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International Co-operation in Science

AT the present time, when all nations are faced with many difficult problems in economics as well as in their political relations with one another, they are being compelled to organise their resources to the best advantage, and this may lead, and in certain cases has led, to preferring a nationalised system to the international co-operation that many would rather aim at. This influence must also be felt by scientific men, and may tend to make them visualise the problems with which they deal from a more restricted point of view.

On the other hand, science itself has been advancing at an ever-increasing pace during recent years, and this has been largely due to the free and active international co-operation which has existed and to the personal relationships which have been formed between scientific men in all countries. Not only has this been the case in the exact sciences and in their various applications to the welfare of the community, but also it is being widely held that investigations carried out on scientific lines will greatly aid in the solution of many of the problems of the present time. Science, which is much more than the mere systematisation of data, has done so much to promote international co-operation in its own field that it may well encourage a similar spirit in other fields of human activity.

International co-operation in science, it may be granted, is generally accepted by scientific workers, but it is by no means certain that the fact is equally appreciated by those who are politically in control of world affairs. The question must often have arisen, therefore, whether or not a clear and formal declaration should be made by a responsible body of the principles of co-operation between men of all nations which have proved so fruitful for the progress of science.

Clearly, such a declaration would have to come from a body as widely representative as possible of scientific thought. There is not at the present time any scientific organisation which includes all nations of the world, but to the International Council of Scientific Unions, which is meeting next month at Brussels, some forty countries have already adhered, and others can join it at their own desire. Moreover, the Unions related to it work through about a hundred and thirty national committees in the various countries, which have adhered to one or more of these

Unions in order to promote international co-operation in their particular fields of science.

Here then is a large and active international organisation which might with advantage discuss at its forthcoming meeting this problem of international co-operation on wider lines; and in fact the Royal Academy of Sciences in Holland has notified its wish as a member of the International Council to bring this question to the notice of the General Assembly. A resolution has been circulated to the countries and the Unions which are members of the Council in which, after expressing the conviction that ultimately a way will be found leading to a more harmonious structure of the world, stress is laid upon the importance of maintaining international co-operation in the domain of science in all circumstances. While realising that in every country scientific men will be drawn more and more into spheres of national organisation, the resolution expresses the hope that they will not lose sight of the international character of science, and will continue to foster the conditions necessary for international co-operation, since the 'brotherhood' of men of science can be an important factor in attaining the mutual understanding and helpfulness so necessary not only for science but also for all aspects of human endeavour.

The International Council cannot dictate a policy to the various Unions, but there is little doubt that the adoption of a resolution on these lines would carry considerable weight. Moreover, although the resolution is directed to allied organisations, it is clear from its tone and general content that it is meant to be an appeal to all scientific organisations, and to all scientific workers as well, urging them never to lose faith in the significance of science, pure and applied, for mankind. It is to be hoped that the appeal will find a response in every country, whether adhering to the International Council or not, for it is a matter which stands above all political and other divisions. The International Council, as the largest existing body representative of international science, is the appropriate body to issue such a declaration, and we trust that it will be given careful consideration. If the immediate effect alone would be to induce those countries which are not yet represented upon the International Council to find an opportunity to join in its work, then the resolution might be regarded as a significant step towards the establishment of fuller co-operation among the scientific workers of the world.

The Description of Nature

Atomic Theory and the Description of Nature. 1: *Four Essays, with an Introductory Survey.* By Niels Bohr. Pp. vi+119. (Cambridge: At the University Press, 1934.) 6*s.* net.

IT is fitting that the year in which the Bohr theory comes of age should hear a pronouncement by its author on the view of Nature to which it has led. It is true that in one sense the pronouncement is not up to date (the book is a reprint of previously published articles, the latest of which first appeared in 1929), but the scant amount of fundamental progress in the last few years, combined with Bohr's remarkable power of always seeing a little ahead of the existing position, makes this of small significance. The most striking of the subsequent advances have been the discoveries of the neutron and the positive 'electron', and in the other volume "containing a number of later essays on the same subject, in which the general point of view is further developed", which we are promised in the foreword, we may hope to find some account of the theoretical aspect of these discoveries. In the meantime, however, the present volume may be taken as a true representation of the view of Nature afforded by the quantum theory to one of the keenest pairs of eyes in the world of physics.

Two of the four essays which, together with an introductory survey, make up the contents of the book are familiar to readers of NATURE, having been published as Supplements in 1925 and 1927. The third essay appeared in German in *Die Naturwissenschaften* in 1929, and the fourth in Danish in *Fysisk Tidsskrift* in the same year. The introductory survey also appeared originally in Danish in the Year Book of the University of Copenhagen for 1929. Although, therefore, only a portion (a little less than half) of the material now makes its first direct appeal to English-speaking readers, that portion is the latest and, as it happens, the most concerned with the broader aspects of the subject.

Bohr's view of the situation created by the quantum theory is well known, and his principle of 'complementarity' is perhaps the clearest expression yet given to the dilemma by which we are faced.

"The definition of the state of a physical system, as ordinarily understood, claims the elimination of all external disturbances. But in that case, according to the quantum postulate, any observation will be impossible, and, above all, the concepts of

space and time lose their immediate sense. On the other hand, if in order to make observation possible we permit certain interactions with suitable agencies of measurement, not belonging to the system, an unambiguous definition of the state of the system is naturally no longer possible, and there can be no question of causality in the ordinary sense of the word. The very nature of the quantum theory thus forces us to regard the space-time co-ordination and the claim of causality, the union of which characterises the classical theories, as complementary but exclusive features of the description, symbolising the idealisation of observation and definition respectively."

It thus appears that the classical theories were aiming at a description of Nature which it is impossible to realise, and whenever we have to deal with phenomena in which the quantum of action becomes significant, we must renounce either the concept of space-time or the principle of causality. This does not mean, however, that the essence of Nature as represented by the statement of natural laws is to be regarded as dual. "There can be no question of a quite independent application of the ideas of space and time and of causality. The two views . . . are rather to be considered as different attempts at an interpretation of experimental evidence in which the limitation of the classical concepts is expressed in complementary ways."

In such a situation our natural impulse—justified, if justification is necessary, by the success of the special theory of relativity—is to re-formulate our ideals so as to make the impossible a thing of no meaning. Just as we escape from the obscurantism of the Michelson-Morley experiment by, fox-like, regarding the grapes of absolute velocity as sour, so we might seek for a point of view from which the concept of space-time or the principle of causality loses all significance. Bohr, however, will not attempt to meet the difficulty in this way. He insists that there can be no escape from a space-time description of experience, space-time being apparently in his view a necessary mode of perception.

"According to the view of the author, it would be a misconception to believe that the difficulties of the atomic theory may be evaded by eventually replacing the concepts of classical physics by new conceptual forms. Indeed . . . the recognition of the limitation of our forms of perception by no means implies that we can dispense with our customary ideas or their direct verbal expressions when reducing our sense impressions to order. No more is it likely that the fundamental concepts of the classical theories will ever become superfluous for the description of physical experience." And again: "It lies in the nature of physical observation, nevertheless, that all experience must ultimately be expressed in terms of classical concepts, neglecting the quantum of action."

With this as a guiding principle there is clearly nothing to do but to accept defeat, and Bohr, who is the incarnation of logic, capitulates unreservedly. "A conscious resignation," he says, is implied in the original quantum postulate, and "we must . . . be prepared to find that further advance . . . will require a still more extensive renunciation of features which we are accustomed to demand of the space-time mode of description".

It may be a futile rebellion against implacable Fate, but we must confess an unwillingness to submit to this depredation of our philosophical rights. Nor does such an attitude seem entirely Promethean. True, there is no evading the choice which the principle of complementarity imposes on us, but we fail to see that in discarding the possibility of a complete space-time description of Nature we weaken in the least our chance of fulfilling the traditional task of science which, in Bohr's accurate and succinct phrase, "is both to extend the range of our experience and to reduce it to order". We cannot accept the view that the interpretation of experience rests ultimately on the space-time concept. Interpretation is a logical process, and the laws of logic are independent of the concepts which they relate together. If the space-time concept has qualities which unfit it for relating the facts of experience, we must discard it in favour of something more suitable. There is nothing inherently impossible in this; it is simply a matter of cultivating our power of abstraction and expelling deeply-rooted prejudices. That space-time is by no means necessary to logical thought is sufficiently evident in the fact that we can reason about such non-spatio-temporal ideas as courage, virtue, desire and a score of others; and although these particular concepts (and, we may add, that of free-will) are obviously unsuited to physical applications, their existence justifies belief in the possibility of suitable ones until proof to the contrary is forthcoming. "Il faut vivre," pleaded the Abbé Desfontaines. "Je n'en vois pas la nécessité," replied the Comte d'Argenson. Only the former, we believe, was committed to a renunciation.

To be somewhat more specific, let us consider what is actually involved in the fact that the state of an observed system is altered in an

unknown way by the agencies of observation. There is an indeterminacy here only if we persist in analysing the observation into a thing observed and a means of observation. As Bohr points out, the details of the analysis are arbitrary (we can include part of the observing apparatus in the system if we like), but what is much more vital is the fact that, so far as the ordering of our observations is concerned, the analysis itself is voluntary. What we are given in experience is simply an observation—represented by a number. Its expression as a relation between an object and a perceiving subject has been (and still is for large-scale phenomena) an exceedingly useful one, but no more inevitable than the analysis of motion into an inertial and a disturbed part. If we so express it, then it is indeed difficult to see how we can make the hypothetical object independent of space and time, and we are forced to submit to the ambiguities of the quantum theory; but this very fact is surely an argument for discarding the analysis.

By this simplification we avoid the dilemma so clearly expressed by Bohr in the following passage: "For describing our mental activity, we require, on one hand, an objectively given content to be placed in opposition to a perceiving subject, while, on the other hand, as is already implied in such an assertion, no sharp separation between object and subject can be maintained, since the perceiving subject also belongs to our mental content." A sharp separation, however, can be maintained—in physics, at least: the object is experience (or observations); the subject, reason. Reason is never an object of study in physics, whatever psychology may do with it, and no overlapping is therefore possible. Confusion arises only when we *sub*-divide the object, experience, into a thing observed and a means of observation, for the quantum theory teaches us that no unambiguous subdivision of this kind can be made. To avoid confusion, therefore, we have simply to accept experience as it is.

On a very interesting page Bohr discusses an unusual aspect of the space-time concept.

"One need only remember here the sensation, often cited by psychologists, which every one has experienced when attempting to orient himself in a dark room by feeling with a stick. When the stick is held loosely, it appears to the sense of touch to be an object. When, however, it is held firmly, we lose the sensation that it is a foreign body, and the impression of touch becomes immediately localised at the point where the stick is touching the body under investigation. It would scarcely be an exaggeration to maintain, purely from psychological experiences, that the concepts of space and time by their very nature acquire a meaning only because of the possibility of neglecting the interaction with the means of measurement."

It is instructive to consider this passage in connexion with the doctrine that the space-time concept is inevitable for the description of Nature. If we could make assertions about space and time "purely from psychological experiences", it is clear that we should have to grant them a sort of inevitability, as Bohr maintains, but a question concerning the use of words arises here. The experience described seems to us no more psychological than that of any physical experiment; it is simply derived from a different physical sense—the sense of touch instead of the customary sense of sight. The problem which suggests itself (an interesting one) is whether the voluntarily adopted concepts of space and time (so far as they are applicable at all) need to be endowed with the same properties to enable them to correlate tactual as to enable them to correlate visual sensations. Physics, however, relies very little on the sense of touch, and the question is therefore of philosophical rather than of practical interest.

If, however, we feel that Bohr presents us with a clear statement of a problem rather than its solution—with an appetite rather than a meal—we must not neglect to point out that the renunciation to which we object is accepted by him not merely with fortitude but with enthusiasm. "We must consider this very renunciation," he says, "as an essential advance in our understanding." "My purpose has been to give expression to our enthusiasm for the prospects which have been opened up for the whole of science." This is an attitude possible only to a fearless mind and a noble spirit: it is one which we respect and admire, but cannot share. HERBERT DINGLE.

Mechanised Medicine

Red Medicine: Socialized Health in Soviet Russia. By Sir Arthur Newsholme and Dr. John Adams Kingsbury. Pp. xi+324+18 plates. (London: William Heinemann (Medical Books), Ltd., 1934.) 10*s.* 6*d.* net.

THIS work is an examination of the conditions of medical practice in Soviet Russia in 1932. Its entertainment value is indubitable and is derived from the description of a five weeks' tour

made in the summer of 1932 during which the distinguished authors travelled more than six thousand miles of Soviet Russia. They write with a boyish enthusiasm and *naïveté* which gives the book great charm. They recognise that in an implacably 'conducted' tour they were shown the best and not the worst.

The scientific value of such a tour is, of course, slight. Seven days of the short period were spent on steamships on the Volga and Black Sea, and much of the rest of the time in railway travel. The real value of the book rests upon the fact that the authors are authorities on their subject and, apart from their brief visit, they have steeped themselves in the literature of Russian medicine. In fact, the work is to be considered as the coping-stone to a considerable series of studies on the relation of private and official practice of medicine carried out in eighteen countries and published in three volumes by the American Milbank Memorial Fund in 1931.

As the result of these studies, the authors became convinced medical (though not necessarily political) communists. Private medical practice, as carried out in western countries, is to them anathema and they passionately desire the cessation of remuneration to the doctor for each medical act. They would have all practitioners State servants. This being so, the organisation of medical practice in Soviet Russia is naturally much to their liking, and their descriptions of it are frequently the occasion of the shaking of a minatory fist or, at any rate, the wagging of a hortatory finger at the medical customs of the west. To emphasise this, the authors, while writing in an enthusiastic manner of all they approve in Russia, studiously avoid discussion of many things of which they clearly disapprove, as this would weaken the effect they wish to produce.

In a chapter on public abortion, we learn that any pregnant multiparous woman in Russia can demand, as a right, entry to an institution in which abortion is induced by State doctors, and we are informed that in Moscow in 1929 total abortions were sixty-one per cent in excess of normal births. There are chapters on the care of maternity, the care of children and youths and the care of the workers, but in vain does one look for a chapter on the care of the aged; to this no reference is made. Amongst the photographs with which the book is lavishly adorned, a picture of a works committee discussing production produces astonishment. This is no witenagemot, for the committee consists of young persons scarcely more than children. Later, figures are given from which it may be deduced that the average age of a Russian of to-day is about twenty years.

The fact appears to be that war, pestilence, famine and pogrom have done their work very well. In the language of the book, old age has been 'liquidated' and in Russia we are faced with a population which consists literally, and not merely metaphorically, in children. This fundamental fact being ascertained, does it not throw a great illumination on all that is happening in the land? The vital statistics which crowd this book need correction for age distribution and cannot be applied crudely for comparison either with western States or with Tsarist Russia.

The authors are amazed at the extent of the provision for the sanatorium treatment of tuberculosis which has been procured by the conversion of nobles' palaces. They do not appear to have been struck with amazement by the need for all this provision. From figures given, it is clear that there is a tuberculous problem in Soviet Russia of great magnitude. The case rate for tubercle per 10,000 of the population is 116·5 and appears to be on the increase. In London it is 16·65. It is not necessary to look far to explain this high incidence. Rapid industrialisation, bad housing, insufficient food supply, and a juvenile population, contain all the necessary ingredients for the production of an alarmingly high incidence.

Although State curative medicine is organised on a vast scale, there is grave doubt not only whether there are sufficient doctors, but also of the efficiency and training of those that exist. In this, as in many other respects, quality has been sacrificed to quantity.

Of preventive medicine there is little said, which is rather surprising since Sir Arthur Newsholme may be regarded as the Nestor of English sanatarians, but, no doubt, the reasons are first that the matter under consideration is not preventive but curative medicine, and secondly that there is as yet little sanitation to be observed in Russia. It is pointed out, however, that the high and continuing incidence of typhoid fever, typhus and dysentery throw a strong light upon the neglect of domestic cleanliness and communal sanitation.

The authors deplore the absence of domiciliary medical treatment, but the word "home" contains a bourgeois idea and where there is no *domus* there can be nothing domiciliary.

At the conclusion, the authors do allow

themselves one misgiving, and this is "Can such an order" (that is, a better social order) "in the fullest sense be created which does not include recognition of man's spiritual relation to the divine ?" This, of course, is also a shockingly bourgeois sentiment.

Scientifically, the case must be judged on biological grounds. Soviet Russia is a vast biological experiment. Unfortunately, our biologists are hopelessly at variance on the very point which would put all doubts at rest, and the question is still an open one. If Prof. MacBride is right, the communist governors of Russia are right and we may order our tumbrils. If Weismann is right, they are wrong and we may sleep quietly in our beds.

Aluminium and Tungsten

Gmelins Handbuch der anorganischen Chemie. Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. (1) *System-Nummer 35 : Aluminium.* Teil B, Lief. 1. Pp. 308. 48 gold marks. (2) *System-Nummer 54 : Wolfram.* Pp. xviii+xi+397. 64 gold marks. (Berlin : Verlag Chemie, G.m.b.H., 1933.)

(1) THIS section of Gmelin's "Handbuch", which has appeared before the publication of Part A, deals with the compounds which aluminium forms with the principal non-metals (except silicon and phosphorus). No stable hydride of aluminium is yet known, the only evidence of its formation being derived from band-spectra produced in various ways, but R. S. Richardson has detected it in the sun's envelope.

A large part of the volume is devoted to alumina. Methods of preparing well-formed crystals of the oxide and a list of patent specifications relating to the manufacture of large single-crystals, which are used as synthetic gems, are detailed. The two main technical processes used in the purification of alumina from bauxite are given in convenient schematic form. Hitherto all attempts to extract alumina from bauxite by means of caustic soda at atmospheric pressure have been unsuccessful. One of the most notable achievements in the technology of aluminium is the separation of sodium aluminate into its constituents by mechanical agitation. The history of this idea is traced to an observation by Bonsdorff in 1833. In 1859 Le Chatelier suggested the crystallisation of alumina from hot supersaturated solutions, but no practical result was attained until 1887, when K. J. Bayer patented the modern process.

In the present process the alkaline liquor is first seeded with crystals of alumina and then mechanically stirred. No completely satisfactory explanation of the process has been devised. Neither sand, glass-powder, graphite nor colloidal alumina can be substituted for the crystals used for seeding, and even crystalline alumina itself is often ineffective. The best material for the purpose is the product which crystallises out between 25° and 35° C. ; and a somewhat narrow range of concentrations is also desirable.

The preparation of alumina from other compounds is also dealt with very fully and the hydroxide is described under the headings of gels, sols and crystals. There is a long list of references to the literature on the manufacture of aluminium nitride, which is used in the Serpek process for synthesising ammonia. Aluminium chloride is also fully described but its use in organic chemistry falls outside the scope of the work.

Several organic derivatives are recorded, for example, aluminium carbide and various salts but not aluminium trimethyl. The organic salts of aluminium have attracted less attention than those of many other metals but the acetate is important both in analytical work and in the dyeing industry. The records of its stability in hot solutions are somewhat contradictory but the formation of colloidal alumina, when a solution of the acetate is boiled, appears to have been observed by Gay-Lussac in 1810. Aluminium formate, acetate and tartrate all give evidence of complex ion formation. Thus normal reactions of the metallic ion are suppressed ; Biot observed so long ago as 1835 that concentrated aqueous solutions of the tartrate were lævorotatory, but the pure salt has not yet been isolated with certainty. The chemical nature of all these organic salts seems to call for further investigation.

(2) The importance of tungsten in modern industry has led to the accumulation of a vast amount of information about the properties and uses of this metal. The first reference to it seems to have been made by Ercker in 1574 but until the end of the eighteenth century the word 'wolfram' (with a great variety of spellings) was used to denote the ores of tungsten, which are often associated with tin and interfere with the extraction of that metal. Scheele first separated the acid oxide in pure form and recognised it as something different from molybdic acid, whilst the Spanish brothers de Lhuyart first isolated the metal in 1783. Exact quantitative work on the

lower oxides was undertaken by Berzelius in 1816, but the industrial application of tungsten was delayed until 1847, although an alloy with iron had long been known. After the Paris Exhibition in 1900 the use of tungsten in steel manufacture became general and three years later filaments of the metal were used in electric bulbs.

Very interesting data are given relating to the production of tungsten. Before 1910, Australia was the largest producer in the world; then Burma and the United States gained the lead for a few years, but since 1918 the greater part of the world's output has come from China. In technical research Germany led the way until her supplies were cut off during the War.

Tungsten is used as a hardening component of certain alloys and also as a pure metal. Carbide of tungsten is an important constituent of the hard alloys, and tabulated lists of references to the patent specifications are grouped according to the melting or sintering properties of the alloys. Recent industrial applications of the pure metal have been largely due to its low volatility and high melting point. It has practically replaced all other metals as lamp filaments and it is used for making electrodes, thermo-elements and many other appliances. This volume is packed with details about the properties of tungsten and its compounds and the literature has been revised to April 1933.

Modern Geometry

Analytical Geometry of Three Dimensions. By Prof. D. M. Y. Sommerville. Pp. xvi+416. (Cambridge: At the University Press, 1934.) 18*s.* net.

THIS is a textbook: it is not too difficult for the average 'honours' student, it includes the material usually required for examinations; yet it also includes less usual subjects such as line-geometry, cubic and quartic curves, cubic surfaces, ruled surfaces, higher space, the Veronese surface, the application of matrices, invariants and invariant factors; above all, it conveys something of the true spirit of modern geometry. For many years geometrical research has been made both easier and more effective by projective methods and space of more than three dimensions, but this had not hitherto found recognition in any sufficiently elementary English textbook.

Though primarily algebraical and three-dimensional, the book provides a more unified knowledge of geometry by the frequent use of purely geometrical methods and by excursions into one, two, four and five dimensions. It does not deal with birational transformations or topology. Its reasoning is in general particularly concise and intelligible, though occasionally condensation renders the argument obscure. A carefully chosen first course of reading makes it really suitable for those whose knowledge of co-ordinate geometry is limited to elementary conics. References to more detailed expositions are too scanty.

The treatment of the straight line, plane and quadric accords with examination requirements, but rectangular Cartesians are systematically supplemented by homogeneous co-ordinates, line co-ordinates, matrices, and (most conspicuously and successfully) the circle at infinity and other projective methods. There are useful notes on imaginary elements. Beginners may possibly find the projective investigation, as an introduction to focal properties, somewhat overwhelming. The invariants of two quadrics are treated extensively. Segre characteristics are sufficiently explained. Certain chapters would benefit from a more comprehensive selection of heuristic examples.

Elsewhere pure projective geometry tends to predominate. In one chapter co-ordinates are established without reference to metrical considerations: difficulties are avoided by assuming, openly, the fundamental theorem.

The curve theory includes developables, the (plane) Plücker relations, Lüroth's theorem, the twisted cubic and its polar system, twisted quartics of both species, curves upon a quadric. A chapter on line geometry deals with the quadric in five dimensions. The treatment of surfaces includes curvature, polar surfaces, the effect of isolated singularities on class, ruled surfaces, double curves, the cubic surface and its twenty-seven lines, the Steiner surface, the Veronese surface, normal varieties, the cyclide.

Misprints are not serious; (y) for (x), on p. 371, is slightly confusing. A few statements require emendation: three concurrent lines on a cubic surface do not necessarily meet in a node; quartic surfaces are known containing as many as sixty-four lines; despite Continental nomenclature, the general point of a double curve should not be confused with a binode; part of 14·683 is incomprehensible. Terms are too freely used in an unconventional sense without warning; for example, linear series (for regulus), self-conjugate tetrahedron.

The excellence of this work emphasises how much geometry loses by the recent death of its author.

Short Reviews

The Physics of Electron Tubes. By Dr. L. R. Koller. (International Series in Physics.) Pp. xiii+205. (New York and London: McGraw-Hill Book Co., Inc., 1934.) 18*s.* net.

ONE of the most useful functions of books or monographs on limited and somewhat specialised branches of scientific knowledge is the summary in a convenient and critical form of all the available information on the subject. This function is admirably fulfilled in Dr. Koller's monograph which, in the space of some sixty thousand words, presents a survey of electron emission and its application to the various types of valves and photoelectric cells in use to-day.

Beginning with the general theory of thermionics, the characteristics of the emission from various types of cathode are described, together with practical advice on the construction of such cathodes and their use in electron tubes. The deleterious action of gases and the methods for securing their removal are dealt with for the high vacuum type of valve; while two chapters are devoted to the gaseous discharge tube, the technical applications of which have been so widely developed in recent years. In a similar category may be placed the photoelectric cell, the fundamental physics of which are adequately covered. The whole book has the merit of not being overloaded with matter which is now more of historical than of fundamental scientific interest. In spite of this, however, the work gives a sense of completeness in reviewing the whole subject, and the tables of data and lists of references given at the end of each chapter will prove invaluable to the reader whose scientific or practical interest in the subject would necessitate his delving much deeper than is possible within the limits of a single volume. The general sense of this notice is thus thoroughly to recommend the book as a scientific and practical introduction to the subject covered by its title. The production of the book is excellent.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1933. Edited by Dr. M. Epstein. Pp. xii+312+184. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1934.) 30*s.* net.

THE full summary of the past year's history again appears in this indispensable work of reference. Great Britain and the Empire naturally receive most attention and there are full accounts of the efforts in the cause of disarmament, and the hopes of the World Economic Conference. Then follow sections on the League of Nations and foreign history, with ample attention to events in Germany and the crisis in the United States. The second part of the volume as usual contains a chronicle of events, the year's obituary with admirable short biographies, and retrospects of literature, art, drama, science, law and finance. Little of importance can be overlooked in these packed reviews of various branches of achievement. Science is dealt with in thirteen pages and is a useful record of the year's discoveries and publications. A full index completes the volume.

Adam's Ancestors: an Up-to-date Outline of what is known about the Origin of Man. By Dr. L. S. B. Leakey. Pp. xix+244+12 plates. (London: Methuen and Co., Ltd., 1934.) 7*s.* 6*d.* net.

IT is no detraction from the merits of Dr. Leakey's book to say that it does not call for extended notice. The alternative would be to devote to controversial matters as much space as the author himself has given to their discussion. For his book is not merely an introductory study for the use of the layman—a purpose which it serves admirably—but it has also afforded the author the opportunity of laying before his fellow specialists his views on obscure and controversial matters—such questions, for example, as the dating and sequence of Mr. Reid Moir's pre-palæolithic cultures in East Anglia, the relation of the various cultures now distinguished in the early phases of the Old Stone Age, the classification of the deposits of late Tertiary or early Quaternary times, and so forth. Dr. Leakey's views are stated clearly and with due restraint.

Handbuch der anorganischen Chemie. In 4 Bänden. Herausgegeben von Prof. Dr. R. Abegg, Dr. Fr. Auerbach und Dr. I. Koppel. Band 4: *Die Elemente der achten Gruppe des periodischen Systems.* Teil 3: *Kobalt und seine Verbindungen.* Lief. 1. Herausgegeben von Dr. I. Koppel. Pp. xvi+626. (Leipzig: S. Hirzel, 1934.) 58 gold marks.

THIS instalment of Abegg's "Handbuch" includes sections on the atomic weight of cobalt, the cobalt atom, cobalt metal, cobaltous and cobaltic compounds, alloys and compounds of cobalt with metals and metalloids, cobalt-ammines, and a final short section on the colloid chemistry of cobalt and its compounds. It provides a monumental record of the properties of a very interesting element at a price which makes it more suitable for libraries than for individual purchasers.

Aids to Botany. By H. J. Bonham. (Students' Aid Series.) Pp. viii+221. (London: Baillière, Tindall and Cox, 1934.) 3*s.* 6*d.*

THIS book sets out to provide a revision course in botany for Higher School Certificate candidates and first-year university students reading for the intermediate science or pre-medical examinations in the subject. The scope of the book, however, is scarcely that of present-day requirements, and in a second edition many of the diagrams should be improved.

Tidal Estuaries: Forecasting by Model Experiments*

By PROF. A. H. GIBSON

THE earliest work on tidal models was carried out by Osborne Reynolds at the University of Manchester in 1885 on scale models of the Mersey estuary. This was followed by an investigation into the general question of the use of such models, in which Reynolds co-operated with a committee appointed for this purpose by the British Association in 1888. The experiments were devoted mainly to an examination of the behaviour of models of the same hypothetical estuary, of symmetrical shape, to different scales. As a result of this investigation, the committee reported in 1891 to the effect that "It would seem therefore that by carefully observing certain [stated] precautions, the method of model investigation may now be applied with confidence to practical problems".

Shortly afterwards, Vernon Harcourt carried out an investigation on a model of the estuary of the Seine, in which the results of improvements made in the estuary since about 1833 are stated to have been reproduced with considerable accuracy. Between 1890 and 1926, very few investigations of this kind appear to have been carried out, and these for various reasons not with any marked degree of success.

Any scale model in which fluid motions are involved must not only be geometrically similar to its original, but also the velocities must be so related to corresponding velocities in the original that all corresponding forces are in the same ratio. The model and its original are then dynamically similar, and all lines of flow and wave formation will be similar. The speeds of model and original at which this condition is satisfied are called 'corresponding speeds'.

In many hydraulic problems, however, viscous forces are unimportant compared with those due to inertia, and in this case it may be proved that the corresponding speeds are proportional to the square root of corresponding dimensions. Thus, in ship model tests the corresponding speeds of model and original are proportional to the square root of their respective lengths. These speeds give similar wave formations. Viscosity, the effect of which is relatively small, prevents exact similarity of the lines of flow in the immediate vicinity of the vessels at these speeds, and this introduces a scalar effect for which a correction can be made.

In the case of a tidal model, the correct propagation of the tidal wave is an all-important factor. The velocity of propagation of such a wave is proportional to the square root of the depth of the water through which it travels, so that the times required for the wave to traverse corresponding distances in the model and the estuary will be proportional to the horizontal scale ratio and inversely proportional to the square root of the vertical scale ratio. This determines the ratio of corresponding times and therefore gives the correct tidal period for the model. If, for example, the horizontal scale ratio is 1 : 40,000 and the vertical scale ratio is 1 : 400, the time ratio is 1 : 2,000, and since the tidal period in Nature is about 12 hours 20 minutes, the correct tidal period in the model is 22·2 seconds.

If the effects of viscosity are small in comparison with those due to inertia, as is the case in a model of suitable size, all velocities will then be in the ratio of the square root of corresponding depths.

DISTORTION OF SCALE

When constructing a river or estuary model, it is seldom possible to adopt the same scale for both horizontal and vertical distances. Especially in tidal models, the horizontal reduction in scale has usually to be considerable in order to keep the model within reasonable dimensions, and a scale of more than 18 in. to 1 mile (1 in 3,520) is unusual, a more common ratio being about 1 : 8,000. If this latter scale were also adopted for the vertical depths in a model of an estuary having a tidal range of say 33 ft., the range in the model would only be 1/20 in. and the current velocities would only be about 1/90 of those in the estuary. In such a model the motion of the water would certainly not be turbulent as in the estuary, and no motion of the bed materials would be likely to occur. To avoid this difficulty, the vertical scale ratio is made much less than the horizontal scale ratio. Thus by making the vertical scale ratio 1 : 200, the tidal range in the case mentioned would be 2 in. and current velocities would be 1/14 of those in the estuary.

Reynolds in his investigations on models of estuaries of simple symmetrical form concluded that, for a model to reproduce estuarine conditions, the product of the cube of its maximum tidal range measured in feet, multiplied by the ratio of the vertical and horizontal scales, should not be less than 0·09, and while, in an estuary of non-symmetrical shape, a smaller value of the criterion may be adopted, it does give an approximate idea of the scales which are likely to give good results in any particular case.

It may be of interest to note that this distortion of scale is usual in Nature, small streams flowing through alluvial ground having much steeper side slopes and gradients than large rivers of similar regime in similar ground. In a very large river such as the Mississippi, the Ganges, or the Irawadi, the maximum depth will rarely exceed 1 : 100 of the maximum width, while in a small stream in similar ground this ratio will seldom be less than 1 : 5.

* From a Friday evening discourse delivered at the Royal Institution on April 13.

A moderate distortion of scale, either in an estuary or river model, would therefore appear to be rather an advantage than otherwise, provided that the side slopes which would be necessary in the model to reproduce those in the estuary do not exceed the natural angle of repose of the bed materials. Since this angle is only about 30°, there will usually be points in a model where the sand is unable to stand up to the required slope, and where, in consequence, the depth of the channel or the height of the banks will be less than in the estuary. The actual slopes in most tidal estuaries are, however, very slight indeed, and experience shows that the areas over which the angle of repose would be exceeded in a model do not usually amount to more than a very small fraction of the whole. In such cases, if thought desirable, a slight stiffening of the bed material with an admixture of clay will usually enable the required slope to be maintained.

Bed Materials

A criticism often levelled at the use of tidal and river models is that since the actual bed material is usually a not very coarse sand, unless something of the nature of an impalpably fine powder is used in the model, the grain size and textual roughness of the bed will not be reduced in the same proportion as the remainder of the model. The idea that the bed material should of necessity be scaled down in size would appear to be based on two misconceptions. The first is that the resistance to flow is appreciably affected by the surface roughness. Actually, in any model of a large river or estuary having a sandy bed, the resistance is almost entirely due to eddy formation caused by curves and irregularities in the sides, and by irregularities in the depth, the magnitude and effect of which are overwhelmingly greater than that of a change in the textual roughness of the surface itself.

The second misconception is that because the current velocities are reduced in the model, the size of particle which they will move is necessarily correspondingly reduced. This overlooks the well-known experimental fact that a given mean velocity of flow has a much greater scouring effect in a shallow than in a deep channel.

Investigators of the problems of silt and scour in Indian and other rivers and canals have found that rivers and canals of similar cross section but differing in size, and having the same bed materials, are subject to similar scour or siltation if the mean velocity is proportional to d^m, where d is the depth and where the value of m as given by various observers varies from about 0·45 to 0·64. All agree that the value is in the neighbourhood of 0·5, and if it were actually 0·5, two similar channels in the same bed material would scour or silt similarly if their velocities were proportional to the square roots of their depths. But this is the ratio of velocities adopted for purely hydrodynamic reasons in tidal models, so that it would appear that materials of approximately the same grain size and density as comprise the moving sand banks in the estuary or river, should logically be used for the model. Actually the determination of the best material and grain size is a matter for experiment, that which gives the best coincidence with Nature being the one to be adopted.

In some German laboratories, working on problems of one-way river flow, a technique has been developed in which bed material considerably coarser and somewhat less dense than that found in the river is used. At the same time the slope of the bed is increased. This has been found to prevent the formation of sand ripples, which occur with some combinations of sand and velocity of flow. On the other hand, in recent work on models of the Mississippi River at the U.S. Waterways experimental station at Vicksburg, a sand has been used having a diameter (0·0107 in.) about a third of that of the somewhat coarse sand in the river, and has been found to give excellent agreement with observations in the river itself.

The Silt Problem

Many estuaries carry a considerable amount of silt of a colloidal nature in suspension. This is originally brought down by the rivers feeding the estuary. It tends to coagulate and to be deposited, forming silt banks especially where the fresh river water meets the saline water from the sea, and in a model of any silty estuary this effect needs to be reproduced.

An examination of samples of the river waters enables the proportion of silt carried in by these to be determined, and the introduction of this proportion in the river water supplied to the model does not present any great difficulty. In order to ensure that this shall tend to be deposited at the same place in the model as in the estuary, it is necessary to reproduce, in the correct ratio, the coagulating effects of the sea water. The matter is somewhat complicated by the fact that, while the ratio of the distances through which a given particle has to sink through corresponding depths equals h/H, the corresponding times in which this is to take place are in the ratio $\frac{l}{L} \cdot \sqrt{\frac{H}{h}}$. It follows that the actual rate of fall of a particle in the model should be greater than that in the estuary in the ratio $\frac{h}{H} \cdot \frac{L}{l} \sqrt{\frac{h}{H}} = \frac{L}{l}\left(\frac{h}{H}\right)^{3/2}$. This greater rate of fall can be produced by increasing the size of the particles, either by using silt of greater coarseness, or by using some coagulating medium more effective than the salts in sea water. In the various models I have constructed, the colloidal silt from the estuary itself has always been used, and alum solution has been used as the coagulating medium, experiments having been carried out in each case to determine the exact degree of concentration of this solution required to give the correct rate of deposition in the model.

SEVERN MODEL

In 1926, the Severn Barrage Committee of what was then the Department of Civil Research decided that the only way to investigate the probable effect of a proposed tidal power barrage across the Severn estuary was to construct a working scale model. Such a model, to a horizontal scale of 1 : 8,500 and a vertical scale of 1 : 200, was made in the Engineering Laboratories at the University of Manchester.

The information required from the model was : (1) The effect of the barrage on the tidal levels above and below its site, at all points between Barry and Gloucester. (2) The effect on the tidal currents. (3) The effect on the configuration of the sand banks and especially of the navigable channels. (4) The effect on siltation above and below the barrage. (5) The effect on sewage disposal. (6) The effect on flooding in times of flood discharge from the rivers entering the estuary.

The available data comprised details of a survey of the upper estuary carried out by Capt. Beechey in 1849, along with Admiralty charts of the lower estuary of about the same period, and some tidal observations from Penarth and Avonmouth and a few points in the upper estuary.

These were supplemented in 1927 by the Hydrographic Department of the Admiralty, which took samples of the water at various points in the estuary, from which the salinity and silt contents were determined ; samples of the bed materials ; additional tide curves ; float and current observations ; observations on the Severn bore ; and, finally, a detailed survey of a large part of the estuary above and including the site of the barrage. This, in conjunction with Admiralty charts of the lower estuary, enabled the general configuration of the estuary at two times approximately seventy-eight years apart to be compared, and these two surveys were used as a basis of calibration of the model.

In the first place, the bed of the model was moulded in sand to the 1927 survey, after which a series of tidal observations were made at its seaward end, at the point corresponding to Penarth. The mechanism and the form of the plunger producing the tides were adjusted by successive trial and error until the correct tidal curves were obtained at the seaward end of the model. As the tidal wave advances up the estuary, considerable changes take place in its height and form, and a comparison with observations in the estuary shows that these changes are closely reproduced in the model.

A comparison of the distances travelled by floats dropped at corresponding points in the estuary and model also shows a very close agreement, while the behaviour of the Severn bore, which was well developed in the model, shows an almost uncanny agreement, both as regards its height and rate of travel, with the behaviour of the original as determined by the Admiralty Survey party.

After having obtained the correct tides, tests were carried out to determine the best bed material. Twelve materials were tested in all, ranging from powdered pumice on one hand to emery on the other. In each case the bed was moulded to the Beechey survey of 1849, and was surveyed after the number of tides (55,200) required to bring the date to 1927. The material which gave the closest agreement with the estuary survey of 1927 was found to be a silica sand about 25 per cent finer in grain than the sand in the estuary, and this was then used for all further work. With this particular sand a comparison of the configuration of the model and of the estuary at the end of the period showed a good general agreement, especially in that part above the site of the barrage. The general agreement, in fact, was such as to indicate that when modified by the introduction of the barrage, the effect of this in the estuary might be expected to be very similar to that in the model.

The tests to determine the effect of the barrage are carried out in pairs. In the first of each, the bed of the estuary is moulded to represent the 1927 contours, and a test is carried out without the barrage, surveys being taken at the end of each 10, 20, 30, . . . years. The bed is then remoulded to the original state, and the test is repeated with the barrage installed and in operation, surveys being taken at the same intervals of time as before. The complete results of these experiments have been embodied in an appendix to the report of the Severn Barrage Committee of the Economic Advisory Council.

GENERAL REMARKS

The successful use of a tidal model depends largely on its being of a suitable scale, and on the possibility of being able to reproduce with reasonable accuracy the physical factors tending to produce movement of the bed materials. As regards the scale, the largest scale which the available space permits is advisable. This is partly because the necessary distortion of scale becomes less as the scale is increased, and partly because it enables details to be developed and studied more accurately.

Much also depends on the conformation of the estuary and on the tidal range, but for the average estuary, for investigating the effect on the navigable channels, the horizontal scale should not be less than about 9 in. to the mile (1 : 7,040). With a tidal range of 30 ft., the Reynolds' criterion in such a model will be satisfied if the vertical scale is about 1 : 214, giving a vertical exaggeration of scale of 33 : 1. If circumstances permitted of a horizontal scale of 18 in. to 1 mile, the vertical scale could be 180 : 1, which would reduce the exaggeration to 19·6 to 1 and obviously increase the usefulness of the model.

As regards the factors tending to produce movement of the bed material, the one factor which is continuously in operation is the scour of the tidal currents, and these can be reproduced with sufficient accuracy in a model. The currents,

especially in the riverine part of the estuary, are modified by seasonal changes in the river flow, and this factor can also be reproduced, given a knowledge of the probable magnitude and sequence of floods and dry periods. Where the estuary is exposed to some prevailing wind, the action of this can also be reproduced by means of fans adjusted so as to produce surface waves of the required height.

One factor which cannot be reproduced is the effect of violent gales, the incidence of which, both as regards time and direction, is casual. It is true that over a long period, where there is no prevailing gale direction, the effects of such extraneous forces may be expected partially to counteract each other, but on the other hand one such gale may produce changes in an exposed estuary greater than would occur in months or even years of normal ebb and flow.

For this reason, close agreement between model and estuary over a definite period of years is scarcely to be anticipated. Close agreement can only be expected where the estuary is comparatively sheltered and where the effect of the ebb and flow currents is all-important. For this reason, a model is likely to be more successful of an estuary in which the physical features are such as to give rise to well-defined currents, and in which the tidal range is large so that the strength of these currents is also large. From this point of view the upper Severn estuary, with its 40 ft. tidal range and current velocities approximating 10 knots at places, is an almost ideal subject for model investigation.

Another difficulty in attempting to reproduce all the changes in an estuary over a long period of time is that of reproducing coastal erosion. In many cases this is comparatively small in Nature, but where it is large the difficulties of finding a material which will erode at approximately the correct rate are great. Where this is necessary, it can only be done by extended experiment. In spite of the difficulty, however, experiments now in progress on a model of the Rangoon estuary (by Sir Alexander Gibb at University College, London), show that it is possible to reproduce this effect. This model, in which the effects of coastal erosion and of the monsoon gales have been incorporated, represents probably the most remarkable investigation of this type yet attempted.

Generally speaking, the great usefulness of an estuary or river model lies in its power to indicate the probable effect of artificial changes such as may be produced by the introduction of a barrage ; or training walls ; or bridge piers. Such changes affect the tides and the set and velocity of the currents to an extent and in a manner which is reproduced with close accuracy in a model. In so much as an increased velocity causes scour, and a reduced velocity causes deposition, if the bed material is moved the movement caused by the change will be in the same direction and of the same general kind as in Nature, and experience shows that in favourable circumstances good general agreement, both quantitative and qualitative, can be obtained.

Some estuaries, owing to their physical characteristics, are not suitable subjects for model investigation, but at the worst such an investigation gives information as to the changes in the velocities and directions of the currents, from which valuable deductions as to the probable effects on the bed may be made.

South African Plants Poisonous to Stock

THE subject of plants poisonous to cattle is of perennial interest to pastoralists, which is receiving in South Africa the scientific attention it needs. The Veterinary Services and Animal Industry Branch of the Department of Agriculture of the Union of South Africa now has a team of workers (Onderstepoort Veterinary Research Station) consisting of Drs. Steyn and Quin, veterinary research officers, Dr. Claude Rimington, chemist working as a research fellow under the Empire Marketing Board, and Dr. A. C. Leeman, botanist attached to the Division of Plant Industry, Pretoria. The first two numbers of the *Onderstepoort Journal*, which is to be issued quarterly in continuation of the annual reports of the Station, contain several interesting papers on the subject.

In a series of six papers in the first issue, Dr. Steyn deals on broad lines with poisonous plants. It is shown that it is possible to develop in animals a considerable degree of tolerance to certain poisonous plants by feeding them with small, but increasing, quantities, whilst with other plants continued ingestion of small quantities may even cause sensitisation or produce cumulative effects. An interesting side-issue is the proposal to use sodium chlorate as a weed-killer for the rag-worts (*Senecio* spp.), which are responsible for poisoning stock, both in New Zealand and South Africa. Before adopting it, its toxicity to stock has been carefully tested and found so low that it is regarded as a safe means of destroying these weeds.

It is still uncertain whether the disease known as 'lathyrism', common in certain parts of India, is due to use of *Lathyrus sativus* peas as a foodstuff, and for that reason a proposal to use *L. sativus* hay as a feeding-stuff in South Africa has been investigated. The hay proved innocuous to rabbits, sheep and cattle even when fed in comparatively large amounts, but was poisonous to horses. Great care was taken to make sure that the hay was entirely derived from *Lathyrus sativus*, and these observations support the view that this plant is the cause of 'lathyrism', and that horses are particularly susceptible to its action.

These studies are continued in the second number of the *Journal*, where Drs. Rimington and Steyn produce an interesting study of the poisoning of Angora goats, suspected to be due to *Psilocaulon absimile*. This plant contains malic, tartaric and oxalic acids, the last-mentioned being present to the extent of 8·6 per cent, which may therefore well be the toxic constituent concerned. On this point, however, the authors say they have evidence of the presence of a second toxic substance on which a further communication will be presented in due course. Six papers entitled "Studies on Photosensitisation" by Dr. Quin have arisen from an attempt to ascertain the cause of 'geeldikkop', a disease of small stock, characterised by photosensitisation and by a generalised icterus. The disease has been generally associated with ingestion of *Tribulus* spp., but it is pointed out that there are well-authenticated cases in which *Tribulus* cannot be the cause. In view of the occurrence of photosensitisation in 'geeldikkop', a number of fluorescent substances such as eosin, erythrosin, acriflavin and quinine were administered to sheep, but though these all caused photosensitisation, in no instance was icterus produced.

The association of *Tribulus* with this disease has naturally led to a chemical examination of plants of this genus. Already in 1928 Dr. Quin had found that administration of the expressed juice of *Tribulus* to sheep caused death, the chief symptoms being discoloration of the conjunctivæ, the blood-vessels having a chocolate-brown colour. Examination of the blood indicated the presence of an abnormal pigment suspected to be methæmoglobin. These observations have been confirmed, and Drs. Rimington and Quin now show that the lethal factor is potassium nitrite, which is only present in traces in the plant, but is produced when the ground plant is placed in water by the action of an oxidation-reduction enzyme system, similar to that present in the potato, on nitrates which may occur in considerable quantity in the plant. These interesting observations, however, leave the association of *Tribulus* with 'geeldikkop' unexplained since, as Dr. Quin points out in a subsequent paper, no fresh or dried *Tribulus* material dispatched to the Onderstepoort laboratory, or cultivated there, has produced a case of true 'geeldikkop' on administration to sheep, although several species of *Tribulus* can definitely be held responsible for outbreaks of the disease in the Karroo areas of Cape Province (see also NATURE, 132, 178, July 29, 1933).

Two species of *Hypericum*, a genus associated with the production of photosensitisation in animals in Europe, have also been examined and found to produce this effect, but unaccompanied by icterus. *Lopholœna coriifolia*, a plant suspected as a possible cause of one outbreak of 'geeldikkop', was found to contain an active substance producing marked fatty changes in the liver, but in no way characteristic of the conditions found in 'geeldikkop'. Two species of *Lippia*, however, did produce both icterus and photosensitisation, but the symptoms were much less severe than those seen in true 'geeldikkop'. Although a final explanation of the cause of this mysterious disease is still to be sought, it is clear that progress is being made, and incidentally a number of interesting observations on plant chemistry and on the effects of minor plant constituents on animals are being accumulated.

Obituary

PROF. W. M. DAVIS

EVERY active worker in geology, in geography and in oceanography will feel that the death on February 5 of William Morris Davis, at the age of eighty-four years, is the passing away of a historical figure in science. His life when written will be the story of the development of geomorphology and of the creation of an American school of international prestige. His whole career, more than sixty years of active scientific work, exhibits the regular series of interests of many great investigators, detailed studies in a relatively limited scientific field, next broader applications supported by intense, varied and enthusiastic studies to test and support the same—and finally the close of life devoted to a single line of investigation, often the ploughing of a lonely furrow.

Davis's first field was the southern part of New England, including New Jersey, and his publications extend to every type of its topography. About 1880 he concentrated on the Hudson and Connecticut valleys. These lie in a region of tilted blocks produced by faulting, the initial fault scarps subjected to extensive erosion. As Davis showed, the cliffing may be completely altered and these cliffs were termed *fault-line scarps*. He was fascinated by these studies of erosion, and he summarised his many publications in "The Rivers and Valleys of Pennsylvania" and "The Rivers of Northern New Jersey". He pictured the work of unchecked erosion on the land, by weathering and by water, in all its stages, finally culminating in a reduction of sea-level, the *base-level* "towards which the land surface constantly approaches . . . but which it can never reach". Here he encountered the established views in respect to marine abrasion, and he characteristically set to work on investigations in Europe, Asia and South Africa to establish the validity of his views. He also studied glacial (recent and Permian) erosion, faulting and shorelines, with a certain disregard of local researches. His work on shoreline topography, the continental slopes and marine shelves, bristles with original ideas, but the soundings on which he was depending were occasionally woefully inaccurate, though I cannot recall that these were such as to invalidate his conclusions as to embayed shorelines. It will be

interesting to mention that in a letter I received more than twenty-five years ago he discussed the down-faulting of a former extension of the Deccan in the area now occupied by the Indian Ocean, the area of the investigations of the "John Murray Expedition".

It is impossible to refer in any detail to the gigantic output of Davis in these thirty years. In his own continent he found every type of country, from completely desiccated to extreme moistness, almost tropical heat to perpetual cold, and he studied the phenomena in respect to each, thus gradually building up that study of the visible earth forms on which modern geography is so largely based. He claimed none of his conceptions as new, but he looked at every phenomenon through new glasses, and he codified all phenomena to form almost a new science. During all these years Davis was teaching not only in his own University, Harvard, but also lecturing almost everywhere he was asked. His exposition was clear and he used every possible device, particularly solid and composite sections, to make his views clear to his auditors and subsequent readers, dismissing all possible opposition, and sometimes ignoring the evidence on which it was based. His scientific opponents could not approve where, as in science, views are nicely weighed in the balance, but undoubtedly he gained an immense following in America and stimulated both teachers and the public to observe. By many he was regarded as an inspired teacher, but his methods were of more use in popularising science rather than in stimulating research. His popular works on geography deservedly secured an immense circulation, for the visible world was therein a connected system, made clear by pictorial methods largely original. Davis came at the right time.

Davis's third period commenced about 1912 when he began to feel a mighty interest in the coral reef problem, upon which he published more than forty papers, actively pursuing the subject until his death. He thoroughly enjoyed the subject, for it became necessary for him to travel extensively, and he saw many new faces and met many new types of mind. He visited the West Indies several times, with longer expeditions to Fiji and New Caledonia, with calls upon the Great Barrier Reef, Tahiti, and many other places. While he criticised Agassiz for the shortness of his visits, and his lack of detailed examination, his methods were much the same, and every locality had to fall into his line. He paid little attention to animals and plants and their dependence on the favourable conditions of their environment. He seemed to love to indite fierce letters in which he was entirely unsparing of his opponents' feelings, but, when, very occasionally, he wrote a letter in his own hand about himself, he revealed a personality happy in spite of great griefs, a man to be loved. Shaler he held in great affection and it gave him joy to write "The Coral Reef Problem", 1928, in the Shaler Memorial Series, a book of value for all time, with its full discussion of embayed shores and unconformable contacts. He felt himself inspired. Did not he, Dana and Darwin all share the same natal day in different years—and must they not be right? What was the use of further expeditions when all seemed to Davis so clear? Why in his necessary travels did the present writer sit down for months on five occasions to look at separate reefs? "A waste of time!" Davis was very human; he deemed it his duty to fight here to gain a great peace hereafter. J. S. G.

Prof. R. Chodat

Geneva, which has always had a great name as a school of botany, has suffered a great loss by the death on April 29 of Prof. Robert Chodat at the age of sixty-nine years. A worthy follower of de Saussure and de Candolle, Chodat upheld the traditions of his predecessors by the wide outlook of his botanical studies, and the thoroughness of his investigations.

Appointed to the professorship in Geneva in 1891 after studying in Basle and Geneva, Chodat has been responsible during the past forty-three years for the development of a first-rate laboratory, herbarium and botanical library. The lack of university botanical gardens, which he frequently deplored, necessitated his researches being centred in the laboratory, and here he elaborated those methods of pure cultures of Algæ which led to such important results. His book on the polymorphism of the Algæ put him at once in the front rank of algologists and stimulated many workers to embark on this line of research. More recently he had taken up mycological investigations, and his sound knowledge of physiological chemistry enabled him to advance considerably our knowledge of fermentative processes.

Chodat did not, however, confine himself to investigations in the laboratory. A visit to Paraguay in 1914 enabled him to study the structure and habits of its plants and resulted in the publication of an important flora of that country. Repeated visits to Spain and Portugal and the Balearic Islands with his students gave him a comprehensive knowledge of the Mediterranean flora, of which he published some interesting accounts.

Chodat rescued from neglect the Alpine Garden at Bourg St. Pierre by attaching it to the University of Geneva, and the vacation courses he gave there every summer attracted many students from England and elsewhere; numerous investigations carried out there were published by the Botanical Society of Geneva. Chodat, like other Swiss botanists, was greatly impressed by the numerous Mediterranean plants found in the upper Rhone valley of Switzerland, and his careful observations led him to the conclusion that many, if not most, of them had been distributed from the south across the mountain passes and had not, as was formerly supposed, immigrated by way of the Lake of Geneva.

Chodat was a good systematist, as is shown by his monograph of the Polygalaceæ; but the wideness of his interests is attested by his publications on fossil plants and genetics as well. His wide and philosophic outlook is mirrored in his excellent "Principes de Botanique", which is in every way an admirable textbook. A stimulating teacher, Chodat trained many first-rate botanists whose researches do credit to their master. So eminent a botanist was sure to receive due recognition abroad, and Chodat was awarded honorary degrees by the universities both of Manchester and of Cambridge, and last year he was awarded the Linnean Medal of the Linnean Society of London, of which he had been a foreign member since 1914. Unfortunately, during the last few years, partly due to systematic overwork, he suffered from ill-health, and shortly after his return from a visit to Egypt and Palestine he died after a short illness. He will be greatly missed in England, as well as Switzerland, for he was a frequent and welcome visitor to this country, where he had many friends. F. E. W.

WE regret to announce the following deaths:

Dr. M. G. Foster, son of Sir Michael Foster and author of numerous papers on balneology and climatology, on June 16, aged sixty-nine years.

Dr. C. E. Grunsky, consulting engineer, president of the California Academy of Science, president in 1924 of the American Society of Civil Engineers, an authority on water engineering and supply, on June 9, aged seventy-nine years.

Prof. Thomas H. Macbride, emeritus president of Iowa State University, professor of botany in the University in 1884–1914, an authority on Myxomycetes, on March 27, aged eighty-six years.

News and Views

Sir Robert Mond

THE honorary degree of LL.D. was conferred by the University of Toronto, on June 6, at the time of the annual Convocation, on Sir Robert Mond. Sir Robert, who was knighted in 1932, is the eldest son of the late Dr. Ludwig Mond, F.R.S., and has inherited his distinguished father's scientific tastes, as is shown by his association with many learned societies, including the Faraday Society, of which he is a past president. Another side of his scientific activity is shown by his interest in archæological studies, and he is president of the Egypt Exploration Society. Sir Robert was one of those chosen to receive an honorary degree at the opening of the new wing of the Royal Ontario Museum in the autumn of 1933, but was unable to visit Toronto until the recent Convocation. The Royal Ontario Museum owes Sir Robert a great debt of gratitude, not only for actual gifts of great value, but also for his constant advice during the development of the Museum from very small beginnings. His most recent gift is in sharing with Dr. Sigmund Samuel, of Toronto, and Bishop White, formerly of Honan, China, now professor of Chinese literature in the University of Toronto, in the donation of a very valuable library of Chinese books, now known as the Chinese Library of the University of Toronto, and containing more than forty thousand volumes.

Excavations at Tell el Duweir, 1933-34

AN exhibition of the material discovered by the Wellcome Archæological Research Expedition to the Near East in the second season's excavation at Tell Duweir, 25 miles south-west of Jerusalem, under the direction of Mr. J. L. Starkey, will be held at the rooms of the Palestine Exploration Fund, 2 Hinde St., W.1, on July 2–21. The work of the Expedition during the past season has now established the extent of the Early Copper Age site as covering at least 150 acres. It includes the remains of a large dolmen. The upper terrace of a limestone ridge flanking the Tell across the western valley was found to be honeycombed with caverns which had been artificially enlarged and adapted as dwellings in the Early Copper Age, and re-used at a later date as burial places. Metal here occurred rarely, but unique for this early period was a heavy gold bead, contemporary with proto-early dynastic age in Egypt. Rough castings from moulds were found on the surface. Pottery was hand-made; and small pottery bowls showing a sharp impress afforded evidence of textiles. A large necropolis lower down the side of the ridge yielded contracted burials in small oval chamber-tombs with a shallow shaft. In these were daggers or darts, food vessels, etc. This cemetery is equated with the Egyptian Old Kingdom. At the north-west corner of the Tell, the Hyksos fosse and revetment were uncovered; and the later system of defence was traced in its entirety. The Persian residency superimposed on the Jewish palace-fort destroyed in the sixth century B.C. was cleared.

AMONG other discoveries, by far the most interesting and important was that of a small temple found in clearing the fosse. This consisted of a square sanctuary containing an altar and shrine, with two small store chambers. Free-standing benches were arranged on three sides of the sanctuary. This building had been destroyed by fire and its contents were thus found complete, although damaged by the flames. They consisted of a large number of ceremonial vessels and utensils, toilet articles, etc. The most important is the painted pot, of which the inscription has already given rise to much discussion among experts, as to the affinities of the script and its translation. Other exhibits from the temple include a number of scarabs bearing the name of Amenhotep III, notably one recording the killing of 102 lions

in the tenth year of his reign. Ivory, glass and faience objects include a beautiful small ivory mask. The art of this and other carved objects, including a carved hand, three-quarter life size, suggest an artistic relation of some kind with Tell Amarna. Some ivories, much calcined by fire, including a remarkable perfume vase fashioned from an ivory tusk, are delicate examples of the engraver's art. A plaque of Rameses II points to the destruction of the temple having taken place not later than 1262 B.C., but until the levels below the temple have been examined, it is not possible to suggest the date of its foundation.

Fuel Research in Great Britain

IN the course of a normal year, about six hundred visitors are received at the Fuel Research Station, Greenwich, but the Fuel Research Board has come to the conclusion that, in addition, a general visitation would be a valuable means of bringing the Station's work before industry and the public. The first visitation was held on June 25, when about three hundred guests were received by Sir Harold Hartley (chairman of the Fuel Research Board), Dr. F. S. Sinnatt (Director of Fuel Research) and Sir Frank Smith (secretary of the Department of Scientific and Industrial Research). The visitors were given an opportunity of seeing practically all the modern methods in the study and treatment of coal. Demonstrations of coal-washing, by wet and dry systems, attracted a large number of visitors. A rotary coal dryer and mill for pulverising, together with such burners as the 'Grid' and 'Vortex' for the powdered fuel, were shown in operation. Coal-oil suspensions showed one line along which research is being conducted with the view of making coal a more flexible fuel. Specimens of the liquid products of low-temperature carbonisation were shown. But perhaps the focus of interest for most visitors was in the hydrogenation building, where compressors for delivering hydrogen at a pressure of 200 atmospheres, and the converters in which the reaction takes place at that pressure and a temperature of 480° C., were demonstrated in action.

Foot-and-Mouth Disease

SOME interesting information was given by the Minister of Agriculture in the House of Commons on June 25, when Sir Arnold Wilson asked two questions on the subject of foot-and-mouth disease at the request of the Parliamentary Science Committee. Sir Arnold asked what progress has been made by the Foot-and-Mouth Disease Research Committee during the last two years; and what, broadly speaking, the results of its investigations have been, more particularly in the direction of preventive treatment by inoculation. Mr. Elliot promised a memorandum on the subject in reply and stated that the Fifth Progress Report of the Committee is in course of preparation, and is expected to be available in the autumn. Sir Arnold also asked whether the Committee has considered the possible connexion between the quality of the food of cattle and the incidence of this disease; and whether the Committee is dealing with the question of the prevention of foot-and-mouth disease by a combination of high-quality food and improved hygiene. Mr. Elliot in his reply stated that the Committee has advised that there is "no evidence to show that diet or hygiene, or a combination of both, have any influence on the spread of foot-and-mouth disease. Clinical observations and experimental work carried out by the Committee have in fact shown that animals in very good condition may contract the disease in a more severe form than animals in poor condition". Referring to the possible spread of foot-and-mouth disease by imported straw, in answer to a question by Col. Acland-Troyte, Mr. Elliot stated that the importation into Great Britain from countries where foot-and-mouth disease exists of hay and straw for use as fodder or litter for animals is prohibited, and imported straw used for packing merchandise has to be destroyed after use; there does not appear to be justification for further prohibition of the importation of this material.

Educational Sound Films

UNDER the auspices of the British Film Institute, 4, Great Russell Street, London, W.C.1, a private demonstration of educational sound films was presented at the Academy Cinema, London, on June 21, before teachers and educationists. As Mr. H. Ramsbotham, M.P., Parliamentary Secretary to the Board of Education, pointed out in his introductory address, such films must not be accepted without reservation, for they should always be looked upon as being supplementary to the teacher himself. The production of the films shown was a piece of pioneer work and experimental in character, and the venture augurs well for the future of the cinematograph in education, especially if the producers receive the constructive criticism from teachers for which they ask. There is little doubt that, provided it is not abused, the sound film will prove an important asset to the teacher of the future. The seven films presented on this occasion clearly showed not only the expert film producers we have at our command, but also where the film will be a useful aid and where it will prove an unwelcome intruder.

THE films of the life-history of the thistle, the growth and irritability of roots, and the physiology of breathing were examples of good educational films—useful tools in the hands of a responsible teacher. They showed the value of the cinematograph film in photomicrography and in demonstrating those types of motion too slow to be watched normally. The film of wheatlands in East Anglia, too, was a good lesson in economic geography and rural science, and demonstrated the possibilities of the film in transporting a class to the actual scene of action, which otherwise has to be done, rather inefficiently, by laborious verbal teaching and much reading. Such films indicate the lines along which it is to be hoped the cinematograph in education will develop. On the other hand, certain films shown depicted the dangers inherent in the cinematograph

as a teaching factor. That on kitchencraft, for example, merely illustrated the processes involved in making a pork pie. Most domestic science teachers, we think, would prefer their pupils to learn such a lesson by doing it themselves. But this is only the experimental stage, and though there is much to learn, a great deal of good work has already been done. To add to their value, the films are produced under authoritative direction. The films shown were made by Gaumont-British Instructional, Ltd., 12 D'Arblay Street, Oxford Street, W.1, who are to be congratulated on the excellent production, beautiful photography and useful running commentary. The whole performance will be presented later in provincial towns.

Repton School Science Society

THE Repton School Science Society held its triennial conversazione in the Science School on June 22–23, when some fifty demonstrations and exhibits in biology, chemistry, and physics were shown by members of the Society. In the biology section a demonstration of the circulation of the blood in the tail of a tadpole was shown, both the pulse and the corpuscles being clearly visible. The laboratory aquarium and numerous specimens collected by the members were also shown. Two points of interest in the chemistry section were a demonstration of the spinning, bleaching, and 'souring' of rayon by a home-made model, and a set of experiments on testing the hardness of water and the various methods of water softening. Perhaps the most conspicuous feature of the physics section was a lecture on the electric spark, which included an elementary account of the mechanism of the spark, illustrated by various experiments on ionisation. The conversazione was well attended, and the visitors were impressed by the able manner in which the lectures and demonstrations were given.

Architects' Unemployment Committee's Exhibition

A NATIONAL crisis must naturally affect immediately those fields of activity most removed from the provision of essential necessities, and at the close of 1931 architects felt very severely the curtailment of their work due to restrictions required by economy. The Royal Institute of British Architects, in this emergency, set up a relief scheme in the form of payment for useful work of a public character made possible by subscriptions to a relief fund started by this and other kindred institutions. A sum of nearly £12,000 was collected, the whole of which has been expended in salaries and incidental costs in making surveys which should be of considerable value. The results are displayed on maps and models now on exhibition at 7, Bedford Square, London. Here on the 25-in. ordnance map may be seen indicated by colours the disposition of public, commercial and industrial buildings, business premises, and private and municipal housing over the whole of the London district and much of Kent. A 6-in. map shows London factories, shops, clubs, banks, and public buildings. A survey of the heights of London buildings has also been made and recorded. An interesting model of the London area is displayed showing the growth of London by centuries from Roman times to the present day. The information which can be grasped from the exhibition at a glance is most striking, and the maps should be of great value to Government and municipal departments. The display suffers from inadequate space, and though ingeniously arranged on curved surfaces, a comparison of the Hampton Court area on the walls with Greenford on the ceiling at some distance is not easy. The exhibition was opened by Lord Snell on June 22.

Leadership in Industry

IN the Mather Lecture of the Textile Institute delivered on May 25, Mr. A. P. Young (*J. Text. Inst.*, May) gives a stimulating discussion of the functions and opportunities of industrial leadership. Reviewing the origin of the scientific era and the imperative necessity for adequate leadership in this age of power production, he sees in it the opportunity for many of the inspired qualities and the spirit of adventure which have animated previous pioneers of creative thought. Such leadership should be capable of harnessing to the task of industrial evolution, world co-operation and reconstruction the increasing productivity of the human unit, the accelerated rate at which raw materials are brought into service, the development of the electrical power era, the diminution of the time lag between discovery and industrial application, the linking of production and distribution. This must be done on a basis of planned co-operation, and leadership will function largely through its ability to stimulate the essential spirit of team work.

MR. YOUNG discusses the qualities required in the industrial leader of this calibre, among which he lists this ability to foster team work, creative imagination, intellectual sincerity and moral courage, power to co-operate with others, knowledge of administrative principles, capacity for delegating authority and scientific and technical knowledge. He emphasises the importance of a science as well as an art of management, and asserts that education for management is one of our greatest national needs, the need extending to the training of foremen and supervisors as well as managers and leaders carrying high responsibilities. Mr. Young discusses in some detail the problems of planning and leadership in the textile industry, laying stress on the service motive in industry. He sees a great future for the textile industry when planned and led along such lines, and concludes with a plea for co-ordination of the activity of the five research associations which now exist and for a five-fold expansion of the industry's expenditure on research within the next five years.

A Photographic Centenary

ON June 23, a gathering took place at Laycock Abbey, Wiltshire, to do honour to Henry Fox Talbot, who in 1834 in that house first succeeded in producing photographic impressions on paper. Fox Talbot, who was born in 1800 and died in 1877, graduated at Cambridge in 1821, and became known

for his original papers on mathematics, physics and astronomy. In 1831 he was elected a fellow of the Royal Society and two years later became M.P. for Chippenham. His experiments of 1834 were the outcome of an idea which had occurred to him when sketching the scenery of Lake Como with the aid of Wollaston's camera lucida, and they resulted in the development of Talbot's first process, photogenic drawing, described to the Royal Institution by Faraday in January 1839. The guests at Laycock Abbey on June 23 were received by Miss M. T. Talbot, the inventor's granddaughter, and an address on Fox Talbot's personality was given by his grandson, Prebendary W. G. Clark-Maxwell. Other addresses were given by Mr. H. Lambert, of Bath, and Mr. A. J. Bull, president of the Royal Photographic Society. A large exhibition of Fox Talbot's early apparatus and of his negatives and prints was arranged in the gallery and among these was probably the earliest existing photograph, a window in Laycock Abbey.

Blériot's Flight Across the English Channel

To commemorate the first flight by aeroplane across the English Channel by M. Louis Blériot on July 25, 1909, twenty-five years ago, a demonstration took place at his aerodrome at Buc near Paris on June 23, which was attended by the President of the French Republic, M. Lebrun, Lord Londonderry and Sir George Clerk, the British Ambassador. The old Anzani-engined monoplane in which the flight was made was on exhibition, and in the fly-past which closed the meeting, modern French aircraft scattered flowers upon it. At the time of the flight, M. Blériot was suffering from injuries to his foot and the crutches which he was using were strapped inside the fuselage. During the afternoon, many displays took part in which a squadron of Hawker Fury fighters of the Royal Air Force joined, and in a speech Lord Londonderry said that M. Blériot found a new high road of the air, which, within the short period of six years from the first flight, was to be traversed, not by a single Englishman paying a return visit to the coast of France, but by British pilots in their thousands, flying to the help and defence of Louis Blériot's fellow countrymen.

Recent Acquisitions at the Natural History Museum

AN important donation to the Zoological Department of the British Museum (Natural History) is a gift from the Rowland Ward Trustees of a mounted head of a female addax (*Addax nasomaculatus*) from the Sudan. An abnormal elephant tusk from Uganda has been presented by Mr. George Howard, of the Queen's Bays. This tusk is of interest as showing an early stage in the formation of the so-called 'four-tusked elephant'. Another donation of interest is that of three skulls of the so-called dwarf elephant from the Gola Forest in Sierra Leone, the gift of Sir Arnold Hodson, the Governor of Sierra Leone. These specimens would seem to substantiate the theory that this animal, known locally as the 'Sumbi', is merely the young phase of what has been termed the 'forest' elephant, which may be known by the name *Elephas africanus cyclotis*. There has been presented to the Department of Geology a large and valuable collection of type and figured specimens of rhinoceroses from the lower Tertiary beds of Baluchistan, described and figured by the donor, Mr. C. Forster Cooper; a large collection of fossil invertebrates from the United States, collected and presented by Miss Mary S. Johnston, and type specimens of three fossil fishes described by Prof. H. H. Swinnerton, and presented by him. An interesting collection of 727 pebbles, illustrating forms, origins, and materials, has been presented to the Department of Minerals by Mr. E. J. Dunnof Melbourne, who commenced collecting so long ago as 1856.

MR. J. E. COOPER has presented his herbarium to the Department of Botany of the Museum. It contains about 2,000 sheets of well-preserved flowering plants, a large number of which are aliens. The other specimens are chiefly from the London district, including parts now built over. A collection of more than 700 plants has been made by Mr. J. E. Dandy, assistant-keeper in the Department, who accompanied an expedition to the Anglo-Egyptian Sudan organised by Mr. C. G. T. Morison to study soil-vegetation relations in an area where there is a big variation in rainfall. The area west of the Nile shows a large range between the dry north and the Nile-Congo divide in the south. Collections were made in many areas which were previously little known, and it is probable that much of interest from the point of view of geographical distribution will result, particularly from that from the high massif of Jebel Marra.

Fire Protection of Electric Generating Stations

IN the *Electrician* of June 22 there is an interesting account of the method adopted for protecting the large power station of the Bristol Corporation at Portishead from fire, by means of carbon dioxide. The great advantage of carbon dioxide for power-house use is that it extinguishes the fire with little risk of interrupting the operation of the station. The maintenance of a continuous supply of electric power is of the greatest importance in generating stations. The installation consists of carbon dioxide cylinder batteries centralised in a special building situated about 80 feet away from the station. Main pipes connect the cylinders with control valves placed at convenient points for directing the gas in the event of fire. Entirely automatic operation is arranged only for the transformer compartments, where thermostats are filled which operate the control valve. The quantity of gas stored is such that any section protected by the system can be flooded with gas more than sufficient to extinguish any fire. The drawbacks to using chemicals having a water content in rooms containing live electric wires are well known. In the event of fire arising in an alternator, there is an initial discharge of gas from ten cylinders. As the rotor continues to revolve for about half an hour before it comes to rest, the initial discharge is liable to be dispersed and so the gas concentration might

fall too low. For this reason ten more cylinders are provided, each of which functions successively at intervals of three minutes and thus a safe degree of concentration is maintained.

Interference between High-Power Radio Stations

A REPORT from Science Service dated May 29 states that Dr. Balth. van der Pol, speaking at a meeting of the Institute of Radio Engineers in Philadelphia, has directed attention to the interference which may arise if the power of broadcasting stations is sufficiently increased. Dr. van der Pol reported that interference has been noticed in Holland between two distant high-power European stations separated in wave-length by more than 800 metres. This interference has been attributed to interaction or cross-modulation of the two sets of signals in the passage through the ionosphere. (See B. D. H. Tellegen, NATURE, **131**, 840, June 10, 1933 : V. A. Bailey and D. F. Martyn, NATURE, **133**, 218, Feb. 10, 1934.) The effect is believed to increase rapidly as the power of the sending station increases, and if the same phenomenon is found to exist in America, it may prove to be a practical limitation to the power at which radio broadcasting stations can be operated. This would appear to be a new problem for the Federal Radio Commission to consider in the United States.

Indian Physico-Mathematical Journal

READERS of NATURE may be interested in the *Indian Physico-Mathematical Journal*, which appears twice yearly. It was founded in 1930 for the purpose of publishing original papers on mathematics and theoretical physics, under the editorship of Prof. J. Ghosh, Presidency College, Madras, assisted by a board of eminent Indian scientific workers. The latest numbers, which we have recently received, contain many interesting papers representative of both the above subjects. These form a definite contribution to science and are worthy of more than a local circulation. The *Journal* does not belong to any particular institution, but exists solely to encourage research. The annual subscription outside India is £1.

Manuring of Vegetable Crops

LITTLE exact knowledge of the effectiveness of artificial fertilisers on vegetables is available, and further, it seems doubtful whether good crops can be raised indefinitely with the use of artificials alone. For these reasons, the Ministry of Agriculture has thought it desirable to collect all the possible information on the subject, and a bulletin compiled by A. H. Hoare entitled "The Manuring of Vegetable Crops" has just been published (No. 71. 1*s*. net). It is recognised that for economic production a thorough understanding of the fundamentals of soil fertility and its relation to plant growth is required, and the first part of the bulletin deals with this subject in a concise and practical manner. Special attention is directed to the possibilities in the less commonly used organic manures that are now available, the need of which is a matter of particular importance for growers on light soils. The various types of crops, brassicas, roots, leguminous, potatoes, etc., are then dealt with in turn and the most suitable fertilisers to use in each case and the best time for their application are supplied. The requirements of the small-scale gardener or allotment holder are not overlooked, and where special instructions for crops intended for canning may be helpful they are included.

Leaflets on Diseases of Fruit Trees

THE Ministry of Agriculture and Fisheries has recently issued five new advisory leaflets dealing with fruit tree diseases. "Leaf Scorch, Glassiness, and Bitter Pit of Apples" (No. 203) gives useful descriptions of these three physiological disorders, outlines the conditions which produce them, and suggests ways in which they may be avoided. Advisory Leaflet No. 205 ("Apple Mildew") replaces Leaflet No. 204, and emphasises the need for cutting diseased twigs well back, in order to remove all the fungus. "Gooseberry Cluster-Cup Rust" (No. 198 ; replacing No. 209) describes the æcidial stage of the fungus *Puccinia Pringsheimiana*, which spends its uredo- and teleuto-spore stages on certain sedges. The æcidial stage occurs on the leaves and fruit of gooseberries, causing malformation. Control is obtained by hand-picking diseased fruits, and removing sedges from the locality. The die-back disease of gooseberries is treated in Leaflet No. 204 (formerly No. 234). The fungus *Botrytis cinerea* kills the outer tissues of the stem, usually just above ground-level, and the whole bush dies. The fungus is usually a saprophyte, and its attacks may be controlled by clearing away decaying material from the neighbourhood, or spraying bushes with 0·4 per cent copper sulphate solution, just before the buds open. "Powdery Mildew of the Vine" (No. 207) is an up-to-date edition of Leaflet No. 133.

Research in Bacterial Chemistry

THE Medical Research Council announces the inauguration of new arrangements for further combined chemical and bacteriological investigations into the conditions which govern the life and multiplication of micro-organisms causing disease. These have been made possible by the generous co-operation of the Middlesex Hospital Medical School, the trustees of the late Viscount Leverhulme and the Sir Halley Stewart Trust. Accommodation and facilities are being provided at the Middlesex Hospital in the Bland-Sutton Institute of Pathology and the adjoining Courtauld Institute of Biochemistry. The investigations will be directed by Dr. Paul Fildes, who has been appointed a member of the scientific staff of the Medical Research Council. The other workers are Mr. B. C. J. G. Knight, with a Halley Stewart research fellowship, and Dr. G. P. Gladstone and Dr. G. Maxwell Richardson, holding Leverhulme research fellowships. The arrangements took effect on June 1, and the support given by the co-operating bodies is sufficient for an initial period of five years.

Leverhulme Research Fellowships

THE following Leverhulme research fellowships have recently been awarded, among others, for research in the subjects indicated: Dr. E. Ashley Cooper, lecturer in chemistry, University of Birmingham (activity of enzymes of bacteria); Prof. E. E. Evans-Pritchard, assistant professor of sociology, University of Cairo, Egypt (detailed ethnological and sociological study of the pagan Galla of Western Abyssinia); Dr. R. MacLagan Gorrie, Indian Forest Service (correlation of erosion damage and grazing in forest lands); Miss M. M. Green, late Government Education Department, Nigeria (anthropological and linguistic research among the Ibo tribe of Southern Nigeria—joint research with Mrs. S. H. Leith-Ross); D. Ll. Hammick, fellow and tutor, Oriel College, Oxford (interaction of nitro-compounds with aromatic bases and hydrocarbons); Dr. H. Stafford Hatfield (behaviour of crystalline substances in electric and magnetic fields); Dr. L. S. B. Leakey, part-time lecturer in the Kikuyu language, School of Oriental Studies, London (prehistory of East Africa); Mrs. S. H. Leith-Ross, late Secretary, Board of Education, Nigeria (home and social life of the women of the Ibo tribe of Southern Nigeria—joint research with Miss M. M. Green); N. E. Odell, geologist to the Louise A. Boyd Expedition to N.E. Greenland, 1933 (structure and metamorphism of the Franz Josef Fjord region of North-East Greenland); Dr. W. H. Taylor, assistant lecturer in physics, University of Manchester (application of X-ray analysis to the investigation of the structures of organic compounds). Grants in aid of researches have been made to the following, among others: Prof. K. A. C. Creswell, assistant professor of Muslim art and archæology, Egyptian University, Cairo, Egypt (researches on early Muslim art and architecture); Capt. C. R. P. Diver, Senior Clerk, House of Commons (South Haven Peninsula Survey, Studland Heath, Dorset. (1) Physiography and history. (2) Distribution of populations and ecology of several animal orders); J. Reid Moir (prehistoric archæology); Mrs. C. F. Tipper, University of Cambridge (plastic deformation of metals).

Museums Association

THE forty-fifth annual conference of the Museums Association will be held at Bristol on July 2–6, under the presidency of Dr. Cyril Fox. The general theme of the conference will be the modernisation of museums and art galleries. Dr. Cyril Fox will deliver his presidential address on July 3. A discussion on folk museums will be opened by Dr. R. E. M. Wheeler. Papers to be read include: "The Popularisation of Geology" by Dr. F. S. Wallis; "Maps in the Museum" by Dr. F. J. North; and "Science and the Public Museum" by Prof. A. E. Trueman. On July 6, the Gaumont-British Co. will give a demonstration of "The Film in the Museum". Further information can be obtained from the Secretary, Museums Association, Chaucer House, Malet Places, London, W.C.1.

International Congress for Applied Mechanics

THE fourth International Congress for Applied Mechanics will be held at Cambridge on July 3–9. The following general lectures will be given: Dr. V. Bush, "Recent Progress in Analyzing Machines"; Prof. A. Caquot, "Définition du domain élastique dans les corps isotropes—Courbes intrinsèques de résistance élastique apparante, et de résistance élastique vraie (endurance)"; Prof. J. P. Den Hartog, "The Vibration Problem in Engineering"; Prof. Th. v. Kármán, "Turbulence"; Prof. Ernst Schmidt, "Heat Transmission"; Prof. G. I. Taylor, "The Strength of Crystals of Pure Metals and of Rock Salt"; Prof. Herbert Wagner, "Über das Gleiten von Kärpern auf der Wasseroberfläche". An extensive series of sectional papers will also be read. Further information can be obtained from the Organising Secretary, Mr. A. H. Chapman, Engineering Laboratory, Cambridge.

Announcements

THE president and council of the Royal Society have recommended Viscount D'Abernon for election into the Society under the special statute which permits the election of "persons who in their opinion either have rendered conspicuous service to the cause of Science, or are such that their election would be of signal benefit to the Society".

THE meeting of the Faraday Society for the general discussion on "Colloidal Electrolytes", originally announced for September 25–27, has been deferred to September 27–29. The date has been changed partly to suit the convenience of those who are travelling to the U.S.S.R. for the Mendeléeff Centenary Celebrations.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of Watford Technical and Art Institute—The Clerk to Hertfordshire County Council, 28, Castle Street, Hertford (July 4). Five probationary forest officers—The Secretary, Forestry Commission, 9, Savile Row, London, W.C.1 (July 4). An assistant lecturer in physics at University College, Nottingham—The Registrar (July 5). A junior scientific officer in the Admiralty scientific pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (July 7). Three geologists on the Geological Survey of Great Britain and Museum of Practical Geology—The Director, Geological Survey and Museum, 28 Jermyn Street, S.W.1 (July 9). A professor of surgery in the King Edward VII College of Medicine, Singapore—The Director of Recruitment (Colonial Service), 2, Richmond Terrace, Whitehall, London, S.W.1 (July 14). An archæological commissioner in Ceylon—Director of Recruitment (Colonial Service), Colonial Office, 2, Richmond Terrace, Whitehall, S.W.1 (July 31). A geologist in the Education Department of the Anglo-Egyptian Sudan—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1.

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.*]

Exchange Forces between Neutrons and Protons, and Fermi's Theory

FERMI[1] has recently developed a successful theory of β-radioactivity, based on the assumption that transmutations of a neutron into a proton and vice versa are possible and are accompanied by the birth or disappearance of an electron and a neutrino.

This theory implies the possibility of deducing the exchange forces between neutrons and protons, introduced more or less phenomenologically by Heisenberg. (This idea occurred also quite independently to my friend, D. Iwanenko, with whom I have since had the opportunity of discussing the question.) Consider two heavy particles a and b, a being in a neutron and b in a proton state. If a becomes a proton and b a neutron the energy remains unchanged. Now these two degenerate states of the system may be linked up by a two-step process: the emission of an electron and a neutrino by the neutron a which becomes a proton, and the ensuing re-absorption of these light particles by the proton b which becomes a neutron. The energy of the system will be in general not conserved in the intermediate state (compare the theory of dispersion). The emission and re-absorption of a positron and neutrino may also take place[2]. In this way the two degenerate states of the system considered are split into two energy states, differing by the sign of the exchange energy.

Since the rôle of the light particles (ψ-field) providing an interaction between heavy particles corresponds exactly to the rôle of the photons (electromagnetic field), providing an interaction between electrons, we may adapt for our purposes the methods used in quantum electrodynamics to deduce the expression for Coulomb forces.

Putting $\psi = \psi_0 + g\psi_1 + g^2\psi_2 + \ldots\ldots$, where g is the Fermi constant ($\sim 4 \times 10^{-50}$ erg. cm.^{3}), and using the theory of perturbations and retaining only that part of ψ which corresponds to the absence of light particles in the initial and final states, we obtain

$$\left(H_0 - i\hbar\frac{\partial}{\partial t}\right)\psi_2 \sim \left(K \mp \frac{1}{16\pi^3\hbar c r^5} I(r)\right)\psi_0,$$

where K is an infinite constant, r is the distance between a and b and $I(r)$ is a decreasing function of r, which is equal to 1 when $r \ll \hbar/mc$ (m is the mass of the electron). Neglecting K, one would obtain the same result if one introduced directly in the wave equation of the heavy particles an exchange energy $A(r)$:

$$A(r) = \pm \frac{g^2}{16\pi^3\hbar c r^5} I(r),$$

the sign of $A(r)$ depending on the symmetry of ψ in respect to a and b. Introducing the values of $\hbar$, c and g, we obtain

$$|A(r)| \ll 10^{-85}\, r^{-5} \text{ erg.}$$

Thus $A(r)$ is far too small to account for the known interaction of neutrons and protons at distances of the order of $r \sim 10^{-13}$ cm.

If the difference of masses of the neutron and of the proton is larger than the sum of the masses of an electron and a neutrino, the emission of light particles by a heavy particle may take place without violation of the conservation of energy. But again the corresponding value of the exchange energy may be shown to be far too small

$$|A(r)| < g\left(\frac{mc}{\hbar}\right)^3 \sim 10^{-18} \text{ erg.}$$

Our negative result indicates that either the Fermi theory needs substantial modification (no simple one seems to alter the results materially), or that the origin of the forces between neutrons and protons does not lie, as would appear from the original suggestion of Heisenberg, in their transmutations, considered in detail by Fermi.

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[1] Fermi, *Z. Phys.*, **88**, 161; 1934.
[2] Wick, *Rend. R. Nat. Acad. Lincei*, **19**, 319; 1934.

Interaction of Neutrons and Protons

As electrons and positrons are expelled in some reactions from nuclei, we can try to treat these *light* particles like the photons emitted by atoms. Then the interaction of *heavy* particles (protons, neutrons) can be considered as taking place *via* light particles described by the equations of a ψ-field in the same manner as electromagnetic, for example, Coulomb, interaction takes place through an electromagnetic field, or photons.

The *first* order effects are the expulsion (or absorption) of an electron, which case was treated recently by Fermi, or of a positron. We may remark that the application of Fermi's formalism to positron disintegration of light nuclei (which we get by changing the sign of the charge number and taking for the latter the appropriate value) gives results which fit, though not very accurately, the observed relation between the half-period and the maximum energy of the disintegration particle[1]. Though there seems to be a quantitative disagreement between Fermi's theory (applied to positrons) and positron disintegration, on the other hand the calculated values for K and Rb support Fermi's assumption of the existence of quadripole transitions of heavy particles, giving too big values for the half periods in comparison with the usual dipole disintegrations. The exceptional position of K and Rb is in some way rather *anschaulich*. We may remark that the Sargent-Fermi rule, in contrast to the Geiger-Nuttall law, shows a less pronounced dependence on the charge number, so that for qualitative considerations even the wave functions of free particles can be used.

The *second* order effects give specially the probability of production of pairs, which is in the case of the ψ-field less effective than in the electromagnetic case, as the charge, e, is much bigger than Fermi's coefficient, g (the 'charge' for the ψ-field). The most important second order effect is the subsequent production and annihilation of an electron and positron, in the field of proton and neutron,

which leads to the appearance of an interaction *exchange* energy (Heisenberg's *Austausch*) between proton and neutron, quite in the same way as Coulomb interaction can be conceived as arising from the birth and absorption of a photon in the case of two electrons. Instead of e^2/r one gets here an interaction of the order g^2/chr^5, which is easily verified dimensionally. The exact calculations were first carried out by Prof. Ig. Tamm, who also insisted on development of this method. With $g \sim 10^{-50}$ (the computations were carried out by V. Mamasichlisov), which value is required by the empirical data on heavy radioactive bodies, we get an interaction energy of a million volts, not at a distance of 10^{-13} cm. but only at $r \sim 10^{-15}$ cm., which is inadmissible. We may ask about the value of r, which would give a *self-interaction* energy of the order of the proper energy of a heavy particle. This value is of the order 10^{-16} cm., which is that of the classical radius of a proton.

The appearance of these small distances is very surprising and can be removed only by some quite new assumptions. Fermi's characteristic coefficient g appears to be connected also with distances of this order of magnitude.

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[1] cf. D. Iwanenko, *C.R. Ac. Sci. U.S.S.R.*, Leningrad, 2, No. 9, 1934.

Barium in Ancient Glass

THE recent interesting exhibition of Chinese glass and beads—the property of the Royal Ontario Museum, Toronto—at the Courtauld Institute (University of London), arranged by Prof. Yetts, prompts us to put on record the results of some work we have done on ancient beads and the presence of barium in them.

The more ancient of the specimens exhibited—for the most part beads—are derived from graves (likely to be known in future as the Han Chün graves) near the village of Chin Ts'un in Honan. Careful consideration by Prof. Pelliot of the circumstances of their discovery leads him to place the date of these graves, and therefore of the beads, in the second half of the third century B.C. In China in 1929, and later by correspondence, we were able to collect a number of beads so closely resembling those of Han Chün that they may well have come from that site, and may definitely be regarded as of the same period and make. Struck by the weight of a number of these specimens, we proceeded to compare their specific gravity with beads of 'Mediterranean' origin, and when we found this generally higher a number of analyses were performed. It is not now our purpose to discuss our conclusions, but simply to direct attention to the following results:

	Specific gravity	Analysis
Blue glass bead with white inlay (Fig. 1)	3·57	SiO_2 41·9 per cent PbO 24·5 ,, BaO 19·2 ,, CaO 4·5 ,, Fe_2O_3, Al_2O_3 4·4 ,, Alkalis 4·5 approx. CuO trace
Glass ear ornament ..	3·5	Contains 10 per cent mixed calcium and barium oxide; of this an appreciable amount is barium oxide.

The ear ornament is of the type sometimes known as 'capstan bead', and there is good evidence for regarding it as of Han date (202 B.C.–A.D. 221).

In modern times barium glass was not made until about 1884, when it was one of the new glasses with a high refractive index and low dispersion put on the market by Messrs. Schott of Jena, nor have we any knowledge of any ancient glass or bead containing barium.

We do not suggest that the ancient Chinese used barium purposefully in their glass—no doubt it was present in the material from which the glass was made; we do, however, consider that its presence may in the future allow of the determination of origin of beads in certain doubtful cases, and thus have some value in questions of early culture contacts between West and East; indeed it was the study of these that led us to our discovery.

FIG. 1. Bead of Han Chün type. Natural size.

It must not, however, be supposed that all Chinese glass of a high specific gravity, or all Han glazes, contain barium. Dr. F. M. Brewer, who has kindly examined by arc spectroscopy two specimens of Chinese glass and a piece of typical green Han glaze, reports that "there was not in any of them any barium either as main or minor constituent". Of the two pieces of glass, one of T'ang age (A.D. 618–907) has specific gravity 2·5, the other—believed to be of this period—a specific gravity of more than 5.

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C. G. SELIGMAN.

Rapid Growth-Rate and Diminishing Heterogony

A STUDY of relative growth in the pistol-crab, *Alpheus dentipes*[1], has disclosed an interesting modification of the simple heterogony law, as expressed by the relation $y = bx^k$, where y and x are magnitudes of organ and body respectively, and b and k are constants, k representing the coefficient of growth-partition between organ and body[2].

This relation may hold over very long periods—for chela-weight in fiddler-crabs, for example, apparently during a two-hundred-fold increase in total weight[2]. The principle, however, may be modified in various ways. One modification in particular may be mentioned here, namely, that found in the mandibles of Lucanidæ. Here, in the upper part of the absolute size-range, the actual values for organ-size fall progressively further below the expected values. This has been interpreted as due to growth occurring in a closed system, namely, the pupa: if the heterogonic organs are very large, they will not be able to complete their growth before the rest of the body has appropriated most of the reserves of nutrient material[3].

Something analogous appears to occur in the chelæ of *Alpheus*. In males (for brevity's sake the only sex considered here) between the smallest and largest classes of the size-range 3–10 mm. carapace length, the small (nipper) claw has a greater growth-partition coefficient than the much larger (crusher) claw ($k = 1·22$ as against $1·19$)[1b]. When all the class-means are considered, however, the log-log curve, instead of being a straight line, is concave down-

wards. This is best shown when the square root of the two most rapidly growing dimensions—width and thickness (depth)—is used as a measure of chela magnitude (Fig. 1). This applies both to crusher and to nipper claws, but is both more pronounced and of earlier onset in the crusher. The k values for equivalent growth-periods are shown in Table 1.

TABLE I. Growth of chelæ in ♂ *Alpheus dentipes*.

Period (classes)	Growth coefficient (k)	
	crusher	nipper
I–II	**1·99**	1·34
II–III	1·24	1·42
III–V	1·10	**1·49**
V–VII	1·09	1·10
VII–IX	0·47	0·59

The interpretation would appear to be as follows :— The growth coefficient of the crusher in very small males, outside the range of the table, must be extremely high (well over 2) to produce the large relative size found at 3 mm. carapace length. The high rate proves physiologically impossible to maintain as the bulk of the crusher increases, and the growth coefficient therefore falls progressively. The nipper has only a moderate heterogony (k never over 1·5), which it maintains (and indeed appears to increase slightly) up to a quite large body-size : then it too shows a decrease.

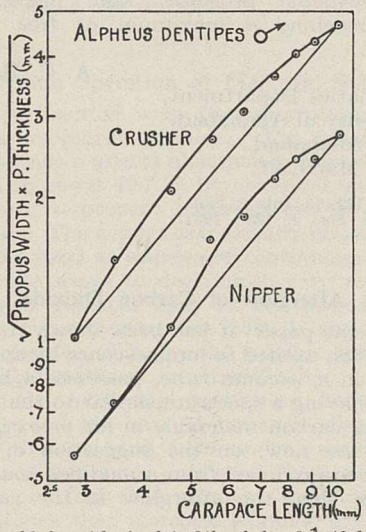

FIG. 1. Double logarithmic plot of the chelæ of ♂ *Alpheus* against carapace length.

It must be left undecided whether the temporary increase of the nipper's relative growth just noted is associated with sexual maturity, and whether the very rapid decrease in the growth-rate of both claws after class VII is a post-maturity phenomenon, as seen in the secondary sex characters of *Gammarus*[4]. What appears clear is the *diminishing heterogony* of the crusher, visible from carapace length 3–8 mm. and deducible at earlier stages ; and this would appear to be the direct outcome of an initial excessively high growth-rate. The phenomenon would be comparable to the diminution in total growth consequent on increased absolute size as noted by Hesse in various animals without a blood-system[5].

While on the subject of heterogony, a further point may be noted. The terms *positive* and *negative heterogony* originally employed[2] to denote relative growth with k values above and below 1·0, have proved in some ways misleading as suggesting that antagonistic processes are dominant in the two cases. The alternative terms *hypergony* and *hypogony* are proposed accordingly, indicating that what is being considered is the level of an organ's growth-intensity relative to that of the body as a whole.

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May 30.

[1] Dawes, Ben, (*a*) *Arch. Entw. Mech.*, **130**, 649 ; 1933. (*b*) *ibid.*, 1934, (in press).
[2] Huxley, J. S., "Problems of Relative Growth", pp. 11, 31. London : Methuen. 1932.
[3] Huxley, J. S., *J. Linn. Soc. (Zool.)*, **37**, 675 ; 1931.
[4] Kunkel, B. W., and Robertson, J. A., *J. Mar. Biol. Assoc.*, **15**, 655 ; 1928.
[5] Hesse, R., "Ueber Grenzen des Wachstums". Jena : G. Fischer, 1927.

The Helmholtz Resonance Theory of Hearing

In a communication to NATURE of April 21, p. 614, Messrs. Hallpike and Rawdon Smith produce evidence of differential sensitivity of different parts of the cochlea to notes of different frequency, which they describe as favouring the resonance theory of hearing. They use the expression "differentially tuned", which I suggest assumes more than is justified by the evidence.

There is one feature which the resonance theory does not explain, and that is that the human hearer cannot name the harmonics entering into the compound tone unless those harmonics are made loud enough to cause actual reversal of the primary wave. I recall Prof. Silvanus Thompson directing attention to this in 1898, at which time I demonstrated for him at a conversazione of the Royal Society a model illustrating an alternative theory of hearing due to Dr. Max Meyer. The following is Thompson's note on the Meyer apparatus :

"According to Max Meyer the ear does not act as a resonator and the perception of the individual tones of a compound sound does not depend on the fibres of corti acting as resonators. His view is that disturbances communicated by the stapes to the inner ear travel up the basilar membrane to distances dependent on amplitude and damping ; and that the perception of tone depends upon the number of times per second that the direction of such motion is changed. The model does not profess to exhibit the mechanism of the ear, but to show, by the number of times that certain lamps light up in a single period, that a mechanism which is sensitive to changes of direction of motion can act as an analyzer of compound periodic motions."

The Meyer apparatus depended upon a loose coupling between a series of parts. Dr. Meyer did not claim to have discovered a corresponding structure in the cochlea. The action of the Meyer apparatus was consistent with the above-stated peculiarity of human hearing as well as with differential sensitivity of different parts of the cochlea and suggests a closer examination of the process and mechanism of travel of sound throughout the length of the cochlea.

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Nuclear Structure, γ-Ray Fission, and the Expanding Universe

PROF. G. W. TODD[1] has put forward evidence against the suggestion that the positron is a constituent of the nucleus. He states that for a definite atomic mass P, and a definite atomic number Z, the arrangement of α-particles, neutrons, etc., in the atomic nucleus should be such as to give a unique structure for the nucleus. Allowing the possibility of positrons, but excluding the possibility of unattached electrons, Todd constructed the following arrangement for the unique structure :

$$\tfrac{1}{2}(Z - K)\ \alpha\text{-particles} + (P - 2Z + 2K)\ \text{neutrons} + K\ \text{positrons}$$

where $K = 0$ or 1, whichever makes $\frac{1}{2}(Z - K)$ an integer.

For reference, Todd's table for α- and β-ray transformations from uranium is given below (n stands for neutron and p for positron) :

	Nucleus			Radiation
UI	46	54	0	α
↓ UX_1	45	54	0	β
↓ UX_2	45	54	1	β
↓ UII	46	50	0	α
↓ Io	45	50	0	

We find as UX_1 is transformed into UX_2, the following change takes place : $0 \rightarrow 1p + 1\beta$, the positron remaining in the nucleus.

Prof. Todd asks : Where do the electron and positron come from in this change ? If we accept the suggestion that a γ-ray of sufficient energy may undergo fission into a positron and an electron in the strong electric field of the nucleus, the apparent anomaly may be explained. Now β-ray emission was preceded by emission of α-particles, and if some α-particles, without getting out of the nucleus, just shift their positions from higher energy levels to lower levels, there would be emission of energy which would appear as γ-ray radiation. Some of the γ-rays would very likely undergo fission into positrons and electrons within the nucleus. The positron of the γ-ray would attach itself to the nucleus and thus increase the atomic number by one, and the β-particle would escape.

We find that as UX_2 is transformed into UII, a new α-particle is created according to the transformation :

$$4n + 1p \rightarrow 1\alpha + 1\beta,$$

the α-particle remaining in the nucleus. This transformation can also be explained by assuming that an α-particle is an aggregate of four neutrons and two positrons, and also a positron and an electron were created out of a γ-ray, and the two positrons combined with the four neutrons to form the α-particle. It may be pointed out that a β-ray transformation is usually accompanied by γ-ray radiation. The binding energy of a proton is presumably great, and so its dissociation into its constituent parts cannot be spontaneous. Naturally we come across a comparatively small number of neutrons and positrons.

Dirac has suggested the possibility of a negative proton[2]. A plausible hypothesis may be formulated according to which super γ-rays or cosmic ray photons may also undergo fission into positive and negative protons. A proton has the energy of $9{\cdot}4 \times 10^8$ electron volts, and a cosmic ray photon may have the energy of the order 10^{11} electron volts.

The breaking up of a photon into an electron and a positron or into a positive proton and a negative proton, may be helpful in explaining why our universe started expanding from the Einstein universe. We know that, mass for mass, matter exerts less gravitational attraction than radiation. So the conversion of radiation into matter will lessen the gravitational factor. Therefore if by some method the photon breaks up into two material particles, the Einstein universe will start expanding. Possibly radiation, as well as the fundamental material particles, already existed in the Einstein universe. Some of the photons broke up into constituent particles in the electric field of already existing charged particles and thereby started expansion.

I also feel that the final end of the universe as predicted by Sir James Jeans, due to all matter ultimately dissolving away into radiation, may not happen, as materialisation of radiation is possible, and electrons, positrons, positive protons and negative protons can be created or re-formed out of the photons. It may also be mentioned here that Prof. Tolman established the possibility of a universe in which reversible processes take place, without entropy reaching a maximum or free energy a minimum.

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March 21.

[1] NATURE, **132**, 65, July 8, 1933.
[2] *Proc. Roy. Soc.*, A, **133** ; 1931.

Afterglow of Carbon Dioxide

IN a recent paper[1] it has been shown that carbon dioxide, when excited to luminescence by an electrical discharge in a vacuum tube, possesses a blue-violet afterglow having a spectrum similar to that obtained by burning carbon monoxide in air or oxygen. The spectrum has now, on the suggestion of Prof. A. Fowler, been produced from a modified source which is brighter than the afterglow in the gas at low pressure.

A powerful uncondensed spark from an 18-in. induction coil was passed between water-cooled aluminium electrodes in a spherical bulb of about three litres volume ; the spark was horizontal ; the distance between the electrodes was variable, but the best results were obtained with a separation of about five centimetres. The bulb was filled with carbon dioxide at a pressure of about a quarter of an atmosphere. It was observed that the spark, which resembled an arc, was accompanied by a blue glow above it. This glow persisted for a fraction of a second after the cutting off of the discharge.

The spectrum of this glow has been examined between 6000 A. and 2900 A., and found to be similar to the spectrum of the afterglow at low pressure and to that of the carbon monoxide flame. The water vapour band at 3064 A., which was such a prominent feature of the spectrum of the afterglow, was, however, not observed when the gas was

carefully dried. Even when the gas was slightly wet, showing the water vapour band in the spectrum of the exciting spark, this band was still quite weak in the spectrum of the glow above the spark. This supports the view that the presence of water is not essential to the occurrence of the afterglow. The spectrum of the exciting spark consisted of the third positive and Ångström bands of carbon monoxide; the afterglow bands were also present on the spectrograms of the spark, but this does not necessarily imply that they were present in the exciting spark as the glow was also included in these spectrograms. No lines of atoms, other than those of aluminium from the electrodes, were observed in the region examined.

The effect of variation of the pressure of the gas has been studied. At a pressure of about half an atmosphere the glow was brighter, but the spectrum included a considerable amount of continuous background, resembling the carbon monoxide flame as usually obtained. At a pressure of about 100 mm. the glow was much fainter, and the spectrum more nearly resembled that of the afterglow in a vacuum tube, showing a well-marked band structure, and being comparatively free from continuum.

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[1] *Proc. Roy. Soc.*, A, **142**, 362; 1933.

Absorption Spectrum of Mercuric Sulphide

WE experimented with the absorption spectrum of gaseous mercuric sulphide. The substance was introduced into a quartz absorption tube which could be heated to about 400° C. by electrical means, steps being taken to prevent condensation on the plane quartz ends. The copper and aluminium-under-water sparks were used as sources of continuous radiation. The sulphide seems to decompose very readily, and we obtained evidence only of the presence of Hg vapour by the resonance line 2536 A. and of S_2 and, at high pressures, of S_8, by the sulphur bands, which we identified without much difficulty. At higher pressures the overlying continuum becomes very prominent, and the banded structure disappears, as is usually the case with a gas under such conditions.

We would not have published these results were it not for the fact that recently Sen-Gupta[1] claims to have shown that mercuric sulphide dissociates in three regions of continuous absorption into Hg ($^1S_0$), and S (^3P), S ($^1D_2$), S ($^1S_0$) respectively. We re-examined our plates in the hope of verifying this, and can only say that the separation of these distinct absorptions from the sulphur continuum must be one of very great difficulty. In fact, we cannot be sure if the first two regions are not entirely due to sulphur, which has two maxima, 4000 A. in the S_8 region and 2670 A. in the S_2 region. Our absorption spectra for HgS followed very closely the spectra published for sulphur at high pressures by Graham[2].

The heat of dissociation of HgS has been calculated to be 60–70 kcal. This makes the reaction $2HgS = Hg + Hg + S_2$ endothermic, so that the dissociation will be greater at the higher temperatures and pressures, and there will be a relatively larger concentration of S_2 compared with HgS. Consequently the interference effect due to S_2 will become more and more pronounced as the temperature is raised, and it seems useless to try to increase the concentration of HgS in this way.

The whole question of the existence of an absorption spectrum of HgS would seem to centre round the electronic state of the molecule. If it is a $^1\Sigma$ ground state, it would not dissociate into Hg ($^1S_0$) and S (^3P) as these atomic states do not combine to give a singlet state (Wigner and Witmer, Herzberg, etc.). Whether the first excited state dissociates in this way will depend on the probability of the intercombination; so that the absorption spectrum of HgS in the necessary region may only be very slight and perhaps immeasurable.

It is noteworthy that V. and C. Meyer[3] found HgS to have a vapour density (compared with air) of 5·39. The vapour density of Hg + Hg + S_2 is not much different from this, namely, 5·35.

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[1] *Proc. Roy. Soc.*, A, **143**, 438; 1934.
[2] *Proc. Roy. Soc.*, A, **84**, 311; 1910.
[3] *Ber.*, **12**, 1262; 1879. See also Scott, *Proc. Roy. Soc. Edin.*, **14**, 410; 1887.

Intranuclear Spindle Formation and Mitosis in *Artemia salina*

CYTOLOGICAL studies on *Artemia* have brought out some new facts about the structure of the spindle and the morphology of the meiotic and mitotic division in this form, which agree only in part with previous hypotheses. (For a recent discussion of these, see Schrader[1].) To what extent these data bear upon the general understanding of the problem of mitotic division will be considered elsewhere in more detail.

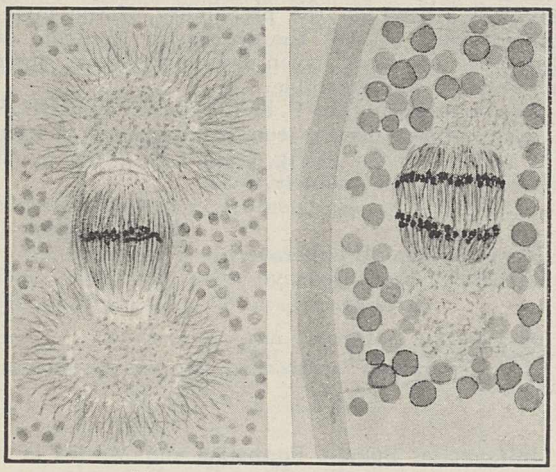
In *Artemia* the spindle, both in meiotic and cleavage divisions, is formed exclusively from nuclear material. It arises as two half-spindles from the poles of the nucleus inside the nuclear membrane, which remains intact up to early metaphase (Fig. 1 *a*). Its formation is accompanied by a steady loss of nuclear volume, indicating that the process involves a great reduction in the fluid content of the nucleus. During metaphase the nuclear membrane rapidly disappears.

There is a distinct structural difference between the polar fibres and the spindle fibres. The metaphase spindle is barrel-shaped and in early cleavage divisions stands out sharply against the polar fibres of the big centrospheres. It has a very similar form in the metaphase of the meiotic divisions, where there are no formed centrosomes or centrospheres, and in the late cleavage divisions, where these are only weakly developed (Fig. 1 *b*).

In the spindle two components can be distinguished: (1) relatively rigid fibres, immersed in (2) a less viscous matrix. During anaphase, the chromosomes move to the two poles leaving a much lighter central space (Fig. 1 *b*). The fibres found in this central space between the two sets of chromosomes would seem at first sight to correspond to Schrader's interzonal fibres; but in this case they appear to be identical with one component of the metaphase spindle, namely, the rigid fibres.

It may be suggested that during anaphase the chromosomes are moving as on tracks—or possibly within tubes, as suggested by Schrader—along these rigid fibres. The anaphase spindle is more cylindrical

and less compact than the metaphase spindle. One can see the underlying yolk granules through it whereas this is impossible in metaphase. These facts suggest that there is a streaming of the interfibrillar substance—the matrix between the rigid fibres—towards the centrospheres and that the movement of the chromosomes is somehow connected with the currents thus produced.



(*a*) (*b*)

FIG. 1 (*a*). Early metaphase of the first cleavage division in a diploid parthenogenetic *Artemia*. Intranuclear formation of the spindle. × 590.
(*b*) Anaphase of a late cleavage division in a polyploid parthenogenetic *Artemia*. The centrospheres are here weakly developed as compared with the first cleavage. Note that the polar regions are denser than the space between the two sets of chromosomes. × 1,320.

As soon as the chromosomes reach the ends of the spindle, they lose their regular arrangement in planes and form more or less spherical clumps. This is consistent with the assumption that the rigid fibres act as supporting structures and at the same time separate the chromosomes from each other. The spindle remnant is always to be seen in telophase. It is noteworthy that in the first cleavage division the chromosomes, after leaving the spindle and assuming the clumped telophase arrangement, may continue their movement towards the centrospheres.

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May 18.

[1] *Z. wiss. Zool.*, **142**; 1932.

The Discovery of *Acanthinula harpa*, Say, in Central Siberia

IN the course of a study of the molluscan fauna of Siberia, carried out under the auspices of the Smithsonian Institution during 1932 and 1933, a point has come to light which appears to merit special notice. This concerns the discovery of the gastropod mollusc, *Acanthinula harpa*, Say, in central Siberia. This species has long been known to occur in Europe, North America, and the eastern fringe of Asia (Kamchatka, etc.), and its apparent absence from the central part of Siberia led Dall[1] to believe that migration into that territory had been delayed by a transgression of the sea, or of glacial ice, over at least a part of this region.

The collection of *A. harpa* in three different localities in the central part of this region, namely, near the River Ket (to the north of Tomsk) at a point situated two hundred and ten kilometres above the River Ob; on the western shore of Lake Baikal, in the vicinity of the village of Listvinichnoye; and on the eastern shore of the same lake, twenty-five kilometres north-east of the mouth of the River Selenga, indicates that this is a circumboreal species, and obviates the need, on these grounds, of the hypothesis noted above.

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[1] Dall, W. H., "Land and Freshwater Mollusks". Harriman Alaska Expedition, **13**, New York, 1905.

Activities of Life and the Second Law of Thermodynamics

I AM at one with Profs. Donnan and Guggenheim in hoping that this discussion will end soon, but ask leave to explain why I think that their supposed paradox[1] is merely a third mare's nest.

It is a well-known, and indeed obvious, fact that entropy has different values according as it is measured with reference to atoms or molecules or other units. Profs. Donnan and Guggenheim have re-discovered this, hail it as a paradox, and claim that because this paradox exists my arguments must be unsound. As well might they rediscover the 'paradox' that temperature has different values according as it is measured on the Centigrade and Fahrenheit scale, and try to use this as ammunition against anyone who mentions temperature.

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[1] NATURE, **133**, 869, June 9, 1934.

Crocodiles or Alligators

PROF. RITCHIE need have no fear that the name *Crocodilus* for the crocodiles in general will be replaced in future by *Champse*[1]. It was unfortunate that Dr. Werner's blunder should have appeared in so authoritative a work as "Das Tierreich" but it was at once corrected by Dr. Stejneger in *Copeia*, No. 3, p. 117, Oct. 1933. The type of *Crocodilus*, both by absolute tautonymy and by subsequent designation, is *niloticus*=the *Lacerta crocodilus* of Linnæus (in part).

[1] NATURE, **133**, 835, June 2, 1934. MALCOLM SMITH.

Constitution of Astacin

ASTACIN, the pigment of the lobster and of other crustaceans, is a derivative of β-carotene, that is, 5, 6, 5′, 6′-tetraketo-β-carotene or 4, 5, 4′, 5 -tetraketo-β-carotene. It forms a dioxime, $C_{40}H_{48}O_2=(NOH)_2$, which besides the two oxime groups also contains two enolic hydroxyl groups. On heating with *o*-phenylenediamine, astacin gives a di-phenazine derivative, $C_{52}H_{56}N_4$. It is therefore a new type of carotene derivative.

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June 2.

Research Items

Cannibalism in North-West America. A study of mortuary and sacrificial anthropophagy on the north-west coast of America and its origins has recently been published by Dr. William Christie MacLeod (*J. Soc. Américanistes* N.S., **25**, fasc. 2). Among the Kwakiutl there is a group of dances either cannibalistic or related to the cannibal dance. A youth, who in his quest for a vision meets the great cannibal spirit or any of the cannibal's attendants, acquires the dance, derivable from the spirit. An analysis of the elements of this belief and of the lore connected with cannibalism indicates that the dance was diffused from the northern Kwakiutl as the centre. It is evident, however, that the dance consists of a number of elements which were diffused separately and have been only imperfectly integrated among the Kwakiutl. There are three elements which have a different history and can be traced. Of these, corpse-eating by the relatives of the deceased was an old culture element of the entire west coast of North America and the northern plateau. It was linked with the custom of bone-carrying by the widow and the custom of smearing with exudations of the corpse, or its blood, as an equivalent of eating. Among the Kwakiutl the custom of mortuary anthropophagy probably represents a survival from the culture of a pre-Kwakiutl tribe. The second element, the custom of biting bits of flesh from fellow-tribesmen at ceremonials, is of inner-American introduction and probably is a by-product of hook-swinging. In inner North America the rite is self-sacrifice of bits of skin. Thirdly, non-anthropophagous sacrifice of captives in war was diffused to the west coast from inner America, and afterwards, through the Kwakiutl, anthropophagous practice followed in connexion with the rite of hook-swinging. The strips-of-flesh technique in sacrifice of both Maidu and Kwakiutl is of inner American origin and still survives among the northern Plains and Woodlands Indians.

Rabbit Fur Production. As a rule, rabbit fur has been worn in garments only when no other could be afforded, objections to it being that the hair soon becomes worn and shabby in appearance and, curiously enough, that it is cheap. In recent years, however, much has been done by careful selection and breeding to improve the lasting quality of rabbit fur, and to furnish a wide range of desirable colourings. As a result, it is now possible to produce natural undyed and untrimmed furs which closely resemble pelts from the rarer and more expensive fur-bearing animals. Much of the progress has been due to the discovery in 1919 of a mutation, later known as castorrex, in which a short, dense, under-fur with almost a velvety texture is the predominant coat, the guard hairs of the outer fur being reduced to insignificance. The rex-coat character acts as a Mendelian recessive, and breeders armed with a knowledge of the behaviour of this character in crossing have to their hand an invaluable aid in producing coat varieties new in colour and texture. The Ministry of Agriculture and Fisheries has published a Bulletin (No. 73) on "Rex-furred Rabbits" (London: H.M. Stationery Office. 1*s*.) which gives a description of experiments carried out by W. King Wilson at the National Institute of Poultry Husbandry. The pamphlet, illustrated by eleven fine reproductions of colour photographs of stages shown in the first and second generations of hybrids resulting from a cross between normal furred lilac and castorrex, should be a useful guide to the breeder. It would be interesting to know if these beautifully coloured natural furs stand exposure to light without fading.

Hair Direction in Man and Apes. Dr. T. D. Stewart, physical anthropologist of the Smithsonian Institution, has made a preliminary classification of the differences in hair growth directions over the whole body between man and the higher apes. The comparisons are based upon 156 skins of gorillas, chimpanzees and orang-outangs, and upon young men stripped for physical examination. There is much in common between the two groups, which possess a basic hair direction pattern from which each species has departed to some extent. In man the pattern has become more modified than in any of the others, the most obvious human feature being the 'cowlick' on the top of the head. In the apes the head hair streams regularly backward from forehead to nape (like that of a modern well-oiled youth !), and this direction is continued without break along the back, where the hair streams downward from neck and shoulders. It is in the back pattern of man that the most striking divergence appears, for, instead of showing a regular downward flow, the hair of each side converges towards the mid-line. Man has the most complex and most variable pattern, but the difference between man and any of the anthropoid apes is greater than that between any two of the apes.

Whaling in the Dominion of New Zealand. Capt. Cook visited New Zealand in 1770, 1773 and 1774 and he was the first to report whales in those seas. In "Discovery" Reports, **7**, 239–252, 1933, Mr. F. D. Ommaney gives a brief outline of the history of the whaling industry in New Zealand and a sketch of the small industry as it exists to-day. One of the first attempts at large-scale whaling in the vicinity of New Zealand was made in 1791 by a fleet of whalers which had arrived in Australasian waters through having brought convicts and stores to Australia. It met with no success because, although whales were abundant enough, the weather proved too bad for profitable fishing. Seven years later, however, Sperm whaling was being actively carried on in New Zealand waters, mainly by British and American ships, the chief bases of which were situated at the northern end of South Island. By the end of the third decade of the nineteenth century the population of Sperm whales in those waters had become seriously depleted. As a result of this diminution in the number of Sperm whales and also because of an increasing demand for Right whale oil and whalebone, a Right whale industry arose in 1830 and quickly eclipsed the Sperm whale fishery in importance. Ten years afterwards this fishery, too, began to decline owing to diminution of the whale population by ruthless overfishing, and by 1892 the New Zealand whaling industry had sunk to insignificance. Several recent attempts to revive it have been disastrously unsuccessful. At present there are only two whaling stations operating on a small scale in New Zealand —one at Whangamumu and one at Torry Channel, Queen Charlotte Sound.

Fæcal Pellets from Marine Deposits. Mr. Hilary B. Moore has already made several studies of the fæcal pellets of various marine animals, finding in them good diagnostic characters for certain species. In vol. 7 of the "Discovery" reports, 1933, he describes a type of pellet occurring frequently in the plankton at some stations which he recognises as agreeing in form with those of euphausiids found in the Clyde. He believes them to belong almost certainly to *Euphausia superba*, which is very abundant in the plankton at the same stations. They were not found in the bottom deposits, probably because they break down quickly, as was observed in the Clyde, where they were seen at the extreme surface of the mud but not below. The pellets from the bottom deposits are not so easily identified although they can be separated into two classes. One appears to be from a mollusc, possibly *Nucula*, and includes many diatoms; the other, which is much more abundant, is of a kind the distribution of which is world-wide, occurring in recent deposits in depths from 0 to more than 2,000 m. and in conditions varying from almost fresh to salt water; also in certain fossil deposits. These pellets are ovoid and composed of the same mud in which they are found and are probably of animal origin. The author is inclined to attribute them to polychæte worms or to molluscs. The former seems very likely as he has found similar pellets in the Clyde, which come definitely from Maldanid worms.

Ascidiacea of the North Sea. The section on Ascidiacea, by J. Huus, in "Die Tierwelt der Nord- und Ostsee" (Lief. 25, Teil $xiia_3$, 1933. Leipzig: Akademische Verlagsgesellschaft m.b.H.) opens with a useful account in about 10 pages of the external features and internal anatomy. The author recommends weak acetic acid as a narcotising agent for these animals which, unless narcotised, contract strongly on preservation. The systematic section, with its diagnoses and key, is followed by a list showing the distribution of the 55 species considered. An excellent summary of the physiology of Ascidiacea is given; attention is directed to glands of unknown function, such as the pylorus glands and the neural gland. The author notes that the latter is known to develop from a part of the larval brain, that Julin pointed out its homology with the hypophysis, and that Butscher found its extract has the specific action of posterior lobe hormone. The development is briefly considered, a first key to the larval forms of the area is provided, and due attention is given to the process of budding. The section concludes with a list of the animals which live symbiotically with, or parasitic within or upon, Ascidiacea.

Discoloration in Preserved Latex. A very valuable discussion of this subject by Edgar Rhodes and K. C. Sekar will be found in the *Journal of the Rubber Research Institute of Malaya* of March 1934. Extending earlier observations by de Vries, it can be shown that such discoloration can usually be traced to the presence of soluble iron, and the presence of the iron may often be associated with acid production due to fermentative changes with the consequent solution of iron from metal containers. This soluble iron then may react with hydrogen sulphide or other soluble sulphide, the sulphide being produced as a rule by the gradual hydrolysis of the protein material in the latex, a process taking place more readily under alkaline conditions, which may occur as the latex before shipping is usually treated with ammonia. Thus acid production following collection, associated with iron containers, and then sulphide production following ammoniation before shipping, are accessory factors in discoloration. The discussion of this problem may enable grower and shipper to combine to reduce the discoloration in the latex which otherwise makes it unsuitable for many of the new processes in which rubber latex is now being utilised.

Vegetation of Prairies. The April number of *Ecological Monographs* (4, No. 2, 109–295; 1934) is a general account of prairie vegetation by J. E. Weaver and T. J. Fitzpatrick. The areas which prairie occupies are characterised by cold winters and hot summers, with a growing season of about seven months, during which there is a fairly even distribution of rainfall amounting to 19–20 inches. The total annual rainfall is from twenty-five inches in the north-west increasing to thirty-six inches in the south-east. Despite the high temperatures and considerable wind, water is almost always present below six inches and this is rendered available by well-branched root systems which tend to form three underground strata. The shallowest roots mostly extend to a depth of about a foot, but the unleached deep organic soil, which is well aerated, permits the development of deeply penetrating root systems, some of which even extend to seventeen feet below the surface. Six types of prairie are distinguished by their floristic constitution, the most important being those dominated by *Andropogon scoparius* and *A. furcatus*. All the dominants and most of the other important species are perennials which reproduce mainly by vegetative means. Most of the prairie areas are stated to have been mown annually for more than fifty years and this, together with the fires and grazing to which they have been subject since prehistoric times, have checked the tendency shown by the more feral areas to form communities of a few dominants only. At the contacts with woodland and forest, colonisation by shrubby species occurs, though their growth is checked by the factors just mentioned. *Rhus glabra* and *Symphoricarpus vulgaris*, both of which spread by vegetative means, are important pioneers in such suppressed scrub, but it is suggested that even if not checked by mowing and fire, chaparral and woodland could not greatly extend the areas which they at present occupy. In this connexion it must, however, be borne in mind that the authors themselves emphasise that the prairies are associated with a wide range of conditions both as to soil and topography. A considerable part of the text of this monograph consists of notes, of varying merit, upon the constituent species.

Blight Diseases of Leguminous Plants. A study of various fungi which produce disease on legume crops in India has recently been published (*Trans. Brit. Mycol. Soc.*, **18**, Part 4, 276–301, April 1934: "A Comparative Study of the Fungi associated with Blight Diseases of certain cultivated Leguminous Plants", by Dr. A. Sattar). Nine species or forms of fungi which cause foot-rots of pea, gram, lentil and vetch are described. The symptoms of each fungus are given for its respective host plants, and cultural characters of the parasites have been determined. *Ascochyta pisi*, a fungus which is well known in England as a parasite of the garden pea, was found to have physiological forms on vetch and lentil. *Phyllosticta Rabiei* also has a close relation

with its host (gram), whilst *Mycosphœrella pinodes* and *Ascochyta pinodella* are not so specialised. The last two organisms cause very severe foot-rot. Considerable discussion of the results of the experiments as they relate to taxonomy appears in the paper, and it is suggested that *P. Rabiei* should be more correctly named *A. Rabiei*.

Earthquakes in Bulgaria. With the exception of Greece and Italy, no European country is more frequently disturbed by violent earthquakes than Bulgaria. It is therefore fortunate that it should possess an efficient seismological service, the work done by which during the last forty years is described in an interesting paper by M. Kiro P. Kiroff, the director of the Central Meteorological Institute (*Matér. pour l'Étude des Calam.*, No. 32, 341–348; 1933). The service was founded by M. Spass Vatzoff, the director at that time. A table is given of the number of earthquake-days during each month of 1892–1931. From this it appears that on an average there were 44·4 days every year on which earthquakes occurred, the highest yearly numbers (213 and 134) being those for 1904 and 1928, including the after-shocks of the destructive earthquakes in April of each year. During the forty years, there were eight earthquakes of destructive intensity with epicentres either in Bulgaria or close to its borders.

Gravity Work in East Africa. The annual report, 1934, of the Committee for Geodesy and Geophysics at Cambridge gives a short account of the notable work done by Dr. and Mrs. Bullard in the recent Cambridge Gravity Expedition to East Africa. Dr. Bullard was in Africa from last November until early April this year, and during that period made gravity observations at 57 stations, several of which were visited twice and some three times. The tour extended from Nairobi through the west and north-west part of Kenya, Uganda, the southern Sudan, part of the Belgian Congo to the west of the Rift Valley, and back to Nairobi through Uganda. Dr. Bullard then proceeded to Mombasa through Tanganyika, and from Mombasa by coast to Cape Town, making shore observations at Dar-es-Salaam and Cape Town. The photographic records of the observations, which were made with invar pendulums by Dr. Bullard's comparison method, were sent to Cambridge weekly by air mail. The reductions are not yet complete, but it appears clear that the accuracy obtained is of a high order. Dr. Bullard also made valuable magnetic observations on his tour, using instruments lent by the Ordnance Survey and the Carnegie Institution of Washington. These observations included 159 of declination, 58 of horizontal force and 18 of inclination.

Insulators. The mechanism by means of which flow of electricity takes place in materials which are almost insulators is still obscure, but the publication of Prof. Joffé's address to the International Congress on Physical Chemistry on the subject, and the discussion which followed, will do much towards clearing away the obscurity (Pp. 35. Paris: Hermann et Cie, 10 francs.) In the case of an insulating crystal, Prof. Joffé considers that the thermal oscillations are sufficient to detach an ion occasionally from its normal position in the space lattice of the crystal, and that the absence of the ion from that position and its presence elsewhere produce deformations of the space lattice which are propagated by the electric field applied to the crystal, but gradually disappear owing to the thermal movements replacing the ions. When this process takes place slowly, the resistance of the crystal may be very small. Prof. Joffé believes that in no case has the replacing ion to overcome an energy barrier. He considers that the retention of conductivity by a crystal when its temperature is suddenly reduced points to the fact that in a crystal some ions exist displaced from their normal positions, and that their number increases with temperature and with the passage of light or X-rays. The pamphlet is to be followed by one on conduction by electron movements.

Strychnine and Brucine. The constitution of these two alkaloids has proved a very difficult problem to the organic chemist, and further communications to the *Journal of the Chemical Society* (May 1934) by Prof. R. Robinson and collaborators (the first bearing the name of the late Prof. W. H. Perkin) bring the number of parts of the work up to twenty-nine. The problem is not yet fully solved but considerable progress has been made. An important contribution is the progress made in the Hofmann degradation of the molecules, which has hitherto proved very intractable. It had been recognised that both strychnine and *neo*strychnine are of the allylamine type, and that Hofmann eliminations in the series of the dihydrobases in which the allylamine structure is no longer present might be a promising line of investigation. This is now shown to be the case. A very interesting and unexpected reaction was also discovered in the reduction of a new base, leading ultimately to a new isomeride of dihydro strychnidine. The previous suggestion that strychnidone obtained by the oxidation of *neo*strychnidine is a keto-amide has also been confirmed. A method of oxidation of *neo*strychnine derivatives by perbenzoic acid is described. The papers contain a number of important observations which cannot be summarised adequately without reference to other previous ones in the series, and it is clear that the solution of the problem of the constitution of strychnine is considerably advanced by the work now recorded.

First Dissociation Constant of Phosphoric Acid. Phosphoric acid is a comparatively weak acid and has the peculiarity that the acid function of its three hydrogen atoms varies greatly. The dissociation constants are important in physiology and the values for the first dissociation constant ($H_3PO_4 \leftarrow H^{\cdot} + H_2PO_4$) available are not in very good agreement. L. F. Nims (*J. Amer. Chem. Soc.*, May) has determined this constant, expressed in terms of activities, over the temperature range 0°–50°, from electromotive force measurements of the cells :

$$H_2/HCl(m_1),\ K.H_2PO_4\ (m_2)/AgCl/Ag,$$

without liquid junctions. The limiting Debye-Hückel equation $\log \gamma = -A\sqrt{\mu}$ was used for the activity coefficient of HCl, the ionic strength μ being expressed by $m_2 + m_H$, in which m_H is the apparent hydrogen ion molality from the electromotive force equation. The values of $pK_1 = -\log K_1$, K_1 being the first dissociation constant of phosphoric acid, were found by graphical extrapolation of very satisfactory lines. The equation $\log K_1 + 2{\cdot}0304 = -5 \times 10^{-5}\ (t + 18°)^2$ was found, t being temperature centigrade. The values so obtained are in very good agreement with those found by conductivity at 18°, and by the quinhydrone electrode at 37·5°, by other experimenters.

Speeds of Chemical Reactions in Biological Processes

SEVERAL interesting points were raised at the discussion on June 14 at the Royal Society on methods of measuring and factors determining the speed of chemical reactions. The discussion, which was opened by Prof. A. V. Hill, had as its main objective the exploration of methods suitable for attack on biological problems.

Several of the difficulties in such work are now generally recognised; we must note, for example, that physical methods of attack are likely to prove more fruitful than chemical methods, since there are few reagents that do not disturb in some manner the complicated series of reactions proceeding in living matter. Again, in the chemical laboratory it is customary to restrict one's attention to reactions in solution which proceed at speeds conveniently measurable. In biological systems, it is the reactions which are predetermined and their velocities have to be measured. Whilst a half-life of some ten seconds after mixing the reactants is almost the limit of accurate measurement by the usual methods, many biologically important reactions proceed much more rapidly. Prof. H. Hartridge and Dr. F. J. W. Roughton showed how, by means of specially designed mixing chambers, using liquids at high pressures and optical or electrical examination of the mixed liquids in flow, reaction velocities having a half-life of as small as 1/4,000 sec. could be determined. An extension of this method by Mr. G. Millikan involving a photoelectric cell permits of a greater degree of sensitivity and the elaboration of a micromethod.

The modern extension of the kinetic theory of reactions to complicated molecules is bringing into prominence the importance of what is termed the steric factor; thus, a very large molecule undergoing reaction at one of its constituent groups may be regarded as only potentially active over a relatively small fraction of its total area. These steric factors may play an important part in biological reactions in two somewhat dissimilar fields. We find that steric factors already intrude in such comparatively simple homogeneous reactions as the addition of hydrogen to, say, the double bond in propylene, and may anticipate that there is indeed a very large steric factor in the reactions of, say, oxygen with hæmoglobin. It will be interesting to examine from this point of view the results obtained from measurement of the reactions of the less common and extremely large molecule biological pigments, the molecular weights of which, as determined by the super centrifuge, run into the millions.

Again, numerous biological processes occur at phase boundaries or interfaces, and such reactions possess several interesting peculiarities which are well worth extended investigation. Prof. H. Freundlich pointed out that whilst surface catalysis is a relatively common phenomenon, there are cases in which retardation of a chemical reaction can be brought about by a simple extension of surface; he cited as an example the reaction:

$$H_2C(Br).CH_2.NH_2 \underset{HBr}{\overset{NaOH}{\rightleftharpoons}} \begin{matrix} CH_2 \\ | \\ CH_2 \end{matrix} > NH + HBr,$$

which is retarded by charcoal in alkaline solution. It is difficult to decide whether the adsorbed molecules are firmly adsorbed and so removed from the solution, to which the reaction is confined, or whether reaction is proceeding both in solution and in the adsorbed layer, but in the latter, which may be regarded as an organic medium, the reaction proceeds much more slowly.

In the case of monolayers at fluid interfaces, it is a simple matter to contract or extend the area per molecule by means of a Langmuir trough, and it is possible to examine reaction rates in monolayers by determination of the rate of change in the phase boundary potential. As has been shown in the present writer's laboratory at Cambridge, the velocity constants of numerous reactions in monolayers may be altered to a marked extent by extension or contraction of the film. Thus there is remarkable decrease in the rate of oxidation (by dilute permanganate solution) of the double bonds in a monolayer of oleic acid on suitable compression of the film; or, to suggest a possible analogy to stretched muscle, there is an increased rate of oxidation on extension of the film. The action of enzymes on monolayers of reactants, for example, lecithinase on films of lecithin, is similarly sensitive to an alteration in the molecular concentration or steric factor, which in these cases can be controlled at will.

In addition to the steric factor, the energy of activation plays a dominant part in determining the rate of chemical action, and it is still a matter of speculation as to the accuracy of assessing the magnitudes of the individual energies of activation in the complex chain of biochemical processes. Prof. M. Polanyi pointed out that many ionic reactions in solution require energies of activation and that unsuspected reactions may indeed be taking place. He cited as a typical example the racemisation of optically active halides by negative ions, which reaction may be written:

$$X^1 + \begin{matrix} R_1 \\ R_2 \\ R_3 \end{matrix} > CY \rightarrow XC < \begin{matrix} R_1 \\ R_2 \\ R_3 \end{matrix} + Y^1.$$

Where X^1 and Y^1 are identical, that is, $X^1 = Y^1$, racemisation can take place without the occurrence of any apparent chemical reaction, although in fact an ion exchange does take place.

Both in chemistry and in physics, a vast number of relative speeds of complicated processes are found to be exponentially temperature dependent, and the mechanisms of these processes are always interpreted on an atomistic hypothesis. Prof. J. B. S. Haldane pointed out that either this inference may not be universally legitimate or a materialistic concept must be given to such curious processes as the subjective measurement of time, for here the logarithm of the relative speed of counting is found to vary inversely as the absolute temperature of the counter, giving a computed energy of activation of 24,000 calories. The speed of bimolecular gas reactions is accelerated by increase of pressure, and the recent experiments carried out by the Imperial Chemical Industries at Northwich have revealed a surprising increase in velocity of many chemical reactions in the liquid phase when suitably high pressures are employed. Prof. Max Cincatel directed attention to this as a possible method of effecting a sudden change in the environment of a living system and examining the

effect of this change on the various reactions taking place.

Some brief references were also made to the importance of finding a really accurate method for measuring the true permeability rates of extremely thin membranes. Theoretical investigations in this field have already been made by Prof. A. V. Hill, and Dr. F. J. W. Roughton indicated how the streaming method could be made applicable to blood cells, thus permitting an examination of the true rates of ingress and egress both of non-electrolytes and of ions.

ERIC K. RIDEAL.

Water Supply

IT is natural and appropriate that the paramount topic of the drought should find a prominent place in the presidential address of Mr. Councillor Thomas Paris at the annual meeting of the British Waterworks Association (Incorp.) at Edinburgh on June 27. Much of what he had to say respecting the pernicious effects of a shortage of water has been a matter of common experience, but he made the pertinent observation that many of the failures in supply can be traced to procrastination and lack of courage in promoting water schemes. This was more particularly in reference to rural areas where, he emphasised, "the importance of an abundant supply of wholesome water is hardly to be over-estimated" since insufficient or impure water in those areas has wide-reaching effects on public health through milk and foodstuffs produced for general consumption. He alluded to the frequent lack of storage facilities and urged all councils, regional, urban and rural, to take action in the direction of increasing their storage and, where necessary, constructing new waterworks. Another of his points was river pollution, which, he contended, in the national interest must cease. He instanced the case of Edinburgh, where a few years ago there was a turbid stream flowing through the city, "offensive to eye and nostril". The action taken by civic authority has resulted in the transformation of a public nuisance and a menace to health into a "fished water". He is opposed to the formation of a national water grid, alleging that the argument for such a grid, so far as Scotland is concerned, is without foundation. The question in his view is not one of water shortage, but rather of storage and distribution.

Among the papers contributed to the Conference was one of a particularly timely character on the "Consumption, Misuse and Waste of Water". Mr. John Bowman, the author of the paper, directed attention to the striking difference in the quantities of water supplied per head per day by various authorities. He gave a list of 114 authorities in England, each supplying a population of more than 50,000, in which the consumption ranged from 13·00 to 73·45 gallons per head per day. Another list showed that among 27 water authorities in Scotland, the consumption ranged from 34 to 92 gallons per head per day. Commenting on the subject of undue consumption, which might be defined as the use of more water than is necessary, he said: "a person living in a country where water is scarce may find it possible to perform all his ablutions with one gallon of water per day, and half as much again for culinary and drinking purposes. In civilised countries it would appear that, at least, from 4 to 6 gallons per head must be allowed, where there is no water used for baths or water-closets". Where water is used in addition for the supply of water-closets, it would appear that the lowest figure is about 10 gallons per head. Much depends on the class of property. Houses of the residential class have a higher *per capita* consumption than small tenements.

Mr. Bowman went on to ask the question: What is to be regarded as the future requirements for ordinary domestic consumption? He gave it as his opinion that within the next twenty years at least 20 gallons per head per day would have to be provided for the increased use of baths. The requirements per head per day would then be in the region of 50 gallons. Perhaps forty years from now a consumption of 80 gallons might be considered possible. In American towns 80 gallons per head is looked upon as a normal consumption. Dealing with the question of waste, which he attributed largely to defective fittings, he stated that a good deal of it might be eliminated by the installation of heavy service piping and good fittings. Useful work, he thought, might be done in educating the householder in the avoidance of waste due to faulty fittings and in getting him to see that taps were left properly turned off and to use water without undue consumption.

Fish Preservation in Trawlers

WITH the introduction of steam-driven vessels —somewhere about the year 1870—the great development of the present long-distance, deep-sea trawling industry became possible. But the industry's present greatness is not due to steam alone. Had not the practice of stowing the catch in crushed ice been also introduced about the same time, the bringing back of fish in a saleable condition from far distant grounds would have been impossible even for large and powerful steamers unaffected by the vagaries of wind-propulsion.

In recent years many experiments have been made in an endeavour to evolve and perfect a more satisfactory method of preserving fish at sea. In spite of every effort towards improvement, however, the stowage of trawled fish in crushed ice is still the general practice, notwithstanding its very serious limitations.

The preservative effect of crushed ice is two-fold. By lowering the temperature of the fish tissues, changes due to autolysis are slowed down. This lowering of temperature also slows down the rates at which the bacteria of decay grow and multiply; but stowage in crushed ice alone cannot inhibit their activities completely.

Bacteria of decay are present on the fish when caught, but only in negligible numbers. As at present handled on board ship after capture, however, the fish become very heavily infected with these organisms. As a result of this severe infection, storage

in crushed ice will in general maintain fish in a really fresh state for not more than 6–7 days. Important researches at the Torry Research Station, Aberdeen[1], have shown that, with care, infection of the fish after capture can be so greatly reduced that they will remain fresh in crushed ice up to a maximum of 10–12 days. By greater attention to cleanliness, therefore, a marked improvement could be brought about in the quality on landing of ice-preserved fish.

Following upon its researches along these lines, the Torry laboratory has now issued a pamphlet[2] directing the attention of owners, skippers, and mates to certain points of importance which should be observed in the treatment of their catches if they are to obtain maximum returns from them.

Many of the recommendations are of a purely common-sense kind, such as minimum handling of the fish and greater attention to washing with clean water of decks, pounds, baskets and fish-room fittings. Certain additional precautions are also suggested, the most important and most practicable of which are the use of town-supply or other clean water heated to 180° F. (see below) for scrubbing all fittings, boards and baskets after the catch has been landed, and the scrubbing of the fish-room with town-water to which has been added 5 parts per 100 of 40 per cent formaldehyde. The fish-room should finally be sprayed with the same solution. At sea, and before the next catch is stored, the fish-room must be again hosed down with sea-water in order to remove all traces of the disinfectant.

While the better preservation of the catch is to be sought in greater cleanliness, attention to certain details of stowage is also recommended. It is pointed out that stowed fish should be protected so far as possible from all draughts, as these hasten the melting of the ice. The use of vegetable parchment for this purpose, at least for the more valuable species, is advocated as being remarkably effective in preventing wasteful melting caused in this way.

A noteworthy and most commendable feature of the foregoing recommendations is that they require little or no outlay of extra capital or additional running expenses, and can be immediately put into practice, with, it is claimed, marked improvement in the quality of the fish landed.

Certain other recommendations are also put forward which entail the installation of special equipment and involve more radical changes in the present normal routine on board ship. At all points where the fish come into contact with the ship or its fittings, it is suggested that heavily galvanised steel be used to replace or to cover the usual wood ; galvanised steel baskets should be substituted for wicker ones ; additional pipes and connexions should be installed on deck to facilitate more thorough washing of the fish after gutting ; and a heater is advocated for providing water at a temperature of not less than 180° F.

Although there can be little doubt of their theoretical desirability, it is not likely that these special and somewhat costly fittings will be quickly and generally installed throughout fishing fleets. But this in no way detracts from the immediate value of the other and simpler recommendations. It is to be hoped that the general distribution of these leaflets amongst them will induce deep-sea trawlermen to test out the proposals on their own vessels without any further loss of time. This result achieved, sufficiently enhanced returns will be adequate incentive to ensure the permanent and universal adoption of the improved methods. To any less practical arguments trawlermen one and all will pay but little attention. G. A. S.

[1] Food Investigation Special Report, No. 37. "The Handling and Stowage of White Fish at Sea." (London : H.M. Stationery Office.) 1*s*. 6*d*.

[2] Department of Scientific and Industrial Research : Food Investigation. Leaflet No. 3 : The Care of the Trawler's Fish. By A. Lumley. Pp. 4. (London : Department of Scientific and Industrial Research, 1933.) Free.

Annual Gathering at Rothamsted

THE annual gathering of subscribers to the Rothamsted Experimental Station, held on June 20, had, this year, a special significance and there was a record attendance. On this occasion, the title deeds of the Rothamsted Estate, which has now become the property of the Lawes Agricultural Trust, were formally handed over to the Trustees by Mr. Walter Elliot, the Minister of Agriculture. The chairman of the Trust Committee, Lord Clinton, who presided at the meeting, announced that a telegram of congratulation had been received from Lord Bledisloe, Governor-General of New Zealand, a former chairman of the Lawes Trust. Lord Clinton then briefly outlined the reasons that compelled the Committee to issue its recent public appeal for £30,000 to purchase the estate. The land on which the building stood, and the fields containing the unique long-period experiments were threatened by building developments. He paid a warm tribute to Mr. R. McDougall and the Sir Halley Stewart Trustees, who provided £20,000, and to Sir Bernard Greenwell, Bart., whose early offer of £1,000 set a standard for the numerous private subscribers and organisations. As a result, the balance was quickly obtained, and the future of Rothamsted is secure for all time.

The director, Sir John Russell, said that the interest in Rothamsted is well shown by the widespread area from which subscriptions came, and by the cosmopolitan nature of the visitors at the annual meeting. He took this as evidence that the policy of Rothamsted is on the right lines : the purpose of the Station is not to teach farmers how to farm, but to give them information that they can use in solving their varied problems on their own farms.

Mr. Elliot congratulated Rothamsted on the successful outcome of the appeal. While it is a pity that an estate, which has been for three hundred years in the possession of one family, has to change hands, it is clear that no more suitable new owners could be found than the organisation Sir John Lawes set up himself. An old tradition has been broken, but a new one has begun which will produce equally great results for agriculture and England. The work of Rothamsted will go on at its present level, for the appeal fund has provided an unmistakable vote of confidence from the agricultural community.

Prof. H. E. Armstrong, vice-chairman of the Trust Committee, thanked Mr. Elliot for his remarks, and joined with Lord Clinton in congratulating the Minister on his efforts in reorganising the agricultural industry. He said that agricultural scientific workers,

thanks to Lawes, have solved one vital problem: the production of sufficient quantity of produce. The next great task is the question of quality, for if animals and human beings were properly fed there would be little or no disease.

During the day the visitors were conducted around the farm and the laboratories. The classical experiments on grassland, wheat, and barley were inspected, and special attention was also given to recent experimental developments.

There is on the farm a number of half-bred ewes with four well-developed teats. These are being mated to a young half-bred F_2 ram, bred on the farm, also with four teats, to ascertain whether ewes with this characteristic are better mothers than those with two teats.

An important investigation on the technique of animal feeding experiments was also demonstrated. Its purpose is to reduce the variations hitherto associated with this type of experiment, by applying the modern statistical methods of design already worked out at Rothamsted for experiments on crops. An interesting feature of this experiment, which is devoted to pig-feeding, is that each animal is fed individually in its own trough enclosure opening off the main pen. In this way all types of rations can be distributed equally over all groups of pens, in contrast to the usual practice in which all pigs in a group are on the same ration.

The investigations on the use of electricity in farm buildings attracted much attention. Numerous farm and barn operations can conveniently be performed by electrical power, and measurements are taken of the number of electrical units required, as compared with the amounts of fuel consumed by internal combustion engines doing the same work. This information is not, at present, available for the farmer who contemplates employing electrical power, and it is the purpose of the experiments at Rothamsted to supply it.

In the afternoon the work of the laboratories was inspected, and demonstrations were given of certain investigations which have reached the stage of practical development. Among these were the inoculation of lucerne; the purification of effluents from sugar beet and milk factories; methods of measuring the properties of flour-doughs; and a number of problems associated with bee-keeping and the grading of honey.

University and Educational Intelligence

GLASGOW.—The honorary degree of LL.D. has been conferred on the following, among others: W. R. Cunningham, University librarian and keeper of the Hunterian books and manuscripts; Prof. H. M. Macdonald, professor of mathematics, University of Aberdeen; Sir Harry McGowan, chairman of Imperial Chemical Industries, London; Prof. Frederick Soddy, professor of inorganic and physical chemistry, University of Oxford.

LIVERPOOL.—Dr. G. C. McVittie has been appointed to a lectureship in applied mathematics rendered vacant by the election of Mr. R. O. Street to the chair of mathematics in the Royal Technical College, Glasgow. Dr. Mary W. Parke has been appointed algologist at the Marine Biological Station, Port Erin, for the coming year, and Mr. R. G. Bruce naturalist-in-charge of the Station.

LONDON.—Prof. L. N. G. Filon has been re-elected vice-chancellor for the year 1934–35, and Dr. George Senter, principal of Birkbeck College, deputy vice-chancellor for the same period.

On the occasion of the celebration of Foundation Day 1934, the honorary degree of D.Sc. will be conferred on Prof. Karl Pearson and the honorary degree of D.Litt. on Dr. A. F. Pollard.

A university postgraduate travelling studentship of the value of £275 has been awarded for one year to Arthur Herbert Cook (Imperial College—Royal College of Science). Mr. Cook proposes to carry out chemical research in the Universities of Zurich and Heidelberg.

OXFORD.—In presenting Prof. A. V. Hill for the honorary degree of D.Sc. at the Encaenia held on June 20, the Public Orator, Mr. Cyril Bailey, spoke of his singular devotion to the study of physiology, and especially of his most accurate investigations of the conditions of muscular activity. As a Balliol man he regretted that Prof. Hill, his fellow-scholar at Blundell's, had preferred to go to Cambridge; "but sometimes gifts were to be given to the Danai". In conferring the degree, the Chancellor, Lord Halifax, addressed Prof. Hill as "most exact of men, who have dealt so acutely with physiology, that we account scarcely any of the secrets of the human frame as foreign to you".

Among the other honorary degrees conferred was that of D.C.L. on Sir Henry Miers.

A SCOTTISH National Conference on the "Place of Biology in Education" has been arranged by the British Social Hygiene Council to be held in City Chambers, Edinburgh, on October 19. The president will be the Right Hon. Sir Godfrey Collins, Secretary of State for Scotland, and among the speakers will be some of the leading Scottish biologists, who will deal with biology in the school and university and in its relation to man. Further information can be obtained from the Secretary-General, British Social Hygiene Council, Carteret House, Carteret Street, Westminster, S.W.1.

Science News a Century Ago

Colonisation of South Australia

The colonisation of Australia owed much to the writings of Edward Gibbon Wakefield (1796–1862) who, it has been said, "brought to the subject for the first time the mind of a philosopher and statesman, equally fitted for framing a comprehensive theory and for directing its working in practical detail". Wakefield's book, "Letters from Sydney", published in 1829, was followed by the formation in 1830 of the National Colonisation Society, while his book, "England and America", 1833, which contained a chapter on the art of colonisation, was followed by the inauguration of a company with the title of the South Australian Association. On July 1, 1834, this company held a public meeting in Exeter Hall, at which its aims were set forth, and soon afterwards the matter engaged the attention of Parliament. Later in 1834, the Colonisation Commissioners for South Australia were appointed and under their auspices the first settlers left England in 1836, arriving in Australia on December 26, Capt. (afterwards Rear-Admiral Sir John) Hindmarsh being the first Governor of the Colony.

Scott Russell's Steam Carriage

John Scott Russell (1808–82), the famous naval architect and shipbuilder, who with Brunel constructed the *Great Eastern*, was a student at the Universities of Glasgow, St. Andrews and Edinburgh, and when Sir John Leslie, professor of natural philosophy at Edinburgh, died in 1832, he was selected to fill his place temporarily. About this time he turned his attention to steam vehicles and on July 2, 1834, took out a patent. That year no fewer than six of his carriages were at work in Scotland. The subject, however, was not pursued and he then turned his attention to the study of waves and the resistance and construction of ships, for which he is remembered to-day.

Prof. Hausmann of Göttingen

On July 5, 1834, Prof. Johann Friedrich Hausmann, the German mineralogist and geologist who occupied a chair at Göttingen, sent a letter to the editor of the *Philosophical Magazine* disclaiming a statement that he had been a pupil of Mohs, whom indeed he did not know, though he esteemed him highly. Hausmann, who was born in Hanover in 1782, studied at Brunswick under Knoch and then at Göttingen under Blumenbach. From 1803 until 1806 he was engaged in the mines of Brunswick, in 1809 was inspector-general of mines in Westphalia, and was appointed to the chair at Göttingen in 1811. He made many excursions into Sweden, Norway, France, Holland and England and wrote many works. "Already in 1803, and therefore earlier than Mohs," he said in his letter, "I became a mineralogical writer, building my system on peculiar views belonging to no other school. I was the first who appeared as opponent to Werner; assisted in the spreading of Haüy's theory; and published my first system in 1809, founded on chemical composition and external character. I gave in 1813 a complete Handbuch on Mineralogy. . . ."

Newton's House

The *Mechanics' Magazine* of July 5, 1834, contained the following note: "We are glad to observe from the newspapers that Mr. Thomas Steele has revived his laudable project for preserving the house and observatory of the illustrious Newton [in St. Martin's Street, Leicester Square] by enclosing it in a monumental building with a lofty dome—in the same manner as the primitive chapel founded by St. Francis, at Assisi in Italy, is enclosed by the great Franciscan church of more modern times." Steele's project never came to anything; the house stood until 1913, and its site is now occupied by a fine building, the Westminster Public Library, on which is a tablet referring to Newton.

Sir Gilbert Blane, F.R.S.

A correspondent has pointed out, in connexion with the paragraph under this title in NATURE of June 23, p. 957, that Sir Gilbert Blane established in 1830, with the sanction of the Admiralty, a fund for the "encouragement of Naval Medical Science". This fund, which is vested in the Royal College of Surgeons, is employed for providing an annual Gold Medal for the medical officer who obtains the highest place in the examination for promotion to Surgeon Commander.

Societies and Academies

LONDON

Royal Society, June 21. P. D. F. MURRAY: Uncoordinated contractions caused by egg-white and by alterations in the cation ratio of the medium, in the heart of the chick embryo *in vitro*. If suitable fragments of chick embryos in primitive streak stages be explanted into the egg-white of four- or five-day eggs there occurs a differentiation of contracting cardiac tissue. The contractions differ from those seen in similar explants in plasma in lacking co-ordination, each cell contracting independently of the others. When entire hearts of 2½-day embryos are similarly explanted into egg-white, the co-ordinate beat always stops, and is usually replaced by uncoordinated contractions. This anarchic activity is given the provisional name of 'twitter'. It is caused by the high potassium content, aided by the lower, but still rather high calcium content, and by the low content of sodium. K. MELLANBY: The site of loss of water from insects. An apparatus is described which will measure the amount of water evaporated from an insect, and is accurate to a hundredth of a milligram. The rate of loss of water from three species of insects was determined: (1) in dry air, (2) in air to which 5 per cent of carbon dioxide had been added, and (3) in a mixture containing less than 1 per cent of oxygen. In insects with a spiracle-closing mechanism the rate of loss of water under (1) and (2) (which caused them to keep their spiracles open permanently) was 2–7 times that in dry air. In insects which could not close their spiracles, the rate of loss of water was practically the same under all conditions. 2 per cent carbon dioxide is sufficient to cause insects to keep their spiracles permanently open; oxygen has to be reduced below 1 per cent to have the same effect. From these experiments it appears that practically all the water evaporated is lost by way of the tracheal system, and that a thin integument may be just as watertight as one which is highly 'sclerotised'. P. A. BUXTON and D. J. LEWIS: Climate and tsetse flies: laboratory studies upon *Glossina submorsitans* and *tachinoides*. It is already known that the number of tsetse flies which can be captured under standard conditions rises and falls with the season, and that many of the species are sharply limited to particular types of vegetation. It is thought that the limits are climatic. Observations made under controlled conditions in the laboratory support those made in the field; taken together, the results should tend to give precision to the control of *Glossina*, which will probably be achieved by altering the vegetation and with it the micro-climate.

PARIS

Academy of Sciences, May 7 (*C.R.*, 198, 1645–1728). A. COTTON and TSAÏ BELLING: The use, with the large Bellevue electromagnet, of a supplementary coil for experiments in magneto-optics where the pencil is normal to the lines of force. Details of construction and measurements of the fields obtained. C. MATIGNON and M. SÉON: The preparation of ethylene and its homologues by cracking heptane in the presence of steam. Heptane and steam, heated to about 900° C., give gas mixtures rich in ethylene and its higher homologues: practically no carbon monoxide is formed. E. L. BOUVIER: New considerations on the African saturnites. JEAN BAPTISTE

SENDERENS : The action of sulphuric acid, cold or at a moderate temperature, on aromatic acids and esters. Aromatic acids in which the carboxyl group is directly united to the nucleus are not sulphonated either at the ordinary temperature or at 80° C. Aromatic acids of the type of phenylacetic acid give sulphonic acids in the cold and at 80° C. LUCIEN DANIEL : The action of repeated grafting carried out on the descendants of absinthe grafted on *Chrysanthemum frutescens*. PAUL LÉVY : Complement to the study of the *V* and *W* spaces. O. LOVETT : Certain skew curves generalising conics. M. SYPTÁK : The hyper-circumferences and hyperhelices generalised in Euclidian spaces of p dimensions. AL. PANTAZI : Conjugated stratifiable quadruples. P. THULLEN : The essential singularities of analytical functions of several complex variables. N. LUSIN : The decomposition of ensembles. J. BERNAMONT and M. LÉVY : The properties of mountings with counter-reaction. MLLE. M. QUINTIN : The influence of gases on the unilateral conductivity of the silicon-carbon couple. The nature and pressure of the gas exert an influence on the electromotive force of silicon-carbon rectifiers. MME. LINA GUASTALLA : The process of oxido-reduction at the level of a membrane interposed in a cupric solution in the course of electrolysis. N. THON : The nature of electrode capacity in alternating current. AUGUSTE PICCARD : The constitution of cosmic rays. A discussion of the corpuscular and electromagnetic theories of cosmic rays, and an attempt to reconcile the two views. A. NAHERNIAC : The study of a characteristic band of the OH function in the near infra-red (about 0·96μ). A comparison of the bands produced in the liquid and vapour states, and of the differences between the bands for primary, secondary and tertiary alcohols. MAURICE CURIE and S. TAKVORIAN : The fractionation of actinium in the presence of rare earths. GEORGES FOURETIER : The measurement of the concentrations during the photographic recording of chemical reactions. HENRI MOUREU and PAUL ROCQUET : The transformation of phosphorus pentanitride into phosphorus mononitride. The nitride P_3N_5, heated in a vacuum at 700° C., gives off one molecule of nitrogen leaving the nitride PN. MME. P. RUMPF : The formation of perchromates in solution. The view of Schwarz and Giese, that the blue perchromate corresponds to the formation of the peranhydride CrO_5, is confirmed by a physico-chemical method. PIERRE SÜE : Study of the action of sodium carbonate on niobium pentoxide. G. DUPONT, W. ZACHAREWICZ and R. DULOU : The synthesis of myrtenol and myrtenal. MLLE. VERA PARASKOVA : The action of ethylmagnesium bromide on sebacic bis-diethylamide. MLLE. M. VEILER : An abnormal reaction of hypochlorous acid on dimethylpentenol. A. LEPAPE, L. MORET and G. SCHNEIDER : The mineralisation of the thermal waters of Aix-les-Bains (Savoy), and its geological signification. Study of the helium-argon ratio in the gases from nine springs. From the data given it is impossible that the hot springs of Aix-les-Bains could have acquired their mineral content from Triassic strata. ARMAND KREMPF : The maregraphic inscription of the cycles of retrogradation of the nodes of the moon by certain reef-making corals. PAUL CHAUCHARD : Some physicochemical characteristics of the water of the bay of Villefranche. JEAN LUGEON : Polar atmospherics. C. L. ALEXANIAN : The establishment of the chart of anomalies of the vertical component of the earth's magnetic field in the Vosges. MME. ELISABETH DAVID-SYLVAIN : The large Foraminifera of the Visso (Central Apennines) synclinal. W. DRABOVITCH and A. and B. CHAUCHARD : Conditioned reflexes and chronaxy. E. FISCHER-PIETTE : The vertical distribution of the organisms fixed in the zone of fluctuations of the sea. JELLINEK : The rôle of the structure of the tissues in their heating by short waves. A. and R. SARTORY, J. MEYER and J. CUENI : The lipido-protein equilibrium in the serum of patients attacked by skin affections or lipemic troubles.

LENINGRAD

Academy of Sciences (*Comptes rendus*, No. 6). I. VINOGRADOV : New theorems on the distribution of quadratic residues. A. N. KOLMOGOROV : Convergence of series of orthogonal polynomes. S. G. MICHLIN : Reduction of fundamental problems of the theory of elasticity to an integral equation of Fredholm. V. GOGOLADZE : The general problem of the integration of a generalised wave equation with variable coefficients. G. K. PUTKOV : A proof of the principal property of the canonical distribution for any given aggregate. S. ROGINSKIJ and A. SHECHTER : The recombination of oxygen and hydrogen atoms on metallic surfaces. The process of recombination includes a stage involving an energy of activation of 2,000 cal. ; some of the experimental results disagree with the Bonhœffer series. At temperatures of 700° C., practically every atom that strikes a platinum or palladium filament recombines and gives its energy to the filament ; the heating of filaments can, therefore, be used for absolute measurements of the concentration of atoms. I. KNUNJANZ, G. CHELINZEV and E. OSETROVA : A new synthesis of acetopropyl alcohol. An easy method was found in the reaction of ethylene oxide with the sodium salt of aceto-acetic ester in a solution of absolute alcohol. N. DEMJANOV and A. IVANOV : The action of N_2O_3 on allene and on dimethylbutadiene (diisopropenyl). Both substances with N_2O_3 in ether solution produce nitrosites of the composition $C_3H_4N_2O_3$ and $C_6H_{10}N_2O_3$, from which a diamine of dimethylbutadiene, $C_6H_{10}(NH_2)_2$ was obtained. I. N. NAZAROV : On the metall ketyls of the aliphatic-aromatic series. The α-branched alkyls, particularly the tertiary ones, are able to increase the dissociation, and this ability depends on the degree of their branching and the molecular weight. P. BUDNIKOV : The reduction of sodium sulphate to sodium sulphide. B. MOROZOV : The stimulating action of embryonic extracts and of tissues on regeneration in Amphibia. Both the regeneration of the dorsal fin and the general growth of tadpoles and axolotls was very strongly stimulated by feeding them with powdered human embryo, one and a half or two months old. B. BARCINSKIJ : On the germination of the seeds of *Orobanche cumana*. The seeds can germinate in distilled water, but the process is greatly stimulated by the cellular content of the root of the host plant (sunflower). The introduction of an extract from the roots into the soil induces the seeds of the parasite to germinate, so that this may be used as a method of control. V. POSPELOV : Imaginal diapause and sterility of butterflies. A symbiotic fungus *Endomyces*, living in the fat body of certain moths and accumulating reserve products, can, under certain conditions, attain parasitic status and prevent the development of the ovaries. S. CHERNOV : On the systematics and distribution of *Agkistrodon* (Ophidia) in the Soviet Union. Diagnoses and notes on the distribution of four sub-species of *A. halys*, Pall., and

of *A. blomhoffii ussuriensis*, Emel. E. P. Slastenenko: A new blennoid fish, *Blennius knipowitschi*, sp.n., from the Black Sea.

ROME

Royal National Academy of the Lincei, November 19. S. Pincherle: Linear operators and factorial coefficients. U. Cisotti: Differential deductions from the definition of reciprocal vectors: geometrical applications (3). A. Bemporad: Stellar currents about R. A. $16^h + 52°$ Decl. Q. Majorana: Experiments on metallic photo-resistance at high frequency. Further experiments confirm the view that light exerts a direct action on the electrical resistance of metallic laminæ. This action is not manifested in its entirety with the promptitude characteristic of the classical photoelectric phenomenon, there being a difference in phase between the light and the resistance which is sometimes less than is required by the theory of the propagation of heat. G. Ascoli: Conditions for the validity of Taylor's abbreviated formula. E. Fubini Ghiron: A unicity theorem for the equation

$$\frac{d^4u}{dx^4} + \frac{d^2u}{dx^2} + \frac{d^2u}{dt^2} = 0.$$

B. Segre: Geometric-functional determination of groups of covariant points, relative to a linear system ∞^3 of curves on an algebraic surface. Natalie Rein: Qualitative characteristics in the restricted problem of three bodies in a gravitating medium. A. Colacevich: The orbit of the spectroscopic double τ Persei. A new orbit, appreciably different from that calculated from the Lick Observatory observations alone, is now calculated from all the observational data available. F. P. Mazza and C. Zummo: The liver dehydrogenase of the higher fatty acids (2). Addition of a fatty acid, either saturated (stearic) or unsaturated (oleic), increases the consumption of oxygen by the liver by 85 or 82 per cent. The two acids are thus oxidised equally well by the liver, which must, therefore, contain a complex system effecting the oxidation. Of this system, the dehydrogenase recently described by Mazza and Stolfi forms one of the components, namely, that which passes into the aqueous liver extract and is most persistent. G. R. Levi and M. Tabet: X-ray examination of electrolytic silver deposits. With bright electrolytic silver deposits obtained from silver bromide in baths rich in sodium thiosulphate, the form of the particles is, with a high degree of approximation, isodiometric. Such deposits are, therefore, widely different from those of chromium, in which the brilliancy of the deposits is connected with the flatness of the granules. With the silver deposits, the direction of growth is perpendicular to the octahedral face.

Forthcoming Events

Friday, July 6

Geologists' Association, at 7.30.—(in the Architectural Theatre, University College, Gower Street, W.C.1).—Sir Arthur Smith Woodward: "Some Recent Studies of Fossil Vertebrate Animals in North America".

Museums Association, July 2–6. Annual Conference to be held at Bristol.

Dr. Cyril Fox: Presidential Address.

Discussion: "Folk Museums", to be opened by Dr. R. E. M. Wheeler.

Dr. F. J. North: "Maps in the Museum".

Dr. A. E. Trueman: "Science and the Public Museum".

International Ornithological Congress, July 2–7. To be held at Oxford.

Fourth International Congress for Applied Mechanics, July 3–9. To be held at Cambridge.

Official Publications Received

GREAT BRITAIN AND IRELAND

Society of Dyers and Colourists. The Jubilee Issue of the Journal of the Society of Dyers and Colourists, 1884–1934. Edited by Dr. F. M. Rowe and E. Clayton. Pp. xii+228+xxxv. (Bradford.) To Junior Members, 5*s.*; Members, 12*s.* 6*d.*; non-Members, 25*s.*

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1570 (I.C.E. 884, 951): Comparative Engine Tests with Petrol and Butane. By P. H. Stokes and F. G. Code Holland. Pp. 66+28 plates. 4*s.* net. No. 1578 (Spin. 159 and 175): Modern Spinning Tests of an Interceptor Fighter. By A. V. Stephens and R. H. Francis. Pp. 17+2 plates. 1*s.* net. No. 1579 (T. 3456): Continuous Rotation Balance for Measurement of Yawing and Rolling Moments in a Spin. By P. H. Allwork. Pp. 6+3 plates. 9*d.* net. (London: H.M. Stationery Office.)

The National Physical Laboratory: Metrology Department. Tests on Volumetric Glassware. Pp. 34. (Teddington: National Physical Laboratory.) Free.

OTHER COUNTRIES

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 79: The "Lucerne Flea" *Smynthurus viridis* L. (Collembola) in Australia. By Dr. J. Davidson. Pp. 66+5 plates. (Melbourne: Government Printer.)

Ontario Research Foundation. Report for the Year 1933. Pp. 33. (Toronto: King's Printer.)

Contribution from the Department of Botany, University of Nebraska. No. 82: The Prairie. By J. E. Weaver and T. J. Fitzpatrick. (Reprinted from Ecological Monographs, 4, April.) Pp. 109–295. (Lincoln, Nebr.: University of Nebraska.)

Allahabad University Studies. Vol. 10 (Arts and Science). Pp. iv+375+3 plates. (Allahabad: The University.) 7.8 rupees.

Education, India. Progress of Education in India, 1927–32. By Sir George Anderson. (Tenth Quinquennial Review, Vol. 1.) Pp. iv+273. (Delhi: Manager of Publications.) 2.14 rupees; 5*s.*

Koninklijk Nederlandsch Meteorologisch Instituut. No. 102: Mededeelingen en Verhandelingen. 35: Oppervlaktetemperatuur in het Noordwestlijk gedeelte van den Atlantischen Oceaan (Surface Temperature in the Northwestern Part of the Atlantic Ocean). By P. M. van Riel. Pp. 92+8 plates. 1.70 fl. No. 106a: Ergebnisse Aerologischer Beobachtungen, 21, 1932. Pp. iv+38+4 plates. 1.50 fl. No. 106a: Ergebnisse Aerologischer Beobachtungen, 21a: Aerologische Beobachtungen und Terminbeobachtungen in Reykjavik während des Internationalen Polarjahres, 1932–1933. Pp. xiii+27+8 plates. 1.50 fl. No. 108: Seismische Registrierungen in De Bilt, 19, 1931. Pp. viii+52. 0.70 fl. ('s Gravenhage: Algemeene Landsdrukkerij.)

Annuaire de l'Académie Royale de Belgique, 1934-C. Pp. 264+3 plates. (Bruxelles: Maurice Lamertin.)

Canada: Department of Mines: Mines Branch. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories) 1932. (No. 736.) Pp. iv+287+2 plates. (Ottawa: King's Printer.)

Canada: Department of Mines: Geological Survey. Memoir 171: Geology and Ore Deposits of Copper Mountain, British Columbia. By V. Dolmage. (No. 2344.) Pp. ii+69. 25 cents. Summary Report 1933, Part A. (No. 2350.) Pp. 82. 25 cents. Summary Report 1933, Part C. (No. 2347.) Pp. 44. 25 cents. (Ottawa: King's Printer.)

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Mémoire No. 50: Bryozoaires oligocènes de la Belgique conservés au Musée Royal d'Histoire Naturelle de Belgique. Par F. Canu et R. S. Bassler. Pp. 26+4 plates. Mémoire No. 51: La faune des grès et schistes de Solières (Siegenien Moyen). Par Eug. Maillieux. Pp. 90+2 plates. Mémoire No. 56: Revision du genre Mallomonas Perty (1851) incl. pseudo-Mallomonas Chodat (1920). Par Dr. W. Conrad. Pp. 82. Mémoire No. 57: Les neuroptéridées des bassins Houillers Belges (Première partie). Par F. Stockmans. Pp. 62+16 plates. Mémoire No. 58: The Freeliving Marine Nemas of the Belgian Coast, 2, with General Remarks on the Structure and the System of Nemas. By L. A. De Coninck and J. H. Schuurmans Stekhoven, Jr. Pp. 163. (Bruxelles.)

University of California Publications in American Archaeology and Ethnology. Vol. 35, Nos. 1 and 2: Yurok Marriages, by T. T. Waterman and A. L. Kroeber; Yurok and neighbouring Kin Systems, by A. L. Kroeber. Pp. 22. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 25 cents.

CATALOGUES

The Beck Projectograph. Pp. 12. (London: R. and J. Beck, Ltd.)

New and Secondhand Books on History through the Ages. (Catalogue No. 572.) Pp. 80. (London: Francis Edwards, Ltd.)

A Dangerous Temperature. Pp. 4. Keep it Running. Pp. 4. (London: Sternol, Ltd.)

Scientific Apparatus: Laboratory Equipment and Apparatus for Mensuration, Mechanics, Sound, Heat, Light, Electricity, Microscopy, Technical Testing, Chemistry, New and Improved Apparatus in the Microid Physical Series, Griffex A.R. Chemicals, Technical Books. (Catalogue No. 50L). Pp. viii+954. (London: Griffin and Tatlock, Ltd.)