, vol. 68, Art. 15, 1926) a new nematode, *Protospirura columbiana*, present in large numbers in the stomach and small intestine of wild rats (*Rattus norvegicus*) captured in the National Zoological Park, Washington. Details are given of the characters of both sexes (the males are 23-43 mm. long and the females 45-100 mm.), and a table is given of the known species of Protospirura. Embryonated eggs from the uteri of the female worms were fed, with bread, to cockroaches in which the larvæ were afterwards found encysted, chiefly in the loose tissue in the abdomen and in the thorax. Though encysted larvæ are to be found in the cockroach about one month after feeding the latter with the eggs of the worm, the larvæ do not appear to be infective until about the fortieth day. Such larvæ when fed to rats developed into adult examples; after 53 days they were mature but not fully grown, but after 115 days they had attained the size of the majority of examples found in the naturally infected rats. The finding of this nematode in wild rats in the Zoological Park, but not in those from other parts of the city, suggests the possibility that the normal host may be a rodent other than the rat living in the Park. "That rats and cockroaches, pests commonly present around such places, may play a part in the dissemination of parasites formerly absent in a country but brought in by the animals in the Zoological Park is a possibility the recognition of which may have a practical significance."

THE CHLOROSIS OF FRUIT TREES.—Messrs. T. Wallace and C. E. T. Mann present some very interesting if puzzling data as the result of the chemical investigation of the foliage of chlorotic apple trees in the *Journal of Pomology and Horticultural Science* (Vol. 5, No. 2, March 1926). They have been studying examples of chlorotic foliage, occurring in soil rich in calcium carbonate, in which there is every reason to associate chlorosis with the calcium carbonate; in some cases comparison was possible with normal foliage, in other cases with green foliage obtained as the result of spraying the trees with sulphate of iron. In either case the same general types of difference between green and chlorotic foliage were noticed and may be summarised as follows: (1) The percentage of dry matter is higher in the green leaves; (2) ash content is usually higher in the chlorotic leaves; (3) the percentage of calcium is markedly lower in the ash of the chlorotic leaves; (4) the percentages of sodium and especially of potassium are always much higher in the ash of the chlorotic leaves. These conclusions are amply justified by the experimental

data quoted and appear very intriguing. Why, for example, should spraying with sulphate of iron produce this marked reversal in the relative proportions of calcium and potassium in the ash of the foliage leaves ?

THE 'FLOWERING' OF LAKES.—The phenomenon termed by the ancients *flos-aquæ* and described by Pliny, who observed it on Lake Bolsena, is not of frequent occurrence on the large sub-alpine lakes, but it appeared during last August on Lake Como. The results of its investigation have now been presented to the Reale Istituto Lombardo di Scienze e Lettere. The 'flowering' was manifested over almost the whole surface of the lake simultaneously and persisted for several days, during which perfect calm prevailed, gradually disappearing when the wind rose. By means of a small net several decilitres of a pea-green gelatinous mass was obtainable in a few minutes, and this proved to be *Microcystis æruginosa* (Henfrey) Lemm. The asphyxiation of fish sometimes occurring when this 'flowering' takes place on small lakes, is usually the cause, and not an effect, of the phenomenon. In sheltered pools subject to frequent and abundant flowering, the algal mass may, however, favour the growth of bacteria and thus lead to such consumption of oxygen and production of non-respirable gases as to render fish life untenable.

VEGETIN.—In the *Rendiconti* of the Reale Istituto Lombardo di Scienze e Lettere, Prof. Montemartini gives the results of experiments made with a fungicide known as vegetin, which is an impalpable, black powder and has carbon as its fundamental ingredient. The experiments were made with leaves of potato, tomato, mulberry, Broussonetia, fig, Ricinus, horse chestnut, and *Tropæolum majus*. Although the efficacy of this preparation as a fungicide is left in doubt, in most instances leaves over which it was dusted performed their metabolic functions appreciably more actively than similar leaves not so treated. A further series of experiments is projected with the view of ascertaining the mechanism of this effect.

THE MINERALS OF BENTONITE.—The first fruits of an important investigation of the mineral composition of clays are presented by C. S. Ross and E. V. Shannon in a paper dealing with bentonites and related clays, and published in the *Journ. Amer. Ceramic Soc.* for February 1926. Bentonite is a widely distributed clay-rock that has resulted from the devitrification and alteration of glassy volcanic ash. Its characteristic minerals are completely crystalline and have a micaceous habit, high birefringence, and easy cleavage. The high absorptive power of bentonite is not due, as has been thought, to the presence of gel colloids, for few of the crystal films are so small as to reach colloidal size. The peculiar properties are held to be a consequence of the easy cleavage of the minerals, giving a very great surface area, and of the felt-like texture which facilitates permeability. A large number of analyses of the clay-minerals from bentonite indicates that, like the type montmorillonite from France, the composition of the most abundant mineral is $(Mg, Ca)O \cdot Al_2O_3 \cdot 5SiO_2 \cdot nH_2O$. This mineral has also been recognised in fuller's earth. Beidellite also occurs in bentonites, and has the formula $Al_2O_3 \cdot 3SiO_2 \cdot nH_2O$. A third micaceous mineral has the composition of halloysite, $Al_2O_3 \cdot 2SiO_2 \cdot nH_2O$, but is visibly crystalline and has a high birefringence.

TROPICAL CYCLONES OF THE PACIFIC.—A description of the storms is given by Dr. S. S. Visher and is published as *Bulletin 20 of the Bernice P. Bishop Museum*, Honolulu, 1925. The general characteristic of the cyclones is described, with their distribution and frequency. The information has been collated from various sources, and in this way the publication is more complete and of greater value. Most of the storms appear to start between 10° and 20° north and south. On an average more than fifty tropical cyclones are said to develop each year in the Pacific. Lists are given of the number of storms experienced in each year, and their occurrence is also listed for the several months. A majority of the tropical cyclones of the Pacific move westward and poleward until they arrive in about lat. 20°-30°, and then they recurve and move eastward. Frequently cyclones move more abnormally. Cyclones differ considerably in their speed of travel, the movement of the storm ranging from 1 mile to more than 50 miles an hour; at their initiation they generally move slowly. Tropical cyclones are classified in three types with respect to duration, the short-lived storm lasting a day or two, the common storm lasting three to six days, and the long-lived storm lasting more than a week; some of the long-lived storms are followed for more than three weeks. The storms are classified for intensity. With reference to predicting storms it is stated that the advantage of prediction would be so great that many attempts have been made at forecasting, but it seems likely that it will always be impossible to do more than state the probability of a hurricane occurring somewhere in a rather large region. Much useful information is given on numerous points of interest with regard to cyclones in the Pacific.

EXTINCT AMERICAN CARNIVORES.—A number of the *Bulletin of the American Museum of Natural History* has appeared giving a very full account by Childs Frick of certain Tertiary carnivores (vol. 66, art. 1, 1926: "The Hemicyoninæ and an American Tertiary Bear"). The author collects together certain genera, namely, Hemicyon, Dinocyon, Hyænarctos, and Ursavus, into what he terms a 'morphological group,' the Hemicyoninæ. A 'morphological group' is explained as a collective term for an assemblage of animals which are united by certain characters but more or less widely separated by others, and is used to avoid the terms 'family or sub-family' with their implication of close relationship. The paper describes in considerable detail the members which form this group, and, as an addendum, a new genus, Plionarctos, of true bears.

A RICH LINE SPECTRUM.—In the March issue of the *Journal of the Franklin Institute*, Dr. Marion Eppley describes a simple means of obtaining a series of closely spaced lines of nearly equal intensities between wave-lengths 6678 and 3990 Å.U. for reference and other purposes. The end of a carbon rod of about 0·6 cm. diameter is heated to redness in a bunsen flame and dipped into a dry powder of vanadic acid, molybdic acid, and anhydrous titanic oxide in the proportions 8 : 5 : 2 by weight. The end of the rod is again heated to fuse the adhering powder and the process repeated until a thick crust of the mixture has been formed on the end of the rod. Two rods with their ends about 1 cm. apart are used as the electrodes of an ordinary spark arrangement. To identify the lines of this spectrum the spark spectrum of an alloy of cadmium, zinc, lead, and tin in the proportions 35 : 35 : 73 : 30 is photographed upon it. This alloy has several advantages over that used by Hartley.

SOLUBILITY OF CALCIUM SULPHATE.—The solubility of those phases of calcium sulphate existent at the temperature of boiler water has been determined by R. E. Hall, J. A. Robb, and C. E. Colman, and the

results published in the *Journal of the American Chemical Society* for April 1926. The solutions were prepared in an iron autoclave with an internal filter consisting of layers of woven cloth supported on a perforated steel frame. Their results and those of previous workers are in good agreement at higher temperatures, but the difficulty in controlling the lower temperatures renders measurements under the latter conditions less trustworthy.

THE ATOMIC WEIGHT OF METEORIC CHLORINE.—The constancy of the atomic weight of chlorine of marine origin has suggested an investigation of the constancy of the atomic weight of the element from minerals of non-marine origin and of that from meteorites. The determinations were carried out by W. D. Harkins and S. B. Stone, who found the ratio of silver to silver chloride by dissolving pure silver in nitric acid in a long-necked quartz flask and treating it with the different specimens of hydrochloric acid. The constancy of the isotopic composition is shown by the values for meteoric and terrestrial chlorine, given in the *Journal of the American Chemical Society* for April 1926, which are identical within the limits of the very small experimental error.

BENZOLE RESEARCH.—We have received a copy of the Report of the Joint Benzole Research Committee for 1926, giving a detailed account of the work carried out by the Association's chief research chemist, Mr. W. H. Hoffert. The report discusses the relative values of the absorption powers of active carbon, silica gel and ferric oxide gel, in the recovery of benzole, and examines the possibilities of cresol and tetralin as wash oils in place of creosote and gas oil. Most important is the investigation of the tendency of poorly refined benzoles to form resins on storage or when used in internal-combustion engines, with several photographs illustrating the effects of different samples on the production of carbon in a motor-car engine after 100 hours running on a test bench. The results of the tests indicate that the deposits are due to the presence of unsaturated constituents. The report is completed by the addition of a classified bibliography.

HEATS OF FUSION OF LOW MELTING-POINT ORGANIC SOLVENTS.—The heat of fusion of a solvent can be calculated from the freezing-points of two solutions at two different concentrations. The apparatus, described in the February issue of the *Bulletin of the Chemical Society of Japan*, consists of a small vessel immersed in an ether or pentane bath cooled in liquid air, the temperature being controlled by an electric heater. The heats of fusion were calculated from the values of two points falling on the straight line obtained by plotting against the logarithms of the molar fractions.

ACCURATE HEATS OF VAPORISATION OF LIQUIDS.—A paper by J. H. Mathews appearing in the *Journal of the American Chemical Society* for March 1926 describes the accurate determination of the latent heats of evaporation of fifty-nine liquids. The liquid, contained in a glass vessel surrounded by vapour and suspended from the arm of a balance, is heated electrically by a platinum spiral immersed in it. The method gives values which are more trustworthy than those obtained from vapour pressure measurements, since small errors in the determination of the vapour pressures lead to relatively large errors in the value of the latent heat.

INFLAMMABILITY OF FIREDAMP IN THE PRESENCE OF BLACKDAMP.—The limits of inflammability of firedamp in atmospheres which contain blackdamp is the subject of a report by H. F. Coward and F. J. Hartwell of the Safety in Mines Research Board (Mines Department: Safety in Mines Research Board. Paper No. 19: The Limits of Inflammability of Firedamp in Atmospheres which contain Blackdamp. H.M.S.O. Price 6*d*. net). It was found impossible to explode air-firedamp mixtures containing more than 25 per cent. of carbon dioxide or more than 38·5 per cent. of nitrogen. The minimum amount of blackdamp necessary to prevent explosion in air-firedamp mixtures lies between these limits and depends on the ratio of carbon dioxide to nitrogen in the blackdamp.

CHANGES IN THE GASTRIC SECRETION OF BIRDS.—In his investigations on the stomach of the pigeon, Claude Bernard found that, while the young are being reared, the glands of the first of the three stomachs of the parent birds furnish a lacteal secretion which, while it softens the grains they eat, also modifies this grain so as to render it suitable for the young birds. After a time, however, the stomachs of the parents resume their normal condition and begin again to secrete ordinary gastric juice, which contains from 2·5 to 5 per cent. of gastric acid. Since this acid would be highly injurious to the young, the latter are driven from the nest by their parents and, if incapable of fending for themselves, soon perish of starvation. That this instinctive knowledge of the poisonous character of the normal gastric juice is not shared by all birds is shown by observations by P. J. Kaas, described in the *Atti della Pontificia Accademia delle Scienze* (*Nuovi Lincei*). A nest of five goldfinches, transferred to a cage, were fed morning and evening, through the wires, by the parent birds, until one day, two hours after their morning meal, they were all found dead. Evidently, if the young birds are unable to fly and feed themselves before the time when the gastric juices of the parents revert to their normal composition, they perish, not by inanition, as is the case with pigeons, but by poisoning. It is a singular phenomenon, which has been repeatedly confirmed, that this reversion occurs simultaneously with both parents. The elimination by these means of the individual birds incapable of supporting themselves is regarded as one of the processes by which the preservation of specific characters is effected.

MANUFACTURE OF SMOKELESS FUEL.—In a paper recently read before the South Wales Institute of Engineers at Cardiff, Mr. David Brownlie discussed the production of free-burning smokeless fuel by low-temperature carbonisation by processes involving the compression or briquetting of the charge. Such processes may involve mechanical compression of the viscous charge during carbonisation, preliminary briquetting by means of pitch or other binder, or preliminary briquetting without the use of an externally produced binder. Processes of the last class usually necessitate the use of very high pressures, but a new process (*Delkescamp*) of German origin was described in which a portion of the coal ground to a colloidal condition with water is admixed with the use of quite moderate pressures, and the mixture can be briquetted and then carbonised at low or high temperatures. Mr. Brownlie put forward a strong plea for the further study of low-temperature carbonisation. That it is difficult to establish on an industrial scale is clear from Mr. Brownlie's statement that the relevant processes and patents are numbered by hundreds; yet none of these is known to have established itself permanently.

## Vocational Guidance.[1]

THE report under notice is the account of a research in vocational guidance undertaken jointly by the Industrial Fatigue Research Board and the National Institute of Industrial Psychology. Up to the present, most of the work on vocational psychology has been concerned with vocational selection, which is an attempt to choose by scientific means those from a group of applicants who are most likely to be suitable for some specific occupation. In vocational selection, no attempt is made to determine the best careers for those who are unsuccessful in the particular tests given. Vocational guidance, on the other hand, seeks to determine the special qualifications of a child with the view of guiding him into the career best fitted for his abilities. It has a wider outlook than vocational selection, and is of greater social importance; it is, however, a far more difficult study on account of the multitudinous occupations which children can enter and their varying psychological requirements.

Only a hundred children were examined during the inquiry, the main object being to test the possibility of the method rather than the reliability of the results. The first step taken was to select a representative London borough, and then to find out the occupations taken up by 1000 children who had recently left the schools where it was proposed to give the tests. This gave an indication of the labour demand in the district and the relative proportions of the various occupations offering employment. One hundred children—half girls and half boys—who were leaving school within a year were then examined. Their intelligence was tested by oral tests, by non-verbal tests, and by performance tests. These various means of testing intelligence served to discover the special medium through which native intelligence expressed itself, and avoided the error of assuming that intelligence can only be expressed by means of words. Scholastic tests and tests of special abilities were also given, and an attempt was made to estimate the character, qualities, and the home conditions of the children examined.

When all possible information in regard to the children had been gathered, a consultation took place between the psychologists concerned in the research, the teachers, and the members of the care committee. Each child was personally discussed, and no hard and fast rules were laid down as to what particular test scores were required in order to recommend an occupation to a child. Each child was considered specially, and all the factors bearing on his case taken into consideration. Thus it might happen that although a particular child had sufficient intelligence for a certain occupation, yet he was lacking in the special abilities or the character qualities it demanded; when this was the case he would be advised to take up an occupation where the lack of such qualities would be no hindrance. Or a child might have the special qualities demanded by an occupation in a marked degree and yet lack sufficient intelligence to make advancement in the occupation possible, so that to send him into that employment would mean that he would ultimately fail.

After two years, the homes of all the children were revisited and information as to their present employment gathered. Among those children who had been able to enter the employment recommended or one similar to it, 83 per cent. were satisfied and only 2 per cent. were dissatisfied; of those who had not entered the employment advised, 39 per cent. were satisfied and 42 per cent. were dissatisfied. Moreover, fewer changes of place had occurred among those who had taken the advice given than among those who had not.

Although the fewness of the numbers of children dealt with and the shortness of the period which has elapsed since the original advice was given make definite conclusions impossible, yet those already obtained are most encouraging and certainly warrant further research along the same lines. Fortunately this is being undertaken on an extended scale by the National Institute of Industrial Psychology through the generosity of the Carnegie United Kingdom Trust.

[1] Medical Research Council: Industrial Fatigue Research Board. Report No. 33: A Study in Vocational Guidance, carried out by the Industrial Fatigue Research Board and the National Institute of Industrial Psychology. Pp. viii+106. (London: H.M. Stationery Office, 1926.) 4s. net.

## Diffuse Matter in Interstellar Space.[1]

AN attempt is first made to estimate the density, temperature and state of ionisation of gaseous matter diffused through the stellar system. It is concluded that the density is about $10^{-24}$ gm./cm.$^3$, temperature 10,000°–20,000°, and that atoms are ionised down to 15-20 volts.

The black-body temperature of space is about 3°, but analysis of the processes of interchange between radiant energy and atomic kinetic energy in diffuse gas indicates that ionisation and capture form the main process; and this tends to raise the temperature to the level of effective temperatures of stars independently of dilution of radiation. (Hottest stars must be given the greatest weight.) Against this, temperature is lowered appreciably, but not excessively, by radiation of electrons at encounters without capture (orbit switches). The temperature of diffuse nebulæ will be same as that of general interstellar gas. This temperature cannot be found accurately, because it depends on the distribution of stellar radiation far in the ultra-violet, where it is rash to apply the black-body law; but it is as likely to exceed as to fall short of estimate.

An upper limit to density (about $10^{-23}$) is obtained from the dynamics of stellar motions; the gravitational effect of greater mass would make the speeds of stars greater than those which are observed. The more definite estimate ($10^{-24}$) is based on the extension and distribution of condensations of the medium (diffuse nebulæ) by the application of the theory of equilibrium of an isothermal gas. It is concluded that the central density of a diffuse nebula of typical size is about $10^{-20}$.

The usual equilibrium formula for the amount of ionisation is modified to apply to matter in a field of 'evenly diluted' radiation. Calcium is mainly doubly ionised, but there is sufficient singly ionised calcium to give $H$ and $K$ absorption in distant stars. Assuming that the abundance of calcium is the same as on the earth, and using Milne's determination of the monochromatic absorption coefficient, the first calculation gives an $H$ and $K$ absorption of 1 mag. per 100 parsecs. Neutral calcium is nearly a million times weaker. Sodium is mainly singly ionised, and the first calculation gives $D$ lines of neutral sodium about $\frac{1}{100}$ strength of $H$ and $K$ lines. Corrections are indicated which would make calcium absorption weaker and sodium absorption stronger, and it appears

[1] Summary of the Bakerian Lecture delivered by Prof. A. S. Eddington, F.R.S., before the Royal Society on May 6.

that the results are consistent with the appearance of *H* and *K* and slightly weaker *D* lines in stars distant 500-1000 parsecs. If the light passes through a nebulous condensation, the required distance is reduced.

These results are compared with the phenomenon of 'fixed' sodium and calcium lines which, according to Plaskett's investigation, must be ascribed to an interstellar cloud. Arguments associating the phenomenon with the stimulation or emission of matter from the star showing the lines appear to be untenable. It is considered that absorption occurs evenly along light-tracks; but it is recognised that limitation to stars of type earlier than B3 is not very satisfactorily explained. In most stars of later type (where fixed lines are not marked by stellar lines) the absence may be ascribed to insufficient distance.

The dimming of distant stars by interstellar gas would be caused chiefly by electron scattering, but this is insufficient to produce observable effects. It is considered that the absence of any reddening of distant stars is no evidence of the transparency of space. It is impossible on the present theory to explain obscuration of stars by dark nebulæ, and the question arises whether we must not admit that these contain non-gaseous (meteoric) matter, in order to account for their opacity.

The accretion of mass by stars moving through the interstellar medium must in general be very much less than loss of mass by radiation, so that there is no appreciable effect on the rate of stellar evolution. It is suggested, however, that there will be sharp differentiation of those stars which have velocities less than the velocity of sound (about 4 km. per sec.). Possibly these may reach a steady mass—a speculation bearing on the association of the B type of spectrum with unusually low velocity and with condensations of interstellar gas.

## Research on the Fauna of Malaysia.

THE periodical *Treubia*, the organ of the scientific institutes centred at Buitenzorg, Java, is now in its eighth volume, and it functions as the chief medium for the publication of researches specially concerned with the Malayan fauna. It is issued at no fixed dates and each completed volume comprises four parts. In the recent numbers of that journal are various papers of interest to students of zoogeography, and to specialists in taxonomy.

Dr. H. C. Delsman, in collaboration with Dr. J. E. de Man (in vol. 6, liv. 3-4), provides a well-illustrated account of certain edible crabs obtainable in the Batavia fish-market under the Malayan name of *radjungans*. The commonest species is *Neptunus pelagicus* (L.), which meets with a ready demand among native consumers. It is identical with the "blue swimming crab" of Australia, which is the chief edible crab in the Sydney markets. The species is very widely distributed, occurring continuously from the Red Sea, through the Indian and Pacific Oceans, to Japan. Its presence at Port Said is remarkable and is probably due to the cutting of the Suez Canal. Although this crab is the dominant saleable species in Batavia, there are a number of other species that are sold in smaller numbers. These have been submitted to Dr. de Man in Holland for examination. Among them, *Neptunus sanguinolentus* (Herbst) also occurs around the Hawaiian Islands in abundance; *Charybdis cruciata* (Herbst), with the cruciform mark on its carapace, has been suggested as the crab mentioned in the story, by old writers, connected with the legend of St. Xavier and the crucifix; *Podopthalmus vigil* (Fabr.) differs from all other Indo-Pacific swimming crabs by its enormously elongated eye-stalks, which together occupy the whole width of the carapace.

Other papers in the same volume are chiefly concerned with insects, and of these, one of the most interesting is by Mr. Oscar John on termites. This contribution is wider in its scope than the others, since it deals with species from Ceylon, the Malaya Peninsula, and the islands of Java, Sumatra, etc. Included in this article is a discussion of post-embryonic development and caste differentiation among such insects. Most of the species belong to the family Termitidæ, and, of these, the economy of *Macrotermes carbonarius* Hag. is very fully illustrated. Of special interest are photographs of the queen surrounded by her attendant workers in the royal cell, which strongly recalls Escherich's well-known figure of the same feature in *Termes bellicosus*.

Vol. 7, liv. 2 is devoted to reports on various orders of animals, mainly insects, found in the island of Buru. Mr. J. K. de Jong of Amsterdam deals with the reptiles. Twenty-seven species are mentioned, two of which are believed to be new. The papers on insects deal with a number of families of Coleoptera by various authorities: Diptera Nematocera are described by Mr. F. W. Edwards of the British Museum, and Dr. H. H. Karny of the Buitenzorg Museum has an extensive paper on the long-horned grasshoppers (Tettigoniidæ) found in the island. Vol. 8, liv. 1-2, is given up to a long memoir by Graf. Hermann Vitzthum of Munich on Malayan Acari, illustrated by more than 100 figures. About one-half the species enumerated are new, and both parasitic and free-living forms are dealt with.

## The Scott Polar Research Institute, Cambridge.

THE inauguration of the Polar Research Institute, founded at Cambridge in memory of the late Captain Robert Falcon Scott, took place on Saturday, May 22. The proceedings were somewhat modified by the recent industrial upset, which prevented Dr. Nansen and a group of other eminent foreign explorers from attending, so that a lecture on the "Aims of Polar Exploration", by Dr. Nansen, had to be abandoned. However, on the invitation of the Vice-Chancellor, Dr. A. C. Seward, a party of some thirty non-residents, of whom more than twenty had crossed one of the polar circles, joined a number of residents at a dinner given by him, and most of the guests were able to visit the Institute in its temporary quarters during the afternoon. Amongst those present at the dinner were Mrs. Hilton Young (Lady Scott), Admiral Sir George Egerton, Rear-Admiral Skelton, Sir J. J. Thomson, Sir Charles Walston, Sir William Hardy, Sir Geoffrey Butler, and representatives of all the important British Antarctic Expeditions.

At the dinner the Vice-Chancellor, in welcoming the guests, spoke of the honour done to the University of Cambridge by the trustees of the Scott Memorial Fund in handing over to it the care of the Institute and an endowment of nearly 12,000*l*.

Sir T. W. Edgeworth David, in returning thanks

on behalf of the guests, spoke of the scarcely touched resources of the polar regions, and of the scientific problems the clues of which are to be found there and nowhere else. He referred also in glowing terms to the man whose name the Institute commemorated, and to his companions. The wonderful sketches of Dr. E. A. Wilson were especially remarked upon, of which some were on view in the Institute in the afternoon.

The toast of the Institute was proposed by Commander Hilton Young and responded to by the Director (Mr. Frank Debenham). Commander Hilton Young pointed out that the Institute now inaugurated should be not only a worthy memorial of the great deeds of the past but also a source of inspiration for the future. The generosity of the Scott Memorial Fund trustees enabled the University to begin the work of the Institute, but in order to erect a building for its accommodation a further 10,000*l.* is required. There must be many who would wish to do honour to the name of Captain Scott and assist in further research in the polar regions.

The Director outlined the means by which the committee of management, consisting of the Vice-Chancellor, Dr. H. R. Mill, Mr. R. E. Priestley, Mr. J. M. Wordie, and himself, hoped to realise the aim of the Institute in assisting polar research. They had seen during the afternoon the nucleus of the collections of books, maps, and polar travelling gear which would gradually become a comprehensive library and museum—a source of information for those who were undertaking research in polar matters, whether by exploration itself or by more academic means. The past discontinuity in polar research was largely due to the fact that the results and experience of one expedition were sometimes not published and were dispersed, so that later expeditions were unable to profit thereby. The Director invited the deposit of original records and technical gear so that such gaps might be bridged. The pictorial side of polar research was not neglected, especially in the pictures of the Franklin Search Expedition, presented by Dr. F. H. H. Guillemard, those of the 1895 expedition, presented by Mrs. Kriel (Lady Markham), and the fine collection of enlargements of the *Terra Nova* Expedition, the gift of the photographic artist, Mr. H. G. Ponting. The building the committee had in mind to construct when funds permitted would contain provision for the rapidly increasing library, the practical museum, and research rooms, to be used by any one discussing the polar regions, whether working up field observations or preparing to go to make them. In expressing his regret at the absence of many eminent foreign explorers from the gathering, the Director emphasised the international character of polar research, and expressed the hope that there would always be close co-operation between those in charge of the Institute and its well-wishers in other countries.

## University and Educational Intelligence.

CAMBRIDGE.—The University has returned to work and with the postponed examinations looming large upon the horizon, the majority of people are looking anxious. This anxiety is in many cases intensified by the fact that some of the tests will now take place within the period allotted to social functions.

The Committee which is engaged in making offers of lectureships and demonstratorships to those entitled to them under the new statutes has presented an interim report dealing with the principles on which it is working. In general, lecturers are being offered a basic salary (for a basic amount of work) of 200*l.* rising to 250*l.* and 300*l.* after three and ten years' service respectively. Demonstrators are being offered 150*l.*; in each case a fellowship allowance is to be made to such persons holding these appointments as are not fellows of colleges. A list of those to whom offers have already been made is published, from which it appears that almost all those who have been called demonstrators in the past will now be termed lecturers. In point of fact they have, in the vast majority of cases, been carrying out the duties of lecturers for a long time; they will now have an official title corresponding to their actual work, but it is doubtful whether they will receive the seniority to which they are entitled.

Mr. J. Gray, fellow of King's College, has been appointed University lecturer in experimental zoology. Mr. Gray has been engaged on cytological research since the War.

EDINBURGH.—The Curators of the University of Edinburgh have appointed Prof. A. J. Clark, at present professor of pharmacology and dean of the Faculty of Medicine, University College, London, to be professor of materia medica in succession to the late Prof. A. R. Cushny, who died on February 25.

LONDON.—The site of 11½ acres behind the British Museum, purchased by the Government for the University of London, has been re-sold to the vendor, the Duke of Bedford, under the terms of the conveyance, which provided that if the site could not be used for the proposed purpose in five years, the vendor should be given the option to re-purchase. The announcement has made a painful impression in the University and cannot fail to have an important bearing on future developments.

Convocation on May 11 adopted three resolutions adverse to the recommendations of the Departmental Committee of the Board of Education. These declared that the creation of a Council to control the finance of the University would have "prejudicial effects" upon the University, that the reconstitution of the Senate would be "a grave error," and that necessary modifications of the constitution of the University should be formulated by the Senate and not by a Statutory Commission. It should be added that the meeting was sparsely attended owing to the general strike, and that the terms of the resolutions, though recommended by the standing committee, were not previously circulated. The suggestion that the question should be considered at an adjourned meeting, or that an extraordinary meeting of Convocation should be convened, was not, however, supported. The opposition which the Senate is offering to the report of the Departmental Committee is centred mainly on the status of the proposed Council. A large majority of the members of the Senate would prefer that the Council should be a statutory finance committee of the Senate with a prescribed constitution. A Committee has been appointed by the Senate to draw up suggestions for an agreed reconstitution.

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A LIMITED number of seed analysts will be admitted to the fifth course of training to be held this summer at the Official Seed Testing Station, Cambridge, on June 21-July 20, on the following conditions. Applicants must be (*a*) nominated by seed firms; (*b*) recommended by universities, agricultural colleges, and institutions; or (*c*) approved by the Council of the Institute. The examination following the course is also open to approved practical seed analysts. Applications must reach the Secretary, National Institute

of Agricultural Botany, Huntingdon Road, Cambridge, not later than June 7.

APPLICATIONS are invited by the Empire Cotton Growing Corporation for a number of research studentships—senior and junior—each of the annual value of 250*l.* plus certain allowances for travelling expenses, lecture fees, and books. Candidates for senior studentships must be graduates who, since taking their degree, have had at least a year's training in research methods, or have done a year's post-graduate work in agriculture, or taken other advanced post-graduate courses. Junior studentships are intended to assist men who, as a rule, have passed all examinations for, and are otherwise qualified to take, a degree qualifying for the senior studentships. Particulars of the studentships and forms of application can be obtained from the Secretary, Empire Cotton Growing Corporation, Millbank House, Millbank, S.W.1. Completed forms must reach the Secretary by, at latest, June 22.

IN an article by Prof. Grossmann in the *Chemiker-Zeitung* for April 17, attention is directed to the fact that interest in the study by technologists of foreign languages and especially of English, which is of vital importance for the rebuilding of the German export trade, has lately begun to recover from the setback caused by the War. At Charlottenburg a lectureship in "Technical English" has been established, and the English lectures have been very popular. Reference is made in the article to the recent publication, under the name of "Technische Sprachblätter," of a cheap series of instructive diagrams, representing a great variety of mechanical and other appliances, reference to the numbers on which greatly facilitates the memorising of technical terms in the foreign language. An illustration is reproduced showing a cross-section through a street, with no fewer than sixty different objects numbered and indexed below in English and in German. Thus the study of technical terms, which often presents considerable difficulty when reliance is placed upon dictionaries, is very greatly facilitated. A parallel series might be very useful to students in Great Britain.

THE fourth biennial conference of the International Federation of University Women is to be held on July 27–August 2 at Amsterdam. A preliminary programme, published in the Federation's *Occasional Paper*, No. 5, specifies the following among other subjects for discussion: the question of an international language, international fellowships for research, recent developments in pre-school education, some results of the inquiry into methods of secondary education. The same Paper contains reports from holders of international fellowships, namely, from Dr. Hanna Rydh, who was awarded 300*l.* by the British Federation of University Women, on "The Age and Art of the Cave Men," and from Dr. Leonore Brecher of Austria, who was awarded 1000 dollars by the American Federation, on "Colour Adaptation of Pupæ," and a summary of publications by the holder of the Swedish Federation prize fellowship for research in science and holders of the Rose Sidgwick Memorial fellowships. A list is given of club-houses in the United States, Belgium, Canada, France, Great Britain, and Italy which offer special privileges to all travelling members of the International Federation. Associations of university women in Bulgaria, Luxembourg, and Roumania were admitted to the Federation in 1925. Egypt, Esthonia, Germany, and Poland have associations which will, it is hoped, be affiliated before long.

## Contemporary Birthdays.

**May 29, 1855.** Sir David Bruce, K.C.B., F.R.S.
**May 29, 1843.** Major Patrick George Craigie, C.B.
**May 31, 1845.** Col. Rookes Evelyn Crompton, C.B.
**May 31, 1863.** Sir Francis E. Younghusband, K.C.S.I.
**June 1, 1866.** Dr. Charles B. Davenport, Ph.D. (Harvard).
**June 2, 1850.** Sir Edward A. Sharpey-Schafer, F.R.S.
**June 2, 1866.** Dr. Leonard Erskine Hill, F.R.S.
**June 3, 1853.** Sir W. M. Flinders Petrie, F.R.S.

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Sir DAVID BRUCE, though by birth an Australian, was educated at Stirling High School and the University of Edinburgh. He entered the Royal Army Medical Corps in 1883. Assistant professor of pathology at the Army Medical School, Netley, from 1889 until 1894, he afterwards engaged in a series of investigations (constituting in reality his life's work) on the causation of certain diseases affecting man and animals, namely, Mediterranean or Malta fever, cholera, sleeping sickness, tetanus, and trench fever. The importance of his discoveries and conclusions in these fields of inquiry are well known. The Royal Society awarded him one of its Royal Medals in 1905, and the Buchanan medal in 1922. Sir David was also the recipient of the Albert Medal of the Royal Society of Arts in 1923. He is a corresponding member of the Paris Academy of Sciences.

Major CRAIGIE, who was born at Perth, was educated there at the Academy, and at the Universities of Edinburgh and Cambridge. He has carried out much official work in agricultural matters and in statistical inquiries for successive Governments and for public authorities. In 1900 he was president of Section F (Economics) of the British Association, and in 1902 president of the Royal Statistical Society. He was, from 1897 until 1906, assistant secretary of the Board of Agriculture and Fisheries. He has been Gilbey lecturer in the history and economics of agriculture in the University of Cambridge.

Col. CROMPTON was educated at Elstree and Harrow. Entering the army after school life, he was, down to the year 1875, in India with the Rifle Brigade. Afterwards he engaged in electrical engineering, founded the firm which bears his name, and continued as managing director for nearly thirty years. During the early period of electric supply, Col. Crompton shared with Mr. Ferranti most of the work of designing the power stations of Great Britain, and abroad in the same field he has developed undertakings. He has been twice president of the Institution of Electrical Engineers. Early this year the Faraday Society awarded him its gold medal. Elected by the Institution of Civil Engineers (1910) as engineer to the Road Board, he was responsible for the major portion of the experimental work which led to modern developments. Col. Crompton, after the War, was the recipient of an award from the Awards to Inventors Commission for work on the 'tanks.'

Sir FRANCIS YOUNGHUSBAND, soldier, traveller, and geographer, was born at Murree, and educated at Clifton College and Sandhurst. After attaining his army captaincy in 1889, he was transferred to the Indian Political Department. He has travelled in Manchuria, Chinese Turkestan, the Transvaal, Rhodesia, and in many other parts of the world. Sir Francis was awarded the Founder's medal of the Royal Geographical Society in 1891. His publications include "Wonders of the Himalaya" (1924).

## Societies and Academies.

LONDON.

**Geological Society**, May 5.—K. A. **Davies**: The geology of the country between Drygarn and Abergwesyn (Breconshire). The area, 20 square miles of country, is situated 5 miles north of Llanwrtyd Wells, and 3 or 4 miles south-west of the Rhayader district. The rocks belong to the Bala and to the Valentian series, but the latter only is described in detail. The Valentian rocks rest conformably upon the Bala. The sediments are generally of the mudstone-and-shale type, with subsidiary bands of grit and conglomerate. A full graptolitic succession in the Valentian rocks has been proved. The area lies on the western flank of the Towy anticlinorium, but the strata are folded into a subsidiary syncline (the Gwesyn syncline) and anticline (the Rhiwnant anticline), with their axes parallel to that of the main structure; that is, from south-west to north-east. Faulting is practically restricted to the southern side of the Gwesyn syncline, where for some distance an important strike-fault separates the Birkhill from the Bala rocks. The rocks are highly cleaved, the strike of the cleavage-planes being approximately parallel to the strike of the strata. The total thickness of the Birkhill rocks is similar to that of the Rhayader country, but much greater than at Plynlimon. The Birkhill rocks are thicker on the north-western than on the south-eastern side of the area.—R. M. **Jehu**: The geology of the district around Towyn and Abergynolwyn (Merioneth). The area, about 35 square miles, lies south-west of the Corris district. The rocks belong to the Bala and Valentian series, and consist mainly of mudstones and shales with subordinate bands of grit. The district is on the south-eastern flank of the Harlech dome, so that, in general, the strata strike from south-west to north-east and dip south-eastwards; but the area is crossed transversely by large anticlinal and synclinal folds, the axes of which trend north-north-eastwards in the south and become north-and-south farther north. The Bala or Tal-y-llyn fault runs from south-west to north-east through the area and is marked by the straight, steep-sided Tal-y-llyn Valley. This is probably a tear-fault with comparatively little vertical displacement. The southern part of the area is much affected by faulting, and three main groups of faults may be recognised: namely, (1) an east-and-west group; (2) a north-east and south-west group; and (3) a north-west and south-east group. The rocks are highly cleaved, and the extraction of fossils is thereby rendered difficult. The strike of the cleavage-planes is approximately from south-west to north-east.

**Linnean Society**, May 6.—A. W. **Hill**: The genus Lilæopsis, a study in geographical distribution. There are some fourteen clearly-marked species. Three occur in N. America from Alaska to Florida and Arizona, one both in E.N. America and in E.S. America, and one in Mexico and in Ecuador. One is found in Brazil and one in the Andes of S. America, another in western S. America and Chiloe, and one in the Falkland Islands and in S. Georgia, while the remaining species are natives of Tasmania, Australia and New Zealand. The leaves are rather in the nature of phyllodes, since a specimen has been found with small leaflets attached to the septate rachis.—R. D'O. **Good**: The genus Empetrum. Empetrum has a very wide but discontinuous geographic range. In the nothern hemisphere it occurs almost everywhere above the latitude 40° N. In the southern hemisphere it was found in western South America below the latitude 35° S., throughout Fuegia and the Falklands, and in the Tristan d'Acunha island group. The abundance of the genus has resulted in the collection of an unusually large number of specimens, which differ considerably among themselves. This variation is due chiefly to the differential development of general habit, degree of hairiness, shape and size of leaf, arrangement of leaves, angle of leaf insertion, sex of flower, and colour of berry, showing three distinct types of variation, 'continuous,' 'compound-continuous,' and 'discontinuous.' Very few of the theoretically possible character-combinations occur, and any individual plant can be placed without hesitation into one of ten distinct units. This feature is due mainly to correlated variation (the association of a particular condition in one variable character with a definite condition in some other character), but also to marked geographical segregation. The generic constitution is best expressed taxonomically by recognising two distinct species, one with a subspecies, a variety and three forms, and the other with three forms.—J. T. **Cunningham**: On the nuptial pads of frogs and toads from the Lamarckian point of view. The nuptial pads of the common frog are thickenings of the horny epidermis on the inner sides of the fore-feet or hands. They are entirely absent in the female. They give the male a firmer hold of the female in the axillary amplexus which precedes spawning. In amplexus, although the male's hands and nuptial pads are partly in contact with the skin of the female, they are also in contact with each other, and the more the female struggles the more tightly are the pads pressed together. There are bones beneath the pads, while the skin of the female in contact with the hands covers the soft abdomen. Thus the nuptial pads are in harmony with other secondary sexual characters in male animals in being related to mechanical stimulation, which is confined to the males.—B. M. **Griffiths**: The phytoplankton of the Isle of Anglesey and of Llyn Ogden, North Wales.—Miss Isobel **Dean**: *Ainigmaptilon haswelli*, n.g. et sp.; a new alcyonarian type.

PARIS.

**Academy of Sciences**, April 19.—Paul **Appell**: The arithmetical nature of Euler's constant. A correction to the note on the same subject in the preceding issue of the *Comptes rendus*.—Charles **Moureu** and Charles **Dufraisse**. Autoxidation and antioxygen action. The catalytic actions of nitrogen compounds. General considerations. Numerous compounds of nitrogen exert an action on autoxidation.— — **Tzitzeica**: Certain congruences.—A. **Buhl**: Continued groups and the integration of Maurer's equations.— — **Cartan**: Certain differential systems the unknowns of which are forms of Pfaff.—Georges J. **Rémoundos**: Paths of determination and asymptotic values of algebroid functions.— — **Swyngedauw**: The change of velocity of a belt close to the points of contact with the pulley.—F. **Baldet**, V. **Burson** and H. **Grenat**: The magnetic storm and the aurora borealis of April 14, 1926. The magnetograph at Meudon Observatory showed two strong deviations on April 14, and several good photographs of the solar layers were obtained at the same time. In the evening a fairly intense aurora was observed, and simultaneously a strong deviation of the magnetic needle was recorded. It is interesting to note that the interval of time between this magnetic storm and the earlier one on March 9 was nearly exactly $8R/6$, in accordance with the rule discovered by M. Deslandres, that the time interval between magnetic storms is a simple multiple of $R/6$, $R$ being the period of synodic rotation of the

sunspots.—Raoul **Ferrier**: The transformation of pre-quantic equations.—Svend Aage **Schou**: The absorption of the ultra-violet rays by aldehydes. Absorption is stronger in hexane solution than in water, and this is interpreted as being due to the formation of the hydrate in water. The absorption of the extreme ultra-violet rays by well purified aldehydes is very small: if this is attributed to the presence of some of the enol form, then the proportion of this in neutral aqueous solution is certainly less than 1 in 15,000.—Michel O. **Samsoen** and P. Mondain **Monval**: The specific heat anomalies of vitreous bodies. The case of boric anhydride and glycerine. The specific heats of these substances, plotted as a function of the temperature, show discontinuities similar to those found by the dilatometric method, but the temperatures of transformation do not exactly correspond.—V. **Auger** and J. N. **Longinescu**: Uranium oranges and reds.—A. **Travers**: The mechanism of the oxidation of manganese to permanganic acid by Proctor Smith's reagent (alkaline persulphate + silver nitrate). The mixture of solutions of alkaline persulphate and silver nitrate gives rise to silver peroxide which can be isolated in the form of $3Ag_2O_2 . AgNO_3$. The formation of this peroxide explains the catalytic action of silver nitrate in the oxidation of manganese salts to permanganate by persulphates.—Jean Marc **Dumoulin**: The catalytic dehydration of the vinylalkylcarbinols. Trials of various catalysts for this reaction showed that the best yields were obtained by alumina precipitated from the sulphate according to the method of Senderens. Three alcohols have been dehydrated and the resulting hydrocarbons (pentadienes, hexadienes, and heptadienes) identified.—R. **Lantz** and A. **Wahl**: Some new derivatives of the naphthoquinones.—C. **Dauzère**: The inversions of temperature. A study of the effect of the nocturnal radiation of the soil on air temperature.—Ph. **Joyet-Lavergne**: The differences of potentials of oxidation and reduction in the spores of *Equisetum arvense*.—E. **Chemin**: *Colaconema reticulatum*. This was found by A. L. Batters developing in the external membrane of *Desmarestia Dudresnayi*, and was considered by him as belonging to the genus Colaconema (?). The author gives further details and considers that the interrogation mark may be removed as the genus is undoubtedly Colaconema.—R. **Combes**: Study of the autumnal migration of the nitrogenous substances in the oak, by analysis of whole plants. By the analysis of seedling oaks it was shown that while changing their colour the leaves lose more than half their nitrogenous substances, and this accumulates in the living organs. During this migration the amount of nitrogen in the whole plant does not vary sensibly.—Marcel **Brandza**: Polychromy in Myxomycetes living in full sunlight.—E. **Aubel**, L. **Genevois**, and J. **Salabartan**: Remarks on the culture of a yeast in a synthetic medium.—Alphonse **Labbé**: A new halophil copepod, *Parametis sanguineus*.

### COPENHAGEN.

**Royal Danish Academy of Science and Letters**, November 27, 1925.—H. A. **Kramers**: Some remarks on the theory of absorption and refraction of X-rays. The general connexion between the absorption and refraction of electromagnetic waves can also be traced in the X-ray region. It allows of a simple explanation of certain features of the experimental laws of X-ray absorption, and leads to definite predictions regarding the dependency of the refraction on the wave-length.

December 11, 1925.—C. **Juel**: Congruence of the second degree. The congruence of straight lines in space can be defined as a congruence contained in a linear complex which is of the second order and the second class and has 0, 2 or 4, or else an infinite number of straight lines in common with each hyperboloid in the complex. This congruence is algebraic, and is determined by purely descriptive results.

January 15.—Niels **Nielsen**: (1) Note on certain developments of a holomorph function. Applying the principle of *renversement* (*Journal de Crelle*, t. 132), two developments are indicated of a holomorphic function in the neighbourhood of the origin, developments of which the region of convergence is generally closed. (2) Research on cylindrical functions and on certain analogous functions. Research on derivatives of the function of Lommel, taken in relation to two parameters, and on homogeneous and linear differential equations of the fourth and sixth order, obtained for their above-mentioned derivatives. Integral representation of these functions and certain relevant developments in infinite series.

January 29.—Niels **Bjernum**: Studies on ion-association. (1) The influence of ion-association on the activity of ions by degrees of association which are not very great. An approximate method is given of calculating the influence of this association on the activity of ions.—Th. **Madsen**: The avidity of diphtheria anti-toxin (Th. Madsen and S. Schmidt). The rate of reaction for the neutralisation of diphtheria with anti-toxin varies considerably for different anti-diphtheric sera. This appears from experiments both *in vitro* and *in vivo*, and is of considerable importance as regards the curative qualities of the serum.

February 12.—C. **Wesenberg-Lund**: Contributions to the biology of the genus Daphnia. The author has investigated numerous races of the genus Daphnia from different localities. Remarks are made upon the systematics, the buoyancy theory, and modern studies of heredity in this genus.

February 26.—C. H. **Ostenfeld**: On the origin of the flora of Greenland. Thanks to the collections made by the many recent expeditions (mostly Danish), the distribution of the flowering plants along the whole of the coast of Greenland is now comparatively well known. Thereby a good base for a treatment of the origin of flora and its ways of immigration is created. A not inconsiderable part of the more hardy species are supposed to have survived the ice-age in Greenland, but a closer limitation of this group is not possible. The main part of the flora, however, has immigrated into Greenland after the maximum extent of the ice-covering, and the immigration has probably had its maximum in the post-glacial warmer epoch which existed also in Greenland. Most of the species have come from N. America, and a much smaller number from Europe. This European element consists of (1) high-arctic species, probably immigrated via Spitsbergen, (2) less arctic species from Iceland, and (3) species which have been introduced in the time of the old Norse settlements.

April 23.—G. **Hevesy**: The exchange of atoms in solid bodies in consequence of heat-movements. Explanations can be offered, on one hand, by the velocity with which one substance diffuses into another, and on the other hand by the magnitudes of their electrolytic conductivities. The paper deals principally with the question of the dependence of the velocity of exchange on the constitution of the crystal aggregate of which the solid is built up.—August **Krogh**: The hormone of the hypophysis in the circulation. Through the action on the melanophores in the skin of the frog, very low concentrations of pituitrin can be determined. The concentration is found to be higher in the jugular than in the saphenous vein.

## Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 56, Art. 2: Tooth Sequence in certain Trilophodont Tetrabelodont Mastodons. By Childs Frick. Pp. 122-178. (New York City.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. iv: Meteorologiska iakttagelser i Sverige, Band 65. Pp. x+183. 7 kr. Årsbok, 7, 1925. i: Månadsöversikt över väderlek och vattentillgång jamte anstaltens årsberättelse. Pp. 97. 2.50 kr. (Stockholm.)

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 6: Om stormar vid Svealands och Götalands kuster. Av C. J. Östman. Pp. 37. 4 kr. Band 3, No. 7: Om sockerbetsodlingens klimatiska betingelser och bevattningsproblemet. Av L. Högberg. Pp. 11. 1 kr. (Stockholm.)

Bulletin of the National Research Council. Vol. 10, Part 4, No. 54: Quantum Principles and Line Spectra. By Prof. J. H. Van Vleck. Pp. 316. (Washington, D.C.: National Academy of Sciences.) 3 dollars.

Report of the Danish Biological Station to the Board of Agriculture, 31, 1925. By Dr. C. G. Joh. Petersen. Pp. 63. (Copenhagen: G. E. C. Gad.)

Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 24: The Preliminary Report on the Platinum Deposits in the South-Eastern Part of the Rustenberg District, Transvaal. By Dr. Percy A. Wagner. Pp. 39+7 plates. (Pretoria: Government Printing and Stationery Office.) 2s. 6d.

## Diary of Societies.

*SATURDAY*, MAY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Moret: Une Révolution sociale en Égypte vers 2000 av. J.-C.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (Annual General Meeting), at 3.—Discussion on Paper by J. G. Taylor on Coal and its Banded Constituents.—Prof. J. Poole: Notes on the Tour in Belgium and Germany (Address).

*MONDAY*, MAY 31.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Lt.-Col. Sir Arnold Talbot Wilson: The Military Record and Potentialities of the Persian Empire.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Major L. M. Davies: Evolution.

SURVEYORS' INSTITUTION, at 5.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 5.30.—Annual General Meeting and Clinical Meeting.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. F. M. Chapman: Darwin's Chile.

*TUESDAY*, JUNE 1.

SOCIETY OF GLASS TECHNOLOGY (at University College), at 2.30.—Sir W. M. Flinders Petrie: Glass in Early Ages (Demonstration and Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Brig.-Gen. Sir Percy Sykes: Shah Abbas of Persia, the Contemporary of Queen Elizabeth.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of May 1926.—Dr. F. Chapman: Exhibition of Lantern Slides illustrating Bird Life on the Barro Colorado Island.—A. S. Le Souëf: On the Habits of the Order Marsupialia.—Prof. R. T. Leiper: (*a*) Some Parasites of Rats in the Zoological Society's Gardens; (*b*) The Starling as a Factor in the Spread of Gapeworm Disease in Chickens.—S. Zuckerman: Growth Changes in the Skull of the Baboon (*Papio porcarius*).—S. Hirst: Descriptions of New Mites, including Four New Species of 'Red Spider.'—J. H. Power: Note on the Occurrence of Hybrid Anura at Lobatsi, Bechuanaland Protectorate.—H. C. Wilkie: The Ossicula auditus of the Common Badger (*Meles taxus*).

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

*WEDNESDAY*, JUNE 2.

SOCIETY OF GLASS TECHNOLOGY (at Research Laboratories, General Electric Co. Ltd., Wembley), at 2.15.—J. W. Ryde: A Communication from the Research Laboratories of the General Electric Co. Ltd., Wembley: Opal Glass.—F. F. S. Bryson: The Electrical Conductivity of Glass at High Temperatures.—Edith M. Firth, F. W. Hodkin, M. Parkin, and Prof. W. E. S. Turner: The Influence of Moisture on the Rate of Melting and on the Properties of Soda-Lime-Silica Glasses.—Dr. S. English and Prof. W. E. S. Turner: The Physical Properties of Zinc Oxide containing Glasses.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. Dayton Miller: Ether Drift Experiment at Mount Wilson.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Sir Jagadis C. Bose: The Action of Alkaloids and Cobra Venom on the Pulse of the Plant and Animal.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) at 6.—P. W. Willans: Low Frequency Intervalve Transformer.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—A. Lucas: Problems in connexion with Ancient Egyptian Materials.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Dr. W. E. Gye: The Origin of Tumours.—J. E. Barnard: Demonstration on Microscopical Methods.

*THURSDAY*, JUNE 3.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Presentation of Bessemer Gold Medal to Sir Hugh Bell, Bart.—Sir W. Peter Rylands: Presidential Address.—Report on Heterogeneity of Steel Ingots. By a Sub-Committee of Committee No. 5, consisting of Dr. W. H. Hatfield, T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M. Service, and J. H. Whiteley.—J. H. S. Dickenson: A Note on the Distribution of Silicates in Steel Ingots.—J. H. Whiteley: Ghost Lines and Banded Structure of Rolled and Forged Mild Steels.—At 2.30.—W. H. Dearden and C. Benedicks: Magnetic Changes in Iron and Steel below 400° C.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 3.—Sir William Willcox: Nasal Sinusitis as a Cause of Toxæmia.—Dr. A. Logan Turner and Dr. F. E. Reynolds: A Fatal Case of Leptomeningitis following Operation on the Ethmoidal Air Cells: with Microscopical Demonstration of the Path of Infection.

ROYAL SOCIETY, at 4.30.—Dr. A. E. H. Tutton: The Alkali Perchlorates and a New Principle concerning the Measurement of Space-Lattice Cells.—Dr. T. E. Stanton: On the Flow of Gases at High Speeds.—Prof. G. I. Taylor and W. S. Farran: The Distortion of Crystals of Aluminium under Compression. Part I.—Prof. E. V. Appleton, R. A. Watson Watt, and J. F. Herd: On the Nature of Atmospherics. II.—*To be read in title only*:—Prof. C. H. Lees: On the Determination of the Specific Heats of Gases at Constant Pressure and at Constant Volume and their Ratio by Adiabatic Expansion.—T. G. Room: A General Configuration in Space of any Number of Dimensions analogous to the Double-Six of Lines in Ordinary Space.—C. N. Hinshelwood and W. K. Hutchison: A Comparison between Unimolecular and Bimolecular Gaseous Reactions. The Thermal Decomposition of Gaseous Acetaldehyde.—P. A. M. Dirac: (*a*) The Elimination of the Nodes in Quantum Mechanics; (*b*) Relativity Quantum Mechanics with an application to Compton Scattering.—A. Fage and L. J. Jones: On the Drag of an Aerofoil for Two-Dimensional Flow.—F. W. Carter: On the Action of a Locomotive Driving Wheel.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, Paddington), at 5.—Dr. C. S. Myers: Freudian Psychology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. Newton Friend: Iron in Antiquity.

CHEMICAL SOCIETY, at 8.

*FRIDAY*, JUNE 4.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Announcement of the Award of the Andrew Carnegie Research Scholarships for 1926-7.—D. Brownlie: Coal Blending.—W. W. Hollings: Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast Furnace.—Dr. W. Rosenhain, R. G. Batson, and N. P. Tucker: Effect of Mass in the Heat Treatment of Nickel Steel.—G. R. Woodvine and A. L. Roberts: Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters.—At 2.30.—I. G. Slater and T. H. Turner: The Hardness of Carbon Steels at High Temperatures.—A. R. Page: The Hardening and Tempering of High Speed Steel.—A. E. Cameron and G. B. Waterhouse: The Effects of Arsenic on Steel.—E. D. Campbell and H. W. Mohr: Specific Resistance and Thermoelectro-motive Potential of some Steels differing in Carbon Content.—R. H. Greaves and J. A. Jones: The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number.—H. O'Neill: Deformation Lines in Large and Small Crystals of Ferrite.—A. Osawa: The Relation between Space-Lattice Constant and Density of Iron-Nickel Alloys.—T. E. Rooney and L. M. Clark: The Estimation of Phosphorus in Steels containing Tungsten.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 10.30 A.M.—Clinical Meeting.

PHILOLOGICAL SOCIETY (at University College), at 5.—C. T. Onions: Dictionary Evening.

ROYAL SOCIETY OF MEDICINE (Otology Section), in afternoon.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. S. H. Reynolds: A Geological Tour in South and East Africa (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. Garstang: Researches in Palestine.

*SATURDAY*, JUNE 5.

ROYAL SOCIETY OF MEDICINE (Otology Section), in morning.

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

### PUBLIC LECTURES.

*MONDAY*, MAY 31.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. T. H. Pear: Fitness for Work. (Succeeding Lectures on June 1 and 2.)

IMPERIAL COLLEGE (Royal School of Mines), at 5.15.—Prof. L. Denoël: Tubbing Deep Shafts, and Subsidence. (Succeeding Lectures on June 1, 2, and 3.)—Sir T. W. Edgeworth David: Past Ice Ages of the World and their Control of Animal and Plant Life, with special reference to the Australian Evidence. (Succeeding Lecture on June 7.)

*TUESDAY*, JUNE 1.

GRESHAM COLLEGE (Basinghall Street), at 6.—Sir A. Walford Davies: Music. (Succeeding Lectures on June 2, 3, and 4.).

*THURSDAY*, JUNE 3.

CHELSEA PHYSIC GARDEN (Swan Walk, Chelsea), at 5.—Prof. J. McLean Thompson: The Plant as an Engineer. (Chadwick Lecture.)

### CONFERENCES.

*SATURDAY*, MAY 29.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (at Northampton School for Girls), at 12.30.

JUNE 1 AND 2.

RÉUNION NEUROLOGIQUE (in Paris).