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Science in Parliament

THAT there should be some machinery for the purpose of establishing a connecting link between Parliament and science is a proposition to which much lip-service has been paid, but, until recently, little more than that. Much might be written to demonstrate the desirability of such liaison. The effort would only amount to pushing an open door ; the outlook for achievement would be more promising if that door were *not* open. To have aspirations accepted without their translation into action is a far less healthy situation than to encounter a virile opposition which engenders conflict. An unchallenged ideal which is not translated into action only finds an inglorious resting place in 'no man's land'.

Under any democratic constitution, scientific workers cannot hope to convince politicians that they control enough votes in a constituency to be able to influence representation in Parliament. Votes dominate the atmosphere in which politicians live and have their being ; they are the politicians' oxygen. Roughly speaking, the electorate of the United Kingdom is thirty millions. At a liberal estimate the workers in pure and applied science in the United Kingdom number thirty thousand—or one thousandth part of the whole. It has been said that under a democracy heads are counted rather than what is in them ; and the late Augustine Birrell once remarked "Minorities must suffer : 'tis the badge of their tribe". Nevertheless the sufferings of minorities frequently prove to be their salvation. Sufferings beget clamour ; clamour begets attention ; and attention precedes achievement. But the clamorous must first of all know what they want, and, above all, speak with a united voice. Having mastered that fact, the world is your oyster—be you a majority or a minority.

In recent months it has been suggested on several occasions that scientific workers and scientific methods might be usefully employed in the construction of schemes for the national well-being. At the Leicester meeting of the British Association in September, the idea of establishing a connecting link between science and Parliament found support, and Sir Frederick Gowland Hopkins in his presidential address, as well as in his speech at the anniversary dinner of the Royal Society, gave strong approval to the movement for promoting closer contact between science and social problems. Some time before these views had been

publicly expressed, the British Science Guild and the Association of Scientific Workers had taken definite steps towards the project of establishing a Parliamentary Science Committee. With the support of these two bodies, the Royal Institute of British Architects, the Institution of Professional Civil Servants, the Society of Engineers, the Institution of Mechanical Engineers, the Institute of Metals, the Institution of Naval Architects, the Joint Council of Qualified Opticians, the Oil and Colour Chemists' Association, the Pharmaceutical Society of Great Britain, the Institute of Physics, and the South Eastern Union of Scientific Societies, the Parliamentary Science Committee has become a corporate entity on strictly non-party lines. Now that the birth-pangs are a matter of past history, there is little doubt that other scientific organisations will desire to be represented in the important and urgent work to be done.

It may not be out of place here to mention a few of the aims and aspirations of this Parliamentary Science Committee. It is proposed to promote discussions in both Houses of Parliament on scientific matters in their application to economic policy and national well-being; to arrange periodical addresses by scientific authorities to the chief Parliamentary committees and groups; to consider Bills before Parliament which involve the application of scientific method; and to urge the proper representation of science on public committees—departmental and otherwise. In the very forefront of the programme will be the modernisation of the system of financing scientific research, with the view of ensuring that State aid to science should either take the form of block grants or outright endowment. It is felt that the present system of fluctuating annual grants alternating between foresighted vision and nervous gusts of parsimony must be relegated to the limbo of oblivion if wise and prudent progress is to characterise national policy. Pressure will be exerted to secure that all scientific and technical departments in the public service, and all work involving scientific knowledge, must be under the direct control of persons of adequate scientific attainments, and that the highest appointments in the public service shall be open to scientific and technical men who possess the necessary administrative ability. It may be said that these are aspirations; but, although the Parliamentary Science Committee is only newly created, it has already given a taste of its quality in compiling from "Hansard" and other sources a summary of all scientific matters dealt with in Parliament during the 1932–33 session, completely indexed. This compilation is entitled "Science in Parliament", and in future it will be issued to subscribers monthly.

Before long, the Committee is likely to have referred to it the report of the Joint Committee of the British Science Guild and the Association of Scientific Workers on the financing of industrial research. The Joint Committee is actively engaged in collating the facts, and in considering the formulation of a desirable future policy. When the task is completed it will then become the function of the Parliamentary Science Committee to persuade Parliament—and Parliament's hydra-headed master, the electorate—of the wisdom of the policy adumbrated. This task will call for all the energy of which the young body is possessed. Nevertheless, it is possible of achievement; and the same cannot be said of the aspirations of all newly-formed bodies. It must be emphasised that the propaganda of the new Committee has to be directed not only to the Parliamentarians, but also to the general public. Possibly it is more important to convince the public than it is to convince the Parliamentarians, for the convictions of the latter are particularly fluid once Demos has made up his—and her—mind.

A start having been made in forging an effective connecting link between science and Parliament, it only remains to emphasise the paramount importance of science speaking with one voice and presenting an unbroken front. So long as Parliamentary committees of scientific bodies work as isolated units, they are regarded with more or less derision by the politicians, who have a very shrewd idea that these bodies represent very limited constituencies. But a united Parliamentary Science Committee, supported by many eminent bodies, each representing in the aggregate thousands of members, *has* perforce to be treated with some show of respect. It is imperative, therefore, that the largest possible number of scientific bodies should be represented upon the Parliamentary Science Committee in order to give it the necessary strength to make it the spear-head of science as a whole, and a worthy co-partner with our rulers at Westminster.

The Royal Society is perhaps in a different position from other scientific and technical societies, as it has almost a semi-official relation to the State through the administration of the

Government grants for publication and scientific investigation, and is often consulted upon scientific matters of national importance. The British Association may also hold the view that, as its sections cover all the chief branches of science, its relation to the Parliamentary Science Committee would be different from that of societies concerned only with particular fields of scientific work. Sir Frederick Gowland Hopkins, who is president of both the Royal Society and the British Association, has shown in no uncertain way that he is strongly in favour of bringing scientific methods into the consideration of social affairs, and the Parliamentary Science Committee is a practical—and practicable—way of achieving this end. Whatever actions the Royal Society and the British Association may take, it is to be hoped that they will assist in the linking up of scientific and technical societies which is the aim of the Committee, so that, when action is necessary, Parliament may be faced with the unity which betokens strength, rather than with that disunity which is regarded as the inevitable sign of weakness and inefficiency.

When the organising committees of the various sections of the British Association meet on January 5 to decide upon their programme for the meeting in Aberdeen next September, they will have before them a memorandum from the Council suggesting that papers, discussions, or symposia should be included bearing upon the relations between the advance of science and the life of the community. As the result of the lead given by the Council in this memorandum, much valuable material is likely to be brought together for consideration and co-ordination. The Association is to be congratulated upon adopting a policy urged upon it thirty years ago by Sir Norman Lockyer, and the neglect of which led him to found the British Science Guild "to promote the application of scientific methods and results to social problems and public affairs". It may confidently be anticipated that the inquiry now instituted by the Council, through the organising committees of the Sections, will make the Aberdeen meeting one of the most notable in the history of the Association. Such an analysis of the scientific factors which affect human welfare and economic life should be illuminating and afford profitable guidance for the future, but if it is to influence our legislature, the best means of promoting this end will be through such a Parliamentary Science Committee as has now been established.

Mass-Spectra and Isotopes

Mass-Spectra and Isotopes. By Dr. F. W. Aston. Pp. xii+248+8 plates. (London: Edward Arnold and Co., 1933.) 15*s*. net.

THE phenomenon called 'autocatalysis' by the chemists is most conspicuously exemplified by the way in which natural sciences develop. A single discovery often leads to a rapid advance in scientific knowledge, each result becoming a nucleus of further progress. The man of science, although fortunate to live in such an illuminating epoch of scientific progress, has the uneasy feeling that he may not be able to keep pace with such gigantic developments. Occasionally he is bewildered by the rapidity of the advance in scientific knowledge. Even if he concentrates on one special field, the development may be so rapid, the papers published so numerous, that he has difficulty in keeping the pace.

It is, therefore, not the lack of admiration at the amazing progress, but rather their shortcoming of being unable to follow its trend, that makes not a few scientific workers secretly wish for a form of disarmament in the field of publication. A few men of science are even so bold as to advocate openly such ideas. Without slackening down the rapid development of science or decreasing the number of papers published, there exists another solution to this state of affairs; namely, the publication of books dealing fully and conscientiously with the field in question, emphasising the main points and leaving aside details of lesser interest. Thus the fellow-worker would be fed on sound dietetic lines and not on those of the boa-constrictor. Dr. Aston is to be congratulated on his admirable way of dealing with his subject on the above-mentioned lines; no one is so qualified as he to do this, since practically all of the work on isotopes has been done by him.

Our knowledge of the nature of isotopes and the numerous fundamental conclusions to which this knowledge leads, becomes a chapter of utmost importance for the chemist and physicist alike. Aston's "Mass-Spectra and Isotopes" covers 250 pages containing all the important information on this many-sided subject, and is written with an admirable lucidity. It is interesting to compare the present edition with the previous one published in 1924. In that second edition, 101 atomic species were enumerated whilst the number of known isotopes has increased since to 190, in spite of the fact that the interest of mass-spectroscopic

research was not so much focused on the discovery of new isotopes as on the accuracy of the determination of the isotopic mass. The latter is one of the most fundamental magnitudes of nuclear physics, its knowledge being of especially great importance in connexion with the transmutation of the elements. The great advance in the knowledge of the accurate isotopic mass is due to further ingenious improvements in the spectrographs used, and in a still higher degree to more efficient methods in the production of the positive rays.

Besides a description of apparatus constructed by the author, the book contains also a detailed account of the arrangement with which Bainbridge obtained his important results. In most of the cases which were simultaneously investigated by Aston and Bainbridge, the same results were obtained. The importance of this coincidence is enhanced by the fact that the apparatus used by them differed so fundamentally in principle, thus making the chance of both instruments producing the same experimental error a very remote one.

The great progress made in the photometry of mass-spectra makes it possible to determine the relative abundance of isotopes in a complex element, a magnitude of fundamental importance, with remarkable accuracy. The knowledge of the relative abundance of the isotopes, coupled with that of the isotopic weight, gives the value of the atomic weight in question.

As a method of determination of chemical atomic weights, photometry of mass-spectra is clearly at its worst for light elements, for its error will be roughly a fixed fraction of the unit of mass. In addition, with isotopes, as in lithium, so different in mass, it is unsafe to conclude that particles of the same energy will affect the photographic plate equally. In the region of mercury, the three sources of uncertainty due to packing fraction, change of scale and relative abundance have about the same value, each about 1 part in 10,000. Here the method will compare favourably with the best chemical ones and has obvious advantages from the fact that, in general, purity is of no importance, and the quantity of material required is usually only a fraction of a milligram.

The great importance of the possibility of checking the values of the atomic weights arrived at by chemical methods by means of the mass-spectrograph is illustrated by the example of hydrogen. When trying to eliminate the discrepancy between the values obtained by the two different methods, Birge and Menzel suggested that hydrogen contains heavier isotopes. Research carried out by Urey and his collaborators led to the discovery of the isotope of mass 2. While the above suggestion led to this most important discovery, the first estimates of abundance did not remove the discrepancy between the chemical and physical atomic weights of hydrogen. However, since Dr. Aston's book was revised, further work has been done which indicates a higher percentage of the heavy isotope and so brings the two figures into good agreement.

Since the atomic number depends only on the net charge in the nucleus, there is no arithmetical reason why an element should not have any number of possible isotopes. Dr. Aston, however, inclines to the view that the number of isotopes of an element, and their range of mass number, have definite limits, and he emphasises the remarkable rule that the elements of odd atomic number never have more than two isotopes. An instructive diagram showing the relative number of atoms of various species present on the earth, two chapters on the isotopic effect in optical spectra and one on the separation of isotopes close a most fascinating volume. G. HEVESY.

Voodoo and Obeah

Voodoos and Obeahs: Phases of West India Witchcraft. By Dr. Joseph J. Williams. Third printing. Pp. xx+257. (London: George Allen and Unwin, Ltd., 1933.) 15*s.* net.

THE study of the superstitions of the American Negro owed much to the interest aroused by the Uncle Remus stories of Joel Chandler Harris; but it was the work of Mary Alicia Owen and her collection of voodoo stories from Missouri which first attracted serious attention to the darker side of these beliefs and the operative magic which they reflected. Miss Owen's account of the voodoo superstitions appeared in 1891 and her stories in 1893; but previously, in 1884, Sir Spencer St. John had published his account of the voodoo cult in Haiti. The scepticism with which that account was received spurred St. John to further investigation and an amplified account was included in the second edition of his "Hayti, or the Black Republic", which appeared in 1889. From that day voodooism, with which commonly, but erroneously, is coupled the obeah of Jamaica, has been obscured with elements of mystery and the subject of a controversy as to how far the

imputation of cannibalism and human sacrifice brought against the cult was justifiable. Educated Haitians deny its existence, except as a form of superstition and black magic, like that found among the uneducated peasantry of other countries, which has crept into Roman Catholic ritual and observance. Yet the best informed of the Haitians who have endeavoured to refute the highly coloured accounts of W. B. Seabrook in his "The Magic Isle" admit the existence of orgiastic assemblies which seem to weaken their case.

The account of the voodoo and obeah beliefs of Haiti and Jamaica, which Father Williams gives in the volume now under notice, is an attempt to examine the evidence in a dispassionate and scientific spirit. It is based in part on documentary evidence and in part on personal observation, which began so long ago as 1906, and in the course of three periods of residence covers in all six years.

Father Williams does not touch on the voodoo or hoodoo of the Negro in the southern United States. There are records of voodoo cult ceremonial observances in New Orleans exactly similar to those of Haiti. The New Orleans cult endured down to the last decade of the nineteenth century at least; but it is said to have died down after the death of the last high priestess, Marie Laveau. White people are reputed to have taken part in the orgiastic ceremonies. The cult would seem to have been introduced into Louisiana, whence it spread to other States, by slaves from Haiti, whose masters had fled to Cuba at the time of the revolution and came to the States when war broke out with Spain in 1809. Belief in hoodoo or voodoo and the voodoo man, the worker of spells and conjurations, still survives among the Negroes.

It has been maintained, as for example by W. W. Newell in 1888, that voodoo was of European origin, having been introduced into the island of Haiti by the French in the seventeenth century as a witchcraft belief, and that the name was a corruption of 'vaudois' as applied to witchcraft in France. There can, however, be little doubt that the true origin was suggested by A. B. Ellis three years later, in 1891. Ellis held that it was a form of, or a survival of, the West African cult of the snake, introduced by Ewe-speaking or Dahomean slaves at the time of the fall of the kingdom of Whydah in West Africa in 1724. 'Voodoo' he derived from *vōdu*, the Ewe term for the central cult-object as an inspirer of fear. Sir Richard Burton had previously asserted the connexion with the west coast of Africa. The view put forward by Ellis is borne out by more recent research into the character of West African belief.

The essential feature of the voodoo cult is the worship of the serpent. Its followers were a regular order with chief priest and priestess, the 'king' and 'queen', holding office for life, and an initiation ceremony. At a certain stage in the ceremonial the serpent, which was in a box, was adored, and the priestess then stood on the box and became inspired, prophesying the result of the supplications proffered by the devotees. White cocks or white goats were sacrificed. Ritual dancing and feasting followed, in the course of which the devotees exhibited all the familiar phenomena of 'possession'. That human sacrifice was offered in voodoo worship has been doubted. The human victim, the 'goat without horns', is assigned to the even more violent rite of 'Don Pedro' or 'Petro', which was introduced into Haiti by a Negro of Spanish extraction in the sixth decade of the eighteenth century. In this rite the usual victim was a pig.

The origin and history of obeah in Jamaica differ essentially from those of voodoo. The practice of obeah belongs to a people of distinct derivation, although they reached the colony at about the same time as the Negroes who brought voodoo to Haiti. The Jamaican Negroes were then known as Coromantins. They were Tshi-speaking peoples, among whom Ashantis predominated; and owing to their tendencies to rebellion, they were not allowed to be introduced into French or Spanish colonies.

Father Williams, studying the Jamaican beliefs and practices in the light of Capt. Rattray's researches in Ashanti religion, maintains that there are two strains or forms of belief, often confused, which should be distinguished, namely obeah and myalism. Further, that while obeah represents the survival of a magical anti-social cult of Ashanti, myalism, like voodoo, had been an official tribal religion, which assimilated itself to obeah and its secret rites when the legislature, becoming alive to the danger of rebellion fostered by the religious beliefs of the Negroes and alarmed by the wholesale poisoning of obeah, forbade these ceremonial assemblies. Thenceforth myalism became a secret cult like obeah and adopted the magic, or some of it, of the obeah man. The ecstatic element of myalism found expression in the more emotional

forms of Christianity ; and after the emancipation, and even down to recent times, it was responsible for much of the Negro enthusiasm in revivalism. When opportunity arose, however, myalism resumed its original function as a tribal religion hostile to anti-social magic by 'digging out', or as the modern African puts it, 'smelling out' the witch, the obeah man—at a price.

In the course of his valuable study of these two singular groups of Negro cults, Father Williams discusses the position of obeah and voodooism as they stand to-day. Although he is somewhat sceptical whether voodooism as an organised cult and ceremonial has died down so completely as some would maintain, his conclusion as to myalism and obeah is that, on the whole, "they have degenerated into a common form of witchcraft not uncommonly associated with devil worship, and even those of the blacks who belittle its general influence, in practice show a wholesome fear of the Obeah man".

Biochemistry and Morphology

Theoretische Biologie. Von Dr. Ludwig v. Bertalanffy. Band 1 : *Allgemeine Theorie, Physikochemie, Aufbau und Entwicklung des Organismus*. Pp. xii + 349. (Berlin : Gebrüder Borntraeger, 1932.) 18 gold marks.

RECOGNISING it as something new in biological literature, biologists everywhere will warmly welcome Dr. Bertalanffy's new book on theoretical biology. For unlike most writers in this field, he is not content to bring forward a heterogeneous mass of purely biological facts which call for, but do not receive, any satisfactory explanation from 'pre-Copernican' biology ; on the contrary, he realises that whatever else may be needed, all that the methods of physics and chemistry can tell us about the living being is a quite indispensable foundation for biological theory. Hence in his book we find, side by side with chapters on logic and methodology or on *Entwicklungsmechanik*, discussions of the colloidal properties of living substance, the permeability problem, or the energetics of carbon compound reactions. Such a synthesis has never before been attempted.

In the earlier sections of the book, Dr. Bertalanffy handles the most fundamental problems of biological methodology, and discusses the famous saying of Kant that in any branch of natural knowledge the amount of true science present is directly proportional to the amount of mathematics. He emphasises that if the word mathematics here is taken in its widest sense, the remark is nothing but a statement of one's conviction of the genuine *Rationalisierbarkeit* of Nature. He realises that there are strange realms in mathematics, unknown to most biologists, out of which concepts essential for the understanding of life phenomena may come, and can envisage the utilisation for biology of order-systems not involving number and quantity. We see, he says, in physics, that new groups of facts require the creation of new sorts of mathematics (compare quantum theory, matrix theory, etc.). Many biologists, on the other hand, suppose that the application of mathematics to biology means no more than the use of calculus for curve-fitting, for example, in growth, or the working out of temperature coefficients (apparently the most variable constants known). But Dr. Bertalanffy's revolutionary dictum, which should be engraved on the hearts of all his readers, runs : "Only by the closest cooperation of the theoretical physicist, the mathematician, and the mathematical logician, will the problem of the mathematisation of biology be solved."

The author's chapters on detailed subjects, such as the various theories of the permeability of the cell membrane, are clear and very free from errors. Previous writers who have treated of such subjects from the point of view of pure theoretical biology, have prowled through the literature like old-fashioned theologians making what use they can of the difficulties for Darwinism in mimicry or bird-lore, but Dr. Bertalanffy is sincerely anxious to learn from the physiologists and soberly discusses their views, from Overton to Michaelis. It is not his fault that the gulf between the highest flights of colloidal chemistry and the simplest facts in experimental morphology is so wide and so deep. But occasionally he makes a slip, and it *is* his fault when he tells us (on p. 81) that the chemical composition of a living tissue remains unaltered when it is ground in a mortar. Here he throws away in a moment something that would have helped to bridge the dreadful gulf, namely, the knowledge we are now gaining about the 'morphological' arrangement of the intra-cellular enzymes. Nor will many of his readers enjoy being told (on p. 234) that mitogenetic rays are "certainly one of the most monumental results of modern biology". On the other hand,

special praise is due to him for his unusually stimulating and valuable chapters on experimental embryology and the determination problem. The book as a whole is worthy of the widest possible circulation, and this, no doubt, it will attain.

The general outcome is not, happily, any premature 'organismic theory' of life, for the time has not yet come for conclusions. But throughout the book Dr. Bertalanffy emphasises that the old mechanism-vitalism controversies are now quite fruitless since the so much disputed 'irreducibility of biological categories' merely means, when analysed, that the configurations of matter which we call biological show a form of organisation or order not met with elsewhere. It is for us to investigate the forces involved in this organisation, the rationale of this order—not, as some thinkers wish, to accept it as axiomatic (NATURE, 131, 458, 664; 1933). The irreducibility of biological categories has nothing to do with the entry of vitalistic concepts; the laws of the nematic or smectic state are similarly 'irreducible' to the rules which hold good for common isotropic liquids. The service of vitalism in past days was that it continually directed attention to the real complexity of the phenomena; Dr. Bertalanffy has now liquidated the old firm, and performs the same service without the old obscurantism.

JOSEPH NEEDHAM.

Short Reviews

Evaporating, Condensing and Cooling Apparatus: Explanations, Formulæ and Tables for Use in Practice. By E. Hausbrand. Translated from the second revised German edition by A. C. Wright. Fifth English edition revised and enlarged by Basil Heastie. Pp. 503. (London: Ernest Benn, Ltd., 1933.) 25*s.* net.

THIS book is a new edition of a work that has become a recognised classic in the literature of chemical engineering. Heat transmission is a very wide subject, on which some of the extensive work published is exceedingly controversial, and the inquirer frequently has difficulty in finding collected and co-ordinated information. This he will find supplied with authority in the familiar "Hausbrand".

The large number of empirical formulæ and useful tables, obtained from experiments on full-scale plant, make the book valuable to the practical man faced with problems of evaporation and distillation. Not only are evaporators and condensers treated exhaustively, but considerable space is also allotted to the study of the flow and heat transmission of fluids in pipes, and to vacuum pumps. The latest edition contains an added chapter on heat exchangers in modern industrial practice, in which the new plate type is described; it also embodies some of the more recent additions to the literature.

There appear to be no serious omissions, but a brief summary of the submerged combustion process would have been an interesting addition, even if as yet its practical importance is scarcely established. Heating with hot oil is perhaps dismissed rather too briefly. The book is not a digest of the literature but is clearly the work of practical men and, as such, it is to be recommended particularly to all designers and users of evaporating plant. Students of chemical engineering will also find it a very valuable reference book.

J. H. P.

Street Traffic Flow. By Henry Watson. Pp. xii+395+13 plates. (London: Chapman and Hall, Ltd., 1933.) 31*s.* net.

THE present work includes the general characteristics of traffic flow, the influence of different types of vehicles, of different kinds of crossings, with suggestions for mitigating the effect of obstructions and improving the flow generally. It deals also with lighting signal systems, with parking, street accident statistics, accident prevention, and there are general chapters on transport management and policy, and layout of streets and cities.

A particularly valuable feature of the book is the large number of illustrations depicting all kinds of traffic under all sorts of conditions in all varieties of streets, broad and narrow, straight and winding, obstructed and clear, together with numerous diagrams to elucidate the text. The author has taken great pains to present a mass of useful and interesting information in a clear and concise style. So far as we know, there is no other book of like compass dealing with this extremely important subject, and the work should therefore prove invaluable to local authorities, transport companies, the police, and indeed to all who are in any way or in any capacity connected with the complicated intricacies of street traffic. The private motorist and other individual users of the road will also find much to interest them in these pages.

The Subject Index to Periodicals, 1932. Issued by the Library Association. Pp. x+270. (London: The Library Association, 1933.) 70*s.*

THE editor, Mr. T. Rowland Powel, and his assistants have shown remarkable energy in preparing and publishing this subject index to the periodicals issued in 1932 ten months after the end of the year. The value of an index of this kind is greatly enhanced when it can be brought out with promptitude. At the same time it would

be foolish, if not impracticable, to attempt to produce a volume indexing all that is published in 1932 and nothing published in previous years. Indeed, this volume will be found to refer to many articles which came out in 1931.

The volume contains entries of nearly 26,000 articles selected from 550 English and American, 21 French, Belgian and Swiss, 19 German and 2 Italian periodicals. Periodicals covered by certain named publications such as *Science Abstracts*, *Index Medicus*, *Engineering Index* and *Photographic Abstracts* are not indexed.

Workers in all branches of science will find this index most useful as a means of ascertaining what has been published in a given subject in the less-known periodicals. Volumes, similar to the present, have now been published for the years 1926 up to the present time. We hope the series will be continued.

What Butterfly is That? a Guide to the Butterflies of Australia. By Dr. G. A. Waterhouse. Pp. viii+291+34 plates. (Sydney: Angus and Robertson, Ltd.; London: The Australian Book Co., 1932.) 12*s.* 6*d.* net.

THE object of this book is to provide a popular guide to the butterflies of Australia. It is gratifying to find such an object attained with due regard to the scientific requirements of the subject and without sacrifice of accuracy. It describes every known species of Australian butterfly and most of them are figured (on a somewhat reduced scale) on the really excellent coloured plates that are appended. The descriptions err possibly on the side of brevity but they are intended to be used in conjunction with the plates. Short diagnoses of the larvæ and pupæ are included, so far as they are known, and many of such stages are extremely well figured in a series of half-tone plates. The book is quite a model of its kind and a great deal of information is compressed within its pages. It deserves wide circulation and is exceptional value for its modest price.

Amateur Telescope Making. Albert G. Ingalls, Editor. With Contributions by Russell W. Porter, Prof. Charles S. Hastings, Rev. William F. A. Ellison, Dr. George Ellery Hale, Clarendon Ions, John M. Pierce, A. W. Everest, John H. Hindle, Rev. Harold Nelson Cutler, Franklin B. Wright, Alan R. Kirkham, F. J. Sellers. Third edition completely revised and enlarged. Pp. xii+500. (New York: Scientific American Publishing Co., 1933.) 3 dollars.

THIS book is a mine of practical information on the arts of making, testing and adjusting telescopes. It is a composite work and, consequently, it lacks continuity. But if the reader, who is ambitious of constructing his own instrument and enjoying the fruits of his labours, will take the necessary trouble, he will easily pick out the parts applicable to his own particular needs and problems. The earlier editions have evidently encouraged a large number of amateurs to make their own telescopes, and for those who are interested in this fascinating hobby the book can be unreservedly recommended.

Gesteinsanalytisches Praktikum. Von Prof. Dr. E. Dittler. Mit einem Anhang: *Kontrolle und graphische Darstellung der Gesteinsanalysen*, von Dr. A. Köhler. Pp. viii+112. (Berlin und Leipzig: Walter de Gruyter und Co., 1933.) 4 gold marks.

THE present work deals with the quantitative analysis of rocks, mainly silicate rocks. The practical directions are clearly and systematically given, and less common elements which may be present are taken into account. Fluorine and boric acid are also included. The determination of the total rare earths forms part of the scheme, but the separation or individual determination is omitted.

The last part of the book deals very fully with the calculations and analytical control, in which the distribution of acidic and basic oxides to various mineral constituents is considered, including such graphical methods as Marchet's felspar triangle.

Qualitative Analysis. By H. S. Moodey. Pp. ix+182. (London: William Heinemann, Ltd., 1933.) 5*s.*

THIS book begins with an account of the elementary conceptions of physical chemistry which are necessary in understanding analytical operations. This part, which occupies one-third of the book, is not characterised by any very novel features and is contained in most textbooks which would presumably be used along with a laboratory manual.

The rest of the book deals with qualitative analysis, including tables of group separations, but not including the collected tests for individual radicals usually provided in books on qualitative analysis. This appears to be a defect. The instructions for the separations in the groups, on the other hand, are very complete. The book will probably be found more useful in schools than in university or analytical laboratories.

Diptera of Patagonia and South Chile: based mainly on Material in the British Museum (Natural History). Part 4: *Empididæ.* By J. E. Collin. Pp. viii+334. (London: British Museum (Natural History), 1933.) n.p.

THE British Museum (Natural History) has recently issued a further part of the series "Diptera of Patagonia and South Chile" which has often been noticed in these columns. The latest contribution to the series is by Mr. J. E. Collin and deals with the family Empididæ. This group is apparently richly developed in the regions in question, since 198 of the species described were previously unknown. The part forms a volume of more than 300 pp. with many text-figures and is well produced in a manner similar to its predecessors.

Soils and Fertilisers*

By DR. ALEXANDER LAUDER

MANY of the investigations in agricultural chemistry during the past half-century have been concerned with the more accurate and detailed working out of the ideas discussed by Gilbert in his presidential address to the Chemistry Section of the British Association in 1880 and with the explanation of various points in agricultural practice which have been evolved by farmers; while nothing spectacular in the way of change may have resulted, the cumulative effect of the more accurate knowledge about soils, fertilisers, crops and nutrition has undoubtedly been important.

In addition, several discoveries of fundamental importance have been made: the synthetic manufacture of ammonia and nitrates; the effects of vitamins in animal nutrition; the theory of base exchange in soils; and the development of bacteriology, to mention some of the more outstanding only.

Some of these, although they might be described as advances purely from the scientific side, have yet had practical applications of the highest importance. The theory of base exchange in soils, which may be said to have originated in Great Britain with the early work of Way in the fifties of last century and is associated in modern times with the names of Gedroiz, Hissink and Wiegner, has provided an explanation of absorption and exchange phenomena and of soil acidity, and has been successfully applied to the reclamation of alkali soils in Hungary (Von Sigmond) and the western States of America, as well as in the treatment of land recovered from the sea.

Amongst other notable advances which have had a practical application may also be mentioned the use of sulphur for reducing fungoid attacks on crops and for reducing alkalinity in soils, particularly soils used for growing potatoes, and the study of the functions of elements which occur only in minute quantities in plants, for example, copper, manganese and boron. The application of modern statistical methods to the interpretation of field experiments and of biological experiments generally, has led to a more accurate appreciation of the experimental errors involved, and of the significance attached to any result.

THE SOIL

The study of the soil may be approached from two points of view. In the first of these it is regarded as the seat of certain chemical, physical and biological processes which are investigated entirely from the scientific point of view without any reference to agriculture. This has been the method of attack of the Russian school in particular, and the supposition is that when a sufficient body of knowledge has been accumulated in this way, the consideration of the facts obtained may result in practical applications of value to the agriculturist; it should be emphasised, however, that the approach in the first instance is purely scientific. The interesting volume published a few months ago by Prof. G. W. Robinson of Bangor gives a clear exposition of the methods of this school and of the results which have, so far, been obtained. The other method has been to study the soil as the medium of plant growth, to investigate practical problems as they arise and to have as its definite aim the giving of advice to those engaged in agriculture as to improving their methods of tillage and crop production. It is obvious, of course, that no definite division can be made between the two methods of approach, as is shown by the history of recent developments. In Great Britain, while the former method has been by no means neglected, as witness the large amount of research work carried on at Rothamsted and to a lesser degree elsewhere, it is the latter method which has been in the main officially supported and subsidised by successive Governments.

Amongst the scientific methods which have emerged and received considerable prominence and support in recent years is the modern method of soil classification. This, while belonging to the scientific method of investigation, also seeks to justify its existence by the claim that it is of immediate importance to the farmer. The method was first developed in Russia, where it was shown as early as 1879 that climate is responsible for the great tracts of similar soil found in that country; this idea was developed by later workers and more recently by Glinka and others, who recognised some of the limitations of the original method and proposed in place of the earlier zonal type of classification a system based on the effect of climate on the development of the soil profile. Soils were divided into two great groups. In the first were placed the soils in which the profile shows that the external soil-forming processes, especially climate, have predominated; the second group comprises those soils in which the internal process, that is, parent material, still predominates. These groups are further subdivided, but the whole system lays special emphasis on the development of the soil profile—that is, the vertical section from the surface soil to the unweathered parent material.

Although soil surveys had been carried out for a considerable time in Europe and the United States, modern soil-surveying may be said to date from the first International Soil Congress held at Budapest in 1909. At this meeting Glinka explained the new method of classifying and mapping

* From the presidential address entitled "Chemistry and Agriculture" delivered to Section M (Agriculture) of the British Association at Leicester on September 7. The address dealt also with biochemistry and agricultural development.

soils on a climatic basis, and soil surveys on the new basis were soon begun in a large number of European countries and in the United States. At the International Soil Congress held at Rome in 1924 it was agreed to construct a soil map of Europe, and in 1926 the special committee representative of the different countries concerned met in Hungary to discuss in the field the practical details of the work on which the map was to be based. At a subsequent meeting in Budapest the details of the methods were adjusted, and it was agreed to undertake the construction of a map of the soils of Europe based on as uniform a method of surveying as possible. The "General Map of the Soils of Europe", under the editorship of Prof. Stremme, Danzig, was published in 1927. The English text, translated by Dr. W. G. Ogg, of the Macaulay Institute for Soil Research, Aberdeen, was published in 1929 with the aid of a grant from the Department of Agriculture for Scotland. The first edition of the map is on the scale of 1 : 10,000,000, and preparations for a second edition are in progress.

Turning next to the methods employed in surveying, the profile is studied as regards horizons, colour and texture changes, structure, drainage and vegetation. The surface horizons are naturally more extensively studied. As regards the chemistry of the profile, most weight is placed on the ratio of silica to sesquioxides ; other factors examined are the presence and accumulation of salts, including calcium carbonate, and changes in acidity with depth. On the results of these observations, the soil is placed in its appropriate class. In passing, it may be noted that there appears to be a certain reluctance on the part of the advocates of these methods to ascertain by means of carefully conducted field experiments whether some of the differences they are mapping are really significant in practice and whether some of the finer differences which they map, between soils within the same type, have any reality and make any appreciable difference in agricultural practice.

As regards the utility of soil surveys generally, a reasonable case can be made out for the benefits which are likely to follow a careful survey of a new country which is just being developed. The difficulty there, is to provide the staff and funds so that the survey work is kept ahead of the development.

In a country like Great Britain, on the other hand, there is doubt on the part of many as to whether the benefits which are supposed to follow such a survey will ever be realised. The question of suitable crop distribution and association is well established, as the result of generations of experience and is not likely to be seriously altered as the result of such an investigation. It is claimed that a soil survey on the scale of 1 inch to the mile would be of great importance in connexion with manuring and in the interpretation of the results obtained by the various methods of estimating the available plant nutrients in the soil. Before undertaking a survey of such magnitude, it should be pointed out that such a claim would require to be based on the results of a wider series of accurate field trials than are available at present. At the same time, the importance of survey methods from the purely scientific point of view and also in connexion with land reclamation problems should not be overlooked.

What the farmer wishes to know about the soil is whether it is adequately supplied with nitrogen, phosphates and potash, and whether there is sufficient lime present to give a satisfactory soil reaction. These are reasonable questions, but it must be admitted that in the past the task of the agricultural chemist who had to attempt to answer them was by no means easy.

With regard to nitrogen, no method exists by which we can judge the requirements of a soil as regards this element ; the fact that most soils respond to dressings of soluble nitrogenous fertilisers is about as far as we can go in the way of prediction.

On the other hand, the lime requirement of a soil can now be given with reasonable accuracy by routine methods which are suitable for use on a large scale. The question as to whether the dressing of lime which is theoretically desirable can be recommended is generally an economic rather than a chemical one.

To determine what the requirements of a soil are with regard to available phosphates and potassium is a more difficult matter. The most that can be aimed at at present is to be able to say whether the soil is well supplied or moderately supplied with these constituents, or is deficient in them.

The difficulties of discriminating between the available and non-available constituents in a soil are obvious. In the first place, the way in which plants take up their nutrients from the soil is still a matter of controversy, and the fact that the soil is a heterogeneous and ever-changing system of extreme complexity greatly increases the difficulties. The chemical methods generally employed involve the extraction of the soil with water or some dilute solvent and the estimation of the phosphates and potassium which come into solution under standard conditions. When the results can be interpreted in the light of field experiments or experience, they are a very useful guide in advisory work. The fact that the method is an empirical one is a great drawback, but the more serious objection is that the results give a measure of the condition of a soil at a particular time only and obviously cannot apply to its condition at different times throughout the year. There is probably no hard and fast line between the 'non-available' and the 'available' constituents, the one set gradually merging into the other.

These fundamental difficulties have suggested the idea of making use of the plant itself as an index to the available plant nutrients in the soil. Much work from this point of view has been carried out and two methods based on these principles have been in use on the Continent for

several years. These are the well-known methods of Mitscherlich and Neubauer. These methods have been very ably and critically reviewed by Dr. R. Stewart in a recent publication of the Imperial Bureau of Soil Science (*Technical Communication* No. 25, 1932).

One general difficulty which applies to both methods is that they can be carried out only at institutes specially equipped for the purpose. The Mitscherlich method requires a whole season to carry out the test, while the Neubauer requires much supervision and extreme accuracy in the analytical work. Attempts have therefore been made to devise simpler biochemical methods suitable for the ordinary laboratory use; of these one is of special interest.

The Aspergillus Method. It is found that under standard conditions the growth of *Aspergillus niger* is proportional to the amounts of available potash and phosphates in the soil.

The mould is grown in a suspension of the soil in a culture solution containing all the constituents necessary for growth except the one being tested for, and the results of a large number of experiments have shown that the standard error is of the order 4 per cent.

The method has been worked out by Prof. Niklas and his colleagues at the Agricultural Research Station at Weihenstephen, near Munich, and has also been subjected to a critical examination by Dr. A. M. Smith, Edinburgh, who has tested the method with a variety of Scottish soils, as well as investigating the effect of different sources of nitrogen on the process.

The *Aspergillus* method is likely to be valuable in estimating the potassium and phosphate requirements of a soil. The results, as might be expected, are more reliable for potassium than for phosphates, and while not rigidly quantitative, give information as to whether the soil is rich or poor in these constituents. It has the advantage of being rapid and requiring no expensive apparatus (A. M. Smith and R. Coull, *Scot. J. Agric.*, vol. 15, p. 262; 1932).

The whole question of available plant food is necessarily bound up with the complex relationships which exist between plant and soil, and it is unlikely that any simple or single method will be devised to overcome the inherent difficulties of the problem and be generally applicable to different sets of conditions. The admitted lack of agreement obtained with the various methods at present in use is undoubtedly due, to a large extent, to the variety of factors involved, as well as to the fundamental objections which may be raised to any one method. We are still very ignorant of the process of assimilation by the growing plant, and until we have more information on this subject, methods of estimating availability must continue to be largely empirical and the results merely first approximations.

The usual method of approach to the problem has been to study the effect of the soil or plant medium on the plant. In Edinburgh attention has in recent years been directed in the opposite direction—namely, to a study of the effect of the plant on the soil. The alterations to be observed are, of course, small, but by applying methods which might almost be described as analogous to modern micro-methods of analysis, measurable changes can be followed with considerable accuracy. The results which have been obtained are interesting and sometimes rather unexpected, and although it is scarcely to be supposed that they will furnish a complete picture of the relationship between soil and plants, one feels that any contribution to the subject from a new angle may be of value in the study of such a complex problem.

Fertilisers

Turning next to the progress which has been made in the manufacture and use of fertilisers since the time of Gilbert's address, there are one or two notable dates and achievements to be mentioned.

First in order of time is the discovery of the value of basic slag as a fertiliser. The earliest experiments with slag in this country were carried out in England by Wrightson and Munro in 1885, and by A. P. Aitken in Scotland about the same time; a year or two later J. J. Dobbie carried out the first experiments with the slag in North Wales.

The now classic experiments laid down by Prof. Somerville in 1896 and carried on and developed by his successors, Sir Thomas Middleton and Prof. Gilchrist, have demonstrated the value of this addition to phosphatic fertilisers and show as the result of twenty-five years' experiments that basic slag is, for certain types of soil, even more valuable than superphosphate.

As regards superphosphate, it should be noted that the former view, that it was an acid manure and that its continued use depleted the soil of lime, is no longer held; the general objection to the use of the so-called physiologically acid manures has been shown to be due to misconceptions as to their action.

In the case of the potash fertilisers, one of the most striking discoveries of recent years is the marked response of most fruits to potash manuring; the effect of potash salts on the quality of the crop, particularly in the case of potatoes and barley, has also received considerable attention.

The most important advance of all is the manufacture of nitrogenous fertilisers by synthetic methods from the nitrogen of the air. Ammonia is now manufactured by a synthetic method on an enormous scale at the works of the Imperial Chemical Industries, Ltd., at Billingham. The successful development of the method is one of the greatest triumphs of chemistry and engineering in modern times. By this process, which incidentally dispenses with the use of sulphuric acid, sulphate of ammonia can now be prepared more cheaply than from gas liquor where the ammonia is obtained as a by-product.

Concentrated Complete Fertilisers. One of the most interesting developments of the synthetic ammonia industry has been the manufacture of concentrated complete fertilisers containing nitrogen, phosphates and potash in suitable proportions and all soluble in water. One ton of such fertilisers supplies as much plant food as two tons of the ordinary mixed fertiliser of similar composition. They possess the obvious advantage of reducing freight and handling charges and cost of distribution to the land; they are granular in texture and very easy to sow, and they can be stored without risk of deterioration; further, the constituents are all soluble in water.

Another point claimed in their favour is that they contain little except the three fertilisers, nitrogen, phosphates and potash, while the ordinary fertilisers contain appreciable, and in some cases large, amounts of calcium, sulphur and other elements. It is possible that in some soils the absence of the additional substances might be a disadvantage, and a careful comparison of the new fertilisers with the old mixed fertilisers will be necessary to show that no disadvantage attends the use of the new compounds over a number of years.

It is obvious that if the concentrated fertilisers were used continuously over a number of years, increased attention would require to be given to liming.

Inter-Atomic Distances and Forces

ON September 11, in Section B (Chemistry) of the British Association meeting at Leicester, Dr. N. V. Sidgwick opened a discussion on "Inter-Atomic Distances and Forces in Molecules", with a review of the methods available for the determination of interatomic forces and distances.

X-Ray Measurements. Since the wave-length of X-rays is of the same order as atomic distances, scattering of these rays gives information about the relative positions of atoms. This method of investigation has been applied extensively to solids, especially by Sir William and W. L. Bragg ever since its original suggestion by Laue, and has been extended more recently by Debye and others to liquids and vapours, where deformation of the molecules by crystal forces is absent. The method has been supplemented by use of electron waves.

Optical and Infra-red Spectra. Electronic energy changes correspond to spectral lines in the visible or ultra-violet region, but oscillation of molecules causes absorption of energy in quanta represented by lines in the infra-red. These differences may be imposed upon electronic changes to give the lines of a band spectrum. Rotational frequencies give lines in the far infra-red which, when imposed upon electronic and vibrational changes, give the fine structure lines of band spectra. From rotational quanta the moment of inertia of the molecules can be calculated; hence with known masses, inter-atomic distances and ultimately valency angles can be found. Oscillation frequencies indicate resistance to deformation of links.

Thermochemical Data. The energy given out when two atoms form a link is connected with the force constant of the link derived from its oscillation quanta; these are connected, however, with small changes only in the energy of the link, while the heat of formation represents the total energy associated with the link.

Dipole moments. These are produced whenever two unlike atoms form a link, and are due to unsymmetrical sharing of electrons. As resultant moments are obtained by compounding the simple vectors, observational values give indications of the valency angles. The values vary with the nature of the atoms, and with the nature and number of the links between them.

The properties of a link depend upon whether it is ionised or covalent, and, if covalent, upon whether it is single, double or treble. It is important to be able to distinguish the different kinds of links, and light has been thrown upon this by wave-mechanics. Measures of the lengths of covalent links accurate to about five per cent are now available and can be assigned in molecular structure. A double link is shorter than a single, and a triple link shorter than a double link between corresponding atoms. When, however, no link is present, atoms cannot approach so near to one another owing to electron repulsion. Atomic centres in the hydrogen molecule H_2 are 0·75 A. apart, but uncombined hydrogen atoms cannot normally approach within less than 2 A. of each other. In methylene chloride there is room for the chlorine atoms if the $C\begin{smallmatrix}\diagup Cl\\ \diagdown Cl\end{smallmatrix}$ angle is the tetrahedral one, but the 'envelopes' interfere causing separation of the chlorine atoms. This is obviously important in questions of steric hindrance.

The theories which have been put forward to explain the covalent link were reviewed by Prof. J. E. Lennard-Jones. In 1927 Heitler and London applied new physical methods to the investigation of chemical linkages. The reactions of atoms to light indicate the energy states of the atoms. There is a natural tendency for a system to revert to its lowest energy state. Heitler and London considered that atoms were each in the lowest ground state when reacting; certain pairings of electron spins were thus possible, but the theory failed to explain either directed valencies or double bonds. Pauling and Slater suggested that it was necessary to consider other states of an atom when a second atom was near. Thus in carbon, two 2_s and two 2_p electrons were replaced by one 2_s and three 2_p electrons, enabling four shared pairs of electrons to be made up. The definite orbits of the Bohr atom are thus diffused by the merging of the neighbouring energy levels, and the superimposing of the four necessary orbits

gave a symmetrical sphere indicative of the symmetry of the carbon atom. A displacement in electron intensity on one side of the nucleus led to the formation of three other corresponding positions of electron intensity symmetrically arranged, indicating the directed character of the valencies. Reactivity was assumed to be associated with intensity of electron charge.

'Resonance' or exchange energy was introduced to explain the energy of the covalent link; where resonance was possible between two atoms, the resulting system had a lower energy than either atomic state singly. Physical conception of this was difficult and it did not serve to explain the co-ordinate link. This can be explained, however, by the concept of *molecular orbitals*. All electrons in a structure are shared to some extent by all the nuclei. Those remaining close to their original nuclei are said to have atomic orbitals; those linking chemically form molecular orbitals, for example, in Li_2 there are two pairs of electrons in atomic orbitals and two electrons in molecular orbitals. Regarding, say, the hydrogen atom as a 'hole' in space, the electron can fill it with a pattern as a sound vibration makes a pattern in a pipe. The bigger the 'hole' the more 'spread' the pattern and the lower the energy of the electron. When two atoms are concerned, chance of the leakage of electrons from one to the other is small when the atoms are far apart, but when the holes overlap, the electrons wander and take up the lowest possible energy pattern. Linking of atoms may be regarded as removing the nodes from the energy pattern and thus lowering the energy.

This theory explains better than that of Heitler and London (1) the nature of the covalent link, (2) partial sharing of electrons by unequal nuclei and (3) polyatomic molecules. Where the nuclei have a symmetrical arrangement, the electrons must take up a pattern conforming to the general symmetry of the molecule, and this will be the lowest energy pattern. Overtones are possible, however, giving nodes, and hence directional effects are developed. 'Lone pairs', for example, in NH_3, may thus be represented by an excrescence in the electron pattern of a molecule which can supply deficiencies in other patterns, for example, BH_3, giving a more symmetrical pattern than either and hence a lower energy state. Consideration of C, CH, CH_2, etc. indicates an induced directed valency in an atom due to atoms already attached.

A means of determining interatomic distances is by the Fourier analysis of X-ray data. The method, which was described by Dr. J. M. Robertson, is laborious, but claims a higher accuracy than any other in use. The periodicity of scattering of electron density is represented by a Fourier series the coefficients of which are proportional to structure factors. By taking sufficient experimental determinations these coefficients can be calculated. Where complex molecules are concerned, this method is the most straightforward for the analysis of X-ray data. Applied to anthracene, by compounding three projections of the molecule, it gives regular plane hexagon rings. The nearest distance between molecules in this compound is 3·7 A. (it is 3·9 A. in aliphatic hydrocarbons) and the distance across the cleavage plane is 4·2 A. The interatomic distance for carbon is 1·41 A. Applied to symmetrical tetramethylbenzene, the method gives a C—C distance from nucleus to side chain of 1·47 A., which is the mean of the diamond (aliphatic) and graphite (aromatic) values, 1·54 A. and 1·41 A. respectively. There is also evidence of repulsion of adjacent methyl groups.

Dr. J. D. Bernal dealt with the nature, accuracy and constancy of interatomic distances. The neutral atomic 'radius' represents the link distance where repulsion becomes appreciable and is in no sense a true radius. It does not occur in ionic compounds or metals although there is an average distance characteristic of the metallic state. In metalloids such as bismuth, link distances show covalency in one direction and metallic combination in another. Homopolar links are shorter than any others (from H_2, 0·75 A., to I_2, 2·7 A.). The shortest molecular distance is 2·76 A. (in water). Xe—Xe in the solid is 4·4 A.

From the point of view of accuracy, Fourier analysis alone gives accurate values without chemical assumptions, but other methods are accurate enough for model building and can be used to eliminate improbable structures. They are not sufficiently accurate to calculate distortions. Intermolecular effects do not alter interatomic distances; intramolecular effects other than valency forces cause distortion, but bond angles rather than bond lengths are affected. The additive law for 'radii' is fairly true as a first approximation but needs correction when resonance is possible between two parts of the molecule. This may be due to the influence of an ionic binding upon a homopolar one. Distances are strictly additive when there is no dipole moment for the link, but marked difference in the electropolar character of the atoms, for example, HF, causes shortening of the link. A truer kind of resonance is due to alternative forms of the molecule involving only changes in the kind of link between specified atoms, for example, variation in the double bond positions in the diphenyl molecule. The case of co-ordinated hydrogen presents special features. The energy of binding in $(OH_3)^+$ formation is the same as in water: it is really an ionic binding with additional resonance energy.

The derivation of the force constant between the atoms of a diatomic oscillator from the characteristic frequencies indicated by the Raman effect, infra-red spectra or fine structure investigations was discussed by Mr. E. J. Bowen. This constant varies with the multiplicity of the link. For single links it is usually between 2 and 4, for double links it is about 9 and for triple links about 17 dynes/cm. $\times 10^5$. In triatomic molecules, there are three modes of vibration, and relative intensities of Raman and infra-red lines indicate which mode corresponds to a particular frequency. From the

presence or absence of a Q branch it is possible to determine whether the vibration is parallel to the axis of least inertia or not, but this requires high dispersion in infra-red measurements. Analogies from other systems with approximately equal energy quanta can also be used for associating modes of vibration with particular lines.

Mr. C. N. Hinshelwood described experiments on the decomposition of molecules in which the rate of decomposition varies with the pressure in a complex manner. Analysis of the results indicates that several modes of decomposition are possible, different modes predominating in different regions of pressure. The decomposition products are apparently the same in each case. This indicates alternative modes of vibration in the molecule and a possible line of attack on structural problems from kinetic experiments.

Obituary

Prof. G. Embden

BY the death on July 25 last of Gustav Embden, professor of chemical physiology in the University of Frankfort-on-Main, science has suffered a very severe loss; one of the most inspiring teachers and workers has passed away at the height of his successful activity.

Gustav Embden was born in 1874 in Hamburg, of a distinguished family; he studied medicine in Freiburg and Strasbourg, where the personal influence of Hofmeister and of his own lifelong friend Bethe brought him (after a few years at Zurich with Gaule and Hoeber, and later in Frankfort with Paul Ehrlich) into the field of physiological and biochemical research. In Hofmeister's biochemical laboratory at Strasbourg, where he worked while he was a member of the staff of Ewald's physiological laboratory, he started the work on intermediary metabolism which occupied him throughout his life.

In 1904 Embden went to Frankfort as head of the chemical laboratory of the city hospital, and in 1909 this laboratory was developed, as were so many laboratories in German hospitals, into a well-equipped and excellent institution with much greater facilities for work than the average university laboratory at that time. As the head of this institute, Embden became in 1914 professor of "vegetative Physiologie" in the University, a position which was founded then: the name implies the physiology of chemical function in the animal body.

Embden's early papers dealt with a number of questions which were investigated by the liver perfusion method, greatly improved in his hands; with the formation of sugar in isolated liver, of sugar from amino acids, of aceto-acetic acid, and of acetone from fatty acids, and from amino acids, of amino acids out of nitrogen-free bodies, and with the formation and disappearance of lactic acid in the liver. He was probably the first to indicate that glucose can be formed from lactic acid and that these two substances are convertible into one another in either direction in the animal body: this idea has been developed into one of the most important in the chemical physiology of muscular activity.

From 1912 onwards the work of Embden and his school was concentrated on muscle chemistry. The discovery by Harden and Young of the rôle of phosphates in alcoholic fermentation led Embden to the idea that, in the glycolysis of animal tissues also, phosphoric esters of carbohydrates must take part as intermediaries; this idea, put forward for the first time by Embden, finally proved, after a long and chequered history, to be correct. It was Embden himself, after twenty years, who brought this idea to a successful conclusion a few months before his death in a paper published early in 1933, in which he traced out the path of the intermediary processes in glycolysis; his scheme is most important for the further development of our ideas on glycolysis both in animals and in yeast cells.

The history of Embden's work on the intermediary rôle of phosphates in glycolysis is a dramatic one indeed: whole groups of laborious papers sometimes appeared as wholly erroneous because of experimental or theoretical mistakes or misinterpretation: sometimes, however, conclusions of his, already abandoned by himself or discredited by others, had to be revived. Embden's idea that a diphosphoric ester of hexose is an intermediary compound in lactic acid formation from glycogen in muscle tissue was finally proved to be correct, after this idea had for years been deserted by the author himself, and another ester, a hexose monophosphate, had been supposed by him to be the 'lactacidogen'. His idea that lactic acid formation is not the chemical change immediately connected with muscular contraction, and that this body is formed after contraction is over, also proved correct; and the strong opposition to this idea, which was held on very good experimental grounds by Hill and Meyerhof, had to be withdrawn when contraction without lactic acid formation was discovered by Lundsgaard, and when new experimental work by Embden and Lehnartz and by Meyerhof demonstrated beyond doubt the existence of delayed lactic acid formation after a muscle twitch.

The following important results of Embden's work on the chemistry of muscle must be quoted: the discovery of the occurrence in muscle of hexose monophosphoric ester (the Embden ester); the formation of Harden and Young's diphosphoric ester in muscle pulp in the presence of fluoride; the action of mineral ions on the changes in muscle pulp; the discovery of adenylic acid in this and other tissues. Embden first recognised that this latter compound is the precursor of the long-known inosinic acid in muscle, and this led him to his

observations of ammonia formation in muscle; he also recognised that the adenylic acid of muscle is different from the adenylic acid of Jones and Kennedy, occurring in yeast nucleic acid. The discoveries of the vasomotor and cardiac action of adenylic acid by Szent Györgyi and Drury, and of adenosinetriphosphoric acid and its rôle as co-enzyme of muscle glycolysis and yeast fermentation, are consequences of Embden's discovery. In addition, the work on muscle permeability and its alleged change during activity, the results of which are still matters of controversy, was started by Embden.

Embden's later work was abundantly referred to in Sir Frederick Gowland Hopkins's presidential address before the British Association meeting at Leicester on September 6 (NATURE, 132, 381, Sept. 9, 1933) and in Dr. Otto Meyerhof's lecture delivered last July at Cambridge (NATURE, 133, 337, Sept. 2 and 373, Sept. 9, 1933). Although others (Neuberg, Nielson) had nearly obtained these results, and although Meyerhof had reached them almost at the same time, the discovery by Embden of phosphoglyceric acid and of its changes in muscle pulp, the realisation of the mechanism of glycolysis, of the rôle of glyceryl phosphate and of pyruvic acid, of the mechanism of lactic acid formation, of its inhibition by fluoride and by iodoacetic acid, will probably be regarded as among the most inspired accomplishments of biochemical thought.

Embden was, to use the phrase employed by Ostwald and Smoluchowski, a romantic explorer: very bold ideas, arising sometimes before, sometimes after his observations, gave him a picture of the process, sometimes down to minute particulars, and this picture was then tested by ample experimental work, not always careful and critical enough but always very fertile and leading to further experiments and consequences. Much of this work and many of his results have been swept away by the further development of research: others, however, have become outstanding facts and ideas in biochemistry. Not only his friends—and they were many—but also those who, like the present writer, have had frequent and even bitter controversy with him, will consider Gustav Embden as a very great biologist, whose keen temperament and uncommon power of grasping the ultimate facts, and whose strenuous work have been stimulating and enlightening factors in the recent development of biochemistry.

He died too soon and at an unhappy time in the history of science in Germany; he had not, however, himself to submit to the hardships and difficulties which were experienced by many of his colleagues. J. K. PARNAS.

M. Emile Meyerson

WE regret to record the death, which occurred on December 4, of M. Emile Meyerson. Many British philosophers knew the hospitable apartment of the Rue Clément Marot, in Paris, where he used to receive his intimate friends. There was an air of sadness about him, for he suffered much ill-health and physical pain. Emile Meyerson seemed to know everything and everybody. It could scarcely be otherwise, when one remembers that he was born at Lublin in Poland in 1859, studied chemistry in Germany before going to France, where he worked at first as a journalist with the Agence Havas and as a director of Jewish charities. From his vast experience of men and things, he drew the material with which he built up his philosophy, for he owned no master and created a method suited to his purpose.

During the past twenty years, Emile Meyerson has given us a series of brilliant books in which he expounds his views with a conviction backed by an amazing wealth of historical and scientific knowledge. His first work, "Identité et Réalité", which has been translated into English, then "L'Explication dans les Sciences" (Payot, Paris, 1921) and "La Déduction Relativiste" (Payot, Paris, 1922), and finally "Du Cheminement de la Pensée" (3 vols., Alcan, Paris, 1931), develop the same theme, that the object of science is not to formulate new laws only, but also to attempt an explanation of Nature. So that his purpose was less to create a new system than to trace and examine the processes of the mind in his search for truth through the sciences. To discover that a certain effect has a certain cause is to identify them ultimately. That is why physics, for example, is dominated by the principle of inertia and the principle of conservation of energy, which eliminate the heterogeneous in favour of the homogeneous. There are many obstacles in the way, however, like Carnot's principle. Yet these irrationals should not stop the forward movement of the mind: it is only in the constant attempt of the mind to reduce the irrational to the rational that science finds its justification.

Emile Meyerson did not wish to go any further. The wider issues of metaphysics are beyond the compass of his philosophy, though he was distinctly a realist as he believed in the existence of the 'thing' which supports the whole structure of science. Nevertheless, no future interpretation of science will be able to avoid negotiating the arguments produced and elaborated by Meyerson. In this respect his philosophical work has a universal importance and will prove to be an everlasting shrine to his memory. T. GREENWOOD.

We regret to announce the following deaths:

Dr. F. L. Chase, assistant astronomer at the Yale Observatory from 1890 until 1910 and acting director from 1910 until 1913, known for his work on stellar parallax and proper motion, on November 8, aged sixty-eight years.

Mr. J. Humphrey, formerly editor of the *Pharmaceutical Journal*, president of the British Pharmaceutical Conference in 1910, who had a large share in the compilation of the British Pharmaceutical Codex, on December 8, aged seventy-one years.

News and Views

The British Trust for Ornithology

AN important step towards the better organisation of field studies of bird life has been taken by the recent initiation of a British Trust for Ornithology. There is probably no country that has so many competent field ornithologists as Great Britain, but so far there has been no centre to give scientific direction to their efforts, to co-ordinate their observations, and to arrange for participation in international investigations. There is, moreover, no permanent Government support for economic ornithology, despite the practical value of its study, and therefore nothing corresponding to the Biological Survey in the United States, or to the official Institute of Ornithology in Hungary: nor have we any *Vogelwarte*, such as those which the Germans maintain at Rossitten and on Heligoland. Notable success has indeed attended several co-operative schemes in Great Britain, both for the marking of migrant birds and for observational work over a wide area, recent census studies of the heron and of the great crested grebe being cases in point: but on each such occasion the machinery has to be created laboriously afresh. As the promoters of the new scheme justly say, "the demands of contemporary research have in this field outstripped the training and organisation available for meeting them".

THE intention is to establish an institute at or near Oxford to serve as "a clearing house for information and contacts", and as "a national field centre which can collaborate with other centres overseas". The institute is to be supervised by a salaried director, assisted by an advisory committee, and a chain of observers will be organised throughout the country. For these purposes an appeal has been issued for £8,000 to cover the cost during the first five years, and it is to be hoped that this will meet with a good response: the honorary treasurer is Mr. B. W. Tucker, University Museum, Oxford. The nucleus of a permanent endowment, also, has been provided by the very generous action of Mr. H. F. Witherby, editor of the magazine *British Birds*, in presenting the sum of £1,400, realised by the sale of his important collection of Palæarctic birds to the British Museum (Natural History). By the same act the national collection becomes enriched by the addition of valuable research material—some 9,000 skins representing about 1,300 forms—which has already been put to good use by Mr. Witherby in the study of plumages and moults and of geographical variation.

Natives of South Australia

THE seventh expedition, organised by the Board for Anthropological Research of the University of Adelaide, in conjunction with the South Australian Museum, has just returned from Ernabella, situated at the eastern end of the Musgrave Ranges and not far distant from the reserve for aborigines in the north-west of South Australia. Much of the expense incurred was defrayed from a fund received from the Rockefeller Foundation and administered by the Australian National Research Council. For two months previously, Dr. C. Hackett and Mr. N. B. Tindale had travelled on camels through the Musgrave Ranges and on to the Mann Ranges, studying the habits of the aborigines and following them in their daily pursuits. These two joined the main party in August, when an intensive survey of nearly a hundred natives, most of them as yet untouched by civilisation, was undertaken. Standard measurements, fifty-three in number, were made on each of 61 individuals by Drs. H. Gray and C. Hackett. Full-face and profile photographs of these same persons and a number of special photographs were secured, and about 2,000 feet of cinematograph films, portraying ceremonies and incidents in the daily life of the natives, were exposed.

THE Director of the South Australian Museum, Mr. H. M. Hale, had no difficulty in obtaining plaster face moulds of four men and two women, and full busts of four men—a remarkable fact when it is realised that this means that the subject must remain absolutely still for half an hour for the face and one and a half hours, or more, for the bust. Dr. K. Fry made observations on the reactions and behaviour of the natives. Mr. N. B. Tindale, ethnologist to the South Australian Museum, devoted his attention more particularly to social anthropology and language. Blood-grouping by Prof. J. B. Cleland and Dr. Hackett showed that out of 63 aborigines tested, 40 belonged to Group A and 23 to Group 0. Prof. C. S. Hicks and Mr. J. O'Connor carried out physiological observations, especially as to the reactions to temperature; the natives naturally wear no clothing of any description, keeping themselves warm at night, when the temperature in winter often falls below freezing point, by means of small fires. Profs. T. Harvey Johnston and Cleland made notes on the plants and animals used in various ways. Dermatographs, finger-prints and phonograph records were also taken. Since the Australian native is essentially a nomad and soon tires of being in one place, organised team-work on expeditions such as these enables much data of very varied nature to be obtained quickly before the novelty wears off.

World Wool Production

THE news that the price of wool is rising concerns more people than the primary producers. When one considers the extent to which the funds available for research institutes, especially those overseas, are liable to suffer in 'hard times', any sign that times are improving for those countries where wool is an important item in the national economy is welcome. The November issue of *Wool Intelligence*, for which the Imperial Economic Committee is now responsible, shows that smaller wool supplies are being accompanied by rising prices. West Riding quotations are 40 per cent higher than a year ago; indeed, there has been a rise in prices of about 15 per cent on the average between wool sales held in mid-October and mid-November. Wool production in the current

season is expected to show a reduction in South Africa, Australia, and New Zealand, and although there may be slight increases in South America, the United States, and Great Britain, the aggregate production of these countries will probably be about 7 per cent less than last year. The increase in prices reflects not only this reduced production but also a real increase in consumption in all the world's textile centres. Along with this, unemployment in the woollen and worsted trades in Great Britain is down to 8 per cent, a half of what it was a year ago. The report gives details of wool trade and manufacture in many countries, mentioning some interesting developments. For example, "Active steps are being taken, with Japanese co-operation, to encourage sheep-raising and wool production in Manchuria with the object of securing for Japan an alternative source of supply" (most of her wool at present coming from Australia). Recovery in the mohair industry is also reported; the development of Empire trade may be seen in the imports into Great Britain, almost all of which now come from the Union of South Africa although in 1928 half came from Turkey. Turkey's best customer is now the Soviet Union.

Preservation of an Old English Village

WEST WYCOMBE is a seventeenth century English village which has recently come into the possession of the Royal Society of Arts and been reconditioned in such a way that its ancient beauty has been preserved and at the same time the amenities of present-day life have been introduced (Weir, W. and Hill, J. B. "Account of the Reconditioning of West Wycombe—Buckinghamshire." *J. Roy. Soc. Arts*, 81, 893–910; 1933). In 1929, when the transfer was made, the local sanitary authority had already served notice of repair on some fifty cottages. The work of restoration has been carried out under the supervision of one of the authors, and the whole village is now let to tenants on agreement. Most of the property has been thoroughly reconditioned, inside and out, and the remaining twenty cottages have been partly reconditioned. Main water supply, main drainage, electric light in some cases, fenced gardens and wash-houses have been provided, and the interiors of many houses have been altered to give larger and better arranged rooms, with more conveniently placed doors and better lighting. The final result is a beautiful group of model cottages, showing what can be done for the preservation of old property as an alternative to its demolition. The series of photographs taken before and after reconditioning afford striking proof of the success of the experiment, and the brief accounts of the work carried out on different houses illustrate the diverse ways in which difficult problems were approached. The Royal Society of Arts is to be congratulated on the preservation of this old English village, together with the improvement in housing conditions that has been effected.

The Exceptional Summer of 1933

AT the meeting of the Royal Meteorological Society held on December 20, Dr. J. Glasspoole read a paper entitled "The Exceptional Summer of 1933". The sunshine recorded over the British Isles exceeded the average in each of the four months June–September, the mean excesses being 21, 17, 35 and 33 hours respectively. During this period many places in the south-east of England registered more than 1,000 hours of bright sunshine, nearly 200 hours more than usual. The total sunshine during these four months fell short, however, of that recorded during June–September, 1911. The mean temperature over the country generally exceeded the usual amount in each month February–October. July 1921 was as warm as July 1933 and these two Julys rank as the warmest on record. The mean temperature of August 1933 fell short of that of the Augusts of 1911 and 1899. The highest shade temperature recorded at Greenwich Observatory since 1841, namely, 100° F., occurred on August 9, 1911, while August 1899 is the warmest calendar month on record for the British Isles as a whole. The outstanding feature of the summer of 1933 was the warmth of June–September. The total rainfall over the British Isles during the six summer months April–September was 13·8 in., which is less than that of any summer since 1870, except 1870 with 12·4 in., 1921 with 13·1 in. and 1887 with 13·7 in. Rainfall was abundant in February and many reservoirs were overflowing at the beginning of April. Afterwards the slightly deficient rainfall of each month April–July, culminating in an unusually dry August, together with the loss by evaporation, resulted in a steady lowering of the level of the water in most reservoirs.

Statistics of Unemployment

AT the Royal Statistical Society's meeting on December 19, Mr. J. A. Dale read a paper on the "Interpretation of the Statistics of Unemployment". He suggested that there is a certain popular misunderstanding of the figures, in that it is generally supposed that 2¼ million unemployed are permanently out of work. The statistics which are most frequently quoted in public discussions do not, and from their nature cannot, disclose the way in which the actual personnel which they represent is constantly changing. It is a fact, however, that, although the total number of the unemployed may be about 2¼ million, the number of different persons unemployed in the course of a year is nearly six million, and a large part of the six million consists of persons whose unemployment is intermittent. Among those are to be included not only the 'temporarily stopped' workers and those whose employment is 'casual' but also many of the so-called 'wholly unemployed'. But there nevertheless remains a group whose unemployment is persistent and prolonged. Mr. Dale estimates that this 'hard core', represented by persons who have been unemployed for eight or nine months, number at most a million during the past year, the remaining five million being less unfortunate. There are many more in proportion suffering from prolonged unemployment in the depressed areas; about 100,000 of them were last employed in the coal mines, and the shipbuilding and iron and steel

centres contain more than their proportionate share. There is a preponderance among them of older and unskilled men. Mr. Dale directed attention to local contrasts in the quality of unemployment. In a depressed coal-mining town the registered unemployment was recently 3,700, or 47 per cent, while in a comparatively prosperous place of the same size it was 1,400, or 11·3 per cent; but the number of men who had been out of work for more than a year was 2,500 in the coal-mining town and only 117 in the other district. Cotton and coal are the industries in which short time is most common.

The Indian Statistical Institute

"A SCHEME for the Organisation of Statistical Researches in India," which was submitted for consideration to the Government of Bengal in August last, is largely concerned with a report on statistical researches which have been carried out since 1923. Prof. P. C. Mahalanobis, of the Presidency College, Calcutta, has been actively engaged during the past ten years in preparing reports for various Government departments, building up a laboratory for the application of modern statistical methods to a variety of problems and encouraging such studies in other ways. His labours in this direction have been receiving growing recognition and a plea is made for official support of the small institution which was created by individual initiative. The Indian Statistical Institute was founded in December 1931, for the purpose of promoting "the study of statistics both pure and applied and allied subjects", and the first part of *Sankhya*: *The Indian Journal of Statistics*, edited by Prof. Mahalanobis, was issued last June. This part contains original researches dealing with the theory of statistics and applications to particular economic, medical, anthropometric and psychological problems. There is obviously an enormous scope for useful work of this kind in India, and it is to be hoped that those who have proved themselves willing and capable of prosecuting it will receive all possible encouragement.

The Christmas World-Wide Broadcasts

FOR the second time, the Christmas Day programmes of all the British Broadcasting stations included a special hour, during which greetings were exchanged with various parts of the British Isles and the Empire, and terminating with a personal message from His Majesty the King delivered from his home at Sandringham. In addition, and for the first time, the special arrangements included a broadcast transmission of the chimes of the bells from the Church of the Nativity, Bethlehem, on Christmas Eve, December 24. A brief description of the technical arrangements by means of which these programmes were effected was given in the issue of the *Wireless World* for December 8. The communication with the different parts of the Empire took place through the Post Office beam transmitting stations at Rugby, the various circuits being operated from the switchboards in the Faraday Building, London, which was connected by a special line to the control room at Broadcasting House. The suggestion for a broadcast of the bells of Bethlehem actually came from the National Broadcasting Company of America last year, but the idea could not then be put into practice. This year, however, thanks to the co-operation of the Colonial Office and the High Commissioner for Palestine, the chimes were relayed by overhead line to Cairo and thence to the Post Office beam station at Abu Zabal, which transmitted the signals direct to the Post Office receiving station at Baldock, England.

These special Christmas programmes were not only broadcast through all stations of the B.B.C. including the Empire station at Daventry; they were also sent direct over the normal Post Office radio telephone routes to the Colonies and Dominions for local rebroadcasting; finally, and by no means least, arrangements were made for the signals and messages to be picked up by the American trans-Atlantic telephony station at Houlton, Maine. This last station was connected to the New York radio terminal switchboard and to the control rooms of the American National Broadcasting Company and the Columbia Broadcasting System, which together operate two great networks of several hundred stations scattered over the United States of America. It was a fitting conclusion to such Christmas programmes that His Majesty the King should broadcast his message from his study to the largest audience ever within the reach of one voice.

Opening of Radio City, New York

AN illustrated description of Radio City, the new headquarters of the National Broadcasting Company of America, in a seventy-story building at Rockefeller Centre, New York, appears in *World Radio* of December 8. This company operates, from the main control desk at Radio City, a network of 85 broadcasting stations stretching right across the United States. The new central building has provision for thirty-five studios, of which sixteen have been put into operation since the opening of Radio City on November 15. The main studio is 78 ft. × 132 ft., and it extends vertically through three stories of the building. A massed orchestra of four hundred instrumentalists were comfortably accommodated in the auditorium studio during the special programmes broadcast in the week following the inauguration. In view of developments in television, the most interesting of the new arrangements is perhaps the so-called 'clover-leaf' group of four studios on the ninth floor. These are built around a circular central control room, the floor of which can turn mechanically so as to face any one of the studios. This device enables four complete scenes to be prepared simultaneously and independently, and should considerably facilitate 'scene-shifting' in television programmes. All the studios have floors, walls and ceilings separated and insulated from the main building. As the provision of windows was impracticable, a large air-conditioning plant has been installed and it is claimed that this completely changes the air in the building every eight minutes. In addition to attention to the acoustical properties of the studios, technical improvements have been

made in the amplifiers between the microphones and the transmitting stations, and the range of audio-frequencies faithfully reproduced now extends up to 11,000 cycles per second. This should ensure that the quality of the broadcasting programmes is limited principally by the capabilities of the receiving instruments and the conditions under which they are used by listeners.

Manufacture of Telephones in Sweden

THE trouble taken by large manufacturing firms abroad to acquaint foreigners with their products and the work they have done is worthy of imitation. During this year, the telephone factory of L. M. Ericsson of Stockholm has published two reviews written in excellent English and well illustrated, each giving about 70 pages of most readable matter mainly about automatic telephones and exchange stations. There is a description of a system which notifies electrically on panels in a bank the quotations from the stock exchange immediately they are fixed officially. These panels can be inspected by the public. The methods of protecting transmission lines from excess voltages due to atmospheric electricity by means of condensers are described and a full scientific description is given of their action. There being so many wooden buildings in Sweden, there is a great demand for automatic fire alarm systems. When a fire breaks out, the effects of the fire itself acting on the device at once summon the fire brigade. The new Ericsson bakelite telephones are described. A description is given of automatic exchanges in Iceland, Norway and Finland and there are many beautiful photographs. With the beginning of this year, the firm started publishing a series of highly technical papers on the theory of telephony and allied subjects. Of the four we have seen, one is in French and three are in English. They record much of the work carried out by the Research and Development Department of the Company.

Railway Electrification

IN the *Electrical Supervisor*, the journal of the Association of Supervising Electrical Engineers, of November, the presidential address of Mr. J. M. Kennedy to the Association is given. Mr. Kennedy makes useful suggestions on problems relating to the economic development and co-ordination of the electric supply industry. He points out that although railway electrification is a straight economic issue based on no increase of traffic, he considers it a much more productive line of capital development than road transport. As a comprehensive scheme for the whole of Great Britain, it is only a paying proposition at the expense of a reduction of personnel and of the total amount of coal used. He considers that both these disadvantages are certain to be outweighed by countervailing advantages. The electrification of railways will give traffic managers a new method of attracting traffic due to greater acceleration, speed, cleanliness and general comfort. In addition, the shorter trains run at more frequent intervals, the absence of smoke, and better time-keeping will help. Experience on the Southern Railway so far indicates that a very great increase in traffic is likely to result. A regular half-hourly service between London, Manchester and Birmingham would lead to a considerable increase in regular passenger traffic. Increased traffic will help to make good the apparent reduction in the number of employees, and the increase in electric production will also help. The electrification would not be completed for 15–20 years and would therefore be assisting employment continuously during this period. The increase in the efficiency of transport will also add its share to reducing unemployment to its normal level.

Gases in Metals

IT is known that the presence of a minute trace of gas in a metal may greatly change its properties. For example, the magnetic permeability of commercially pure iron is greatly increased by eliminating the small amount of gas which it contains. In the *Bell Laboratories Record* of September, E. E. Schumacher gives an interesting account of the methods employed to free metals from gases, particularly those used in the telephone industries. When the high degree of purity required for research purposes is desired, the metal is usually heated in a vacuum at a temperature above the melting point for a considerable time. But even at low pressures, sufficient gas may be left in the metal to be troublesome. When this occurs, alternately melting and partially solidifying the metal is employed in a high vacuum. In this way, almost complete elimination of the gas can be obtained. The metal to be freed of gas is placed in a shallow boat of fused aluminium oxide. This gives a large surface exposure and reduces the head of metal through which the gas must pass to escape. The apparatus is sealed in a pyrex glass tube connected to the pumping system. The tube is placed in a nichrome resistance furnace and a temperature of 450° C. is maintained until gas is no longer liberated. A high-frequency coil is then substituted for the nichrome furnace and the metal is melted by induced high-frequency current. It is possible to keep the metal at its melting temperature indefinitely without heating the pyrex glass tube to its melting point. The final pressure may be as low as one thousand millionth of an atmosphere. The comparison of the properties of the purified samples with those of samples of any given gas content is of great importance.

Noiseless Underground Trains

A SERIOUS drawback to underground trains is the noise in the carriages when the train is in motion. In many cases this makes conversation even between people sitting next to one another difficult, if not impossible. It is interesting therefore to hear that experiments are being carried out on one of the busiest of New York subways with the object of eliminating most of the noise nuisance. According to the *Electrician* of December 15, five cars equipped with special noise-control devices have been placed in service by the Inter-borough Rapid Transit Co. with the object of finding out how they attract the public. If the silent cars attract the passengers, the

new type of car is to be standardised. It is estimated that the new type of car eliminates about ninety per cent of the noise inflicted upon passengers by the usual equipment. The new cars are said to be so noiseless that passengers can converse across the aisles without raising their voices. Doors and windows are kept closely shut. This excludes dirt and dust as well as noise. The ventilation is provided by electrically driven blowers suspended from the ceiling. The cost of installing the new equipment in the old type of car is about sixty pounds.

Mining Research at Birmingham

THE report of the work of the Mining Research Laboratory in the University of Birmingham during 1932 has been published. This is mainly financed by the British Colliery Owners' Research Association, and the investigations are largely addressed to the subjects of silicosis and nystagmus, which are costing the industry annually a very large sum of money. A great deal of work appears to have been done upon the determination of free silica in rocks, and it may be suggested that if the work of Dr. W. R. Jones, published in a recent number of the *Journal of Hygiene*, is supported by other observers, very much of this work may prove to be useless. On the other hand, the physiological and physical investigations on illuminations promise to be of great help in the matter of nystagmus. Other matters which have been investigated are such important points as the extension of the use of coal, the investigation of spontaneous combustion, the production of dangerous atmospheres in the mine, suitable wetting agents, etc.; and are bound to be of service to the coal mining industry. The report gives the impression of a year's very energetic work.

Industrial Design Competition

THE Royal Society of Arts has recently issued its report on the competition for industrial designs in 1933. For the six sections into which the competition was divided—architectural decoration, textiles, furniture, book production, advertising and commercial art and miscellaneous—2,623 designs were submitted by 1,131 competitors, of whom 724 were students of schools of art, Canada, Australia, New Zealand and South Africa being all represented. The report gives full details of the awards and much information about the prizes. Altogether a sum of £1,614 15*s.* 0*d.* was offered by the Society, the City Companies and various industrial firms, and since the competitions were started about ten years ago, the Society has expended about £5,000 on them. Unfortunately, for financial reasons the Council now finds it impossible to carry on the competitions, so none will be held in 1934. This is much to be regretted, for the competitions have proved of great educational value, and have proved that there is no lack of creative talent among the younger generation.

Liver Preparations and Œstrin

WE have received from the British Drug Houses, Ltd., London, N.1, leaflets describing their preparations of liver for use in the treatment of anæmia and their preparation of œstrin called "Œstroform". For the treatment of pernicious anæmia, there is available liver extract in the form of a powder or in solution for oral or parenteral administration: the former two are pharmacopœial preparations; the latter is issued in 1 c.c. ampoules, each equal in anti-anæmic activity to 50 gm. fresh liver. Œstroform is a standardised preparation of ketohydroxyœstrin and is issued in ampoules for intramuscular or subcutaneous injection and in tablets for oral use, each ampoule or tablet containing 1,000 (international) units. Œstroform is of value in certain disorders of menstruation, in the vomiting of pregnancy and in prematurity of infants.

New Whale Hall at the Natural History Museum

FROM January 1 the exhibit of whales at the Natural History Museum will be closed to the public, and the removal of the specimens to the Hall in the new building, which was completed two years ago, will be commenced. Owing to the difficult economic position which has existed since the completion of the new building, money has hitherto not been available either for the removal of the exhibited specimens or for their erection in the new Hall. Means have, however, now been found to enable a start to be made with the work. Moreover, the old iron building in which the whales and dolphins have been exhibited for thirty-five years past is shortly to be pulled down to make way for a permanent building which is intended to provide storage and study-space mainly for the Department of Entomology.

Museum of Practical Geology

IN consequence of the impending transfer of offices, library and collections of the Geological Survey of Great Britain from the Museum of Practical Geology, Jermyn Street, to the new Museum in South Kensington, London, the Museum of Practical Geology will be closed to the public on and after January 1. The Library of the Geological Survey will remain open to the public until the transfer of the books commences. Entrance will be through the door in Piccadilly.

The Sky in January

VENUS, which has been a brilliant object in the sky during the last months of 1933, is now passing towards inferior conjunction, which is reached on February 5. The casual observer will see little of the planet until its next eastern elongation, but it will be a brilliant object in the early morning sky later in the year. By the middle of January, Mars will set about two hours after the sun; Jupiter will be an early morning object, rising six hours before the sun, and Saturn will be close to Mars in the evening sky. There will be a partial eclipse of the moon, partly visible at Greenwich, on January 30. The circumstances of this eclipse are as follows: Moon enters penumbra, 14h. 07m., leaves, 19h. 17m.; enters umbra, 16h. 01m., leaves, 17h. 20m. Middle of eclipse, 16h. 43m., magnitude, 0·12 (moon's diameter = 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.*]

Evidence for the Formation of Active Hydrogen

THE study of active hydrogen made by J. L. Binder, E. A. Filby and A. C. Grubb[1] showed no evidence for the formation of silicon hydride as proposed by E. Hiedemann[2]. In a special investigation, A. B. Van Cleave and A. C. Grubb[3] confirmed and extended this work and found no evidence for either silicon hydride or atomic hydrogen. Further work by A. B. Van Cleave has shown that this active hydrogen has properties that do not point to atomic hydrogen as proposed by some investigators. With plastic sulphur mounted in a reaction chamber, 20 centimetres from the discharge, there is a definite relation existing between voltage and pressure for the activation of hydrogen. For the region investigated, 10 mm. to 80 mm., the voltage necessary to activate the hydrogen increased with the pressure but not directly proportional to it. Above 80 mm. pressure no active gas was formed and a further increase in voltage had no effect in producing the active hydrogen. At the higher pressure the active constituent apparently decayed before reaching the sulphur. This same general relation was obtained for other tubes, but the maximum pressure at which activity is shown is related to the dimensions of the tube and to the distance of the sulphur from the discharge. It is possible to obtain positive or negative results at will with a shift of five volts on the primary of the transformer. Pure metallic sulphides mounted in place of the plastic sulphur are reduced if the heat of formation of the sulphide is not more than 23,000 calories per mole.

When the tube is operated at 40–80 mm. pressure, a faint afterglow appears in the reaction chamber. This afterglow was investigated with a Hilger spectrograph. The plates showed two prominent lines in the region λ 4634 and λ 4582 and three faint lines in the region of λ 4205, λ 4354 and λ 4674. A continuous spectrum shows in the region between H_β and H_γ, but no spectrum appears in the red region. In a study using an uncoated discharge tube, it was found by a determination of the rate of decay that the reaction follows the first order equation. The active constituent decays to half value in one fifth of a second. The same tube operated under identical conditions, but coated with syrupy phosphoric acid, gave one third less active hydrogen than formerly. This is the opposite of what one would expect if atomic hydrogen were present. Binder, Filby and Grubb found from 0·001 per cent to 0·025 per cent of active constituent. The quantity depended upon the velocity of the hydrogen and the distance of the sulphur from the discharge. The values obtained by A. B. Van Cleave, using a different method of determination and different tubes, fall within this range.

A. C. Grubb[4], and Y. Venkataramaiah[5], have shown that a small amount of active hydrogen is produced when sulphuric acid is electrolysed using a high cathode current density. Thus previous work points to a small percentage of constituent in hydrogen that has some influence upon its activity. The values obtained by Binder, Filby and Grubb, and by Van Cleave and Grubb, approach the order of one part in 4,000, which is about the proportion of heavy isotope, H^2, in hydrogen. G. N. Lewis states[6] regarding the isotope, "I believe that it will be so different from common hydrogen that it will be regarded almost as a new element".

This relation is being investigated further by using hydrogen from heavy water. Details of this work will be published in a subsequent paper. We wish to express our appreciation to the National Research Council of Canada for aid during the course of this investigation.

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A. C. GRUBB.

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[1] *Can. J. Research*, **4**, 330; 1931.
[2] *Z. phys. Chem.*, **153A**, 210; 1931; and **164**, 20; 1933.
[3] *J. Phys. Chem.*, **36**, 2817; 1932.
[4] NATURE, **111**, 671, May 19, 1923.
[5] NATURE, **112**, 57, July 14, 1923.
[6] *J. Amer. Chem. Soc.*, **55**, 1297; 1933.

Carbon Dioxide from the Soil and Plant Assimilation

THE rôle of carbon dioxide formed as the result of biological decomposition of organic matter in the soil has long been a subject of controversy among scientific workers, one school of thought holding the view that it facilitates increased assimilation, and the other that it has no beneficial effect on plant life[1]. There is also difference of opinion as to whether the increased concentration of carbon dioxide observed around the growing plant is the result of oxidation changes in the soil or merely plant respiration. The position is still obscure because (*a*) no systematic experiments would, so far, appear to have been carried out, growing plants in the absence of atmospheric carbon dioxide, and (*b*) the carbon and oxygen relations between the soil, the plant and the atmosphere have not yet been studied collectively, so that it is not possible to define, at any particular stage, the extent to which the plant is indebted to the atmosphere or the soil for the carbon dioxide assimilated by it.

With the view of throwing some light on the above, barley (Plumage Archer) was grown in small pots made up with soil and farmyard manure. One set of plants was maintained in the open as control while others were kept under big glass jars: through one set of the latter, ordinary air was drawn at a gentle rate, while through the other, air free from carbon dioxide was drawn at the same rate. It was observed that the plants grew equally well in all the cases: at the end of one month no striking difference could be observed between the weights of plants grown under different conditions.

Condition under which the plant was grown	Total No. of plants	Average weight per plant in mgm.	
		Fresh	Dry
In open air (control) ..	36	298·9	33·3
Under glass (ordinary air)	28	319·3	32·7
Under glass (CO_2-free air)	27	311·5	32·9

The above observations would suggest that, at any rate in the early stages of its life, the plant draws the bulk of its carbon dioxide requirements from the soil and manure and not from the atmosphere as is generally believed.

A further observation of interest is that the

availability of carbon dioxide from the soil can be increased by treatment such as stirring or introduction of potsherds, which is already known to facilitate aeration of the soil. Even more striking effects can be produced by treating the soil with small quantities of oxidising agents such as ferric oxide, potassium permanganate or hydrogen peroxide. The following observations relating to barley grown on unmanured soil are of interest.

Treatment	Average dry weight per seedling in mgm.
Soil alone ..	38·2
,, + Fe_2O_3 ..	51·2
,, + $KMnO_4$ ..	53·6
,, + H_2O_2 ..	49·8

Further work is in progress, growing plants in big, specially constructed cages through which air of any desired composition and humidity can be drawn. The carbon exchanges between the atmosphere, the soil and the plant are being followed quantitatively. The practical significance of treating soil or manure with small amounts of different oxidising agents is also being investigated.

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[1] Lundegårdh, *Soil Sci.*, **23**, 417; 1927. *Biochem. Z.*, **194**, 453; 1928. *Z. Pflanz. Düng.*, A. **12**, 1; 1928. Keuhl, *ibid.*, A. **6**, 321; 1925. Reinau, *Z. angew. Chem.*, **39**, 495; 1926. Rippel, *Z. Pflanz. Düng.*, B, **5**, 49; 1926. Gerlach, *ibid.*, 65; Lemmermann, *ibid.*, 70; Ehrenberg, *ibid.*, 85. Hasse and Kirchmeyer, *ibid.*, A, **10**, 257; 1928.

Change from Aromatic to Metallic Electrons in Organic Compounds

THE recently published work on the crystal structures of anthracene, chrysene and dibenzanthracene[1] has shown that the graphitic structure, with all the atoms lying in one plane, and an interatomic distance of 1·41 A., is already fully developed in these molecules. We may imagine graphite to be built up by successive fusion of benzene nuclei to these compounds, and the only changes in crystal structure will lie in changes of the orientation of these plane molecules to the axes of the crystal, and in changes of the distance between molecules.

The fact that electrical conductivity is shown by graphite, and not by diamond, is probably to be explained by the fact that the former consists of large plane molecules made up of fused *aromatic* nuclei, whereas the linkages between the carbon atoms in diamond are aliphatic in character. The work of Huckel[2], and others, on the quantum mechanics of the benzene nucleus, suggests that the aromatic p_H electrons originally present in any one aromatic nucleus have a certain possibility of movement to other nuclei within the same molecule. The probability of a jump from one molecule to the next is, however, much smaller, on account of the relatively large distance between molecules.

With graphite, the distances that the electron can move within any one molecule are so large, that electrical conduction is observed when a potential is applied. Graphite is not a typical metal, however, since it has a negative temperature coefficient of resistance. This is smaller the smaller the specific resistance of the sample (for metallised graphite). If the electric conduction of graphite is due to the mobility of the p_H electrons, as is here suggested, it will take place principally along the planes of the molecules, the transition from one plane to another being much less probable. Furthermore, since the molecules are not infinite, transitions from one molecule to the next still have to overcome an appreciable potential barrier. These facts may explain some of the anomalies of this conductor.

It is clearly important for the theory of metallic conduction to determine how large molecules made up of condensed aromatic nuclei must become, in order to show electrical conductivity. From the X-ray evidence, the structure of molecules made up of four or five condensed nuclei is essentially the same as in graphite, and unless metallic conduction depends in a critical way upon size of the system, and number of mobile electrons, they should show a phenomenon of electron wandering, but over much smaller distances. Although the number of barriers between the molecules is too large for metallic conduction to be present, we would expect marked anomalies in certain of their physical properties. The electric polarisability would be anomalously large in directions parallel to the planes of the molecules, and marked birefringence should be evident. Similar anomalies might show themselves in the magnetic susceptibility and dielectric strength, if we compare these properties in directions parallel and perpendicular to the planes of the molecules.

The purpose of these remarks is to emphasise that a study of the physical properties of large molecules with condensed aromatic nuclei is of considerable importance, not only in biochemistry, but also for the theory of the metallic link. Unless this depends on the presence of a critical minimum number of mobile electrons, the catalytic activity of these compounds in biological processes might possibly be ascribed to their pseudo-metallic properties.

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Oxford.
Dec. 2.

[1] J. M. Robertson, NATURE, **132**, 750, Nov. 11, 1933.
[2] *Z. Phys.*, **83**, 632; 1933.

Light of the Night Sky and Active Nitrogen

THE afterglow in the remarkable nitrogen tube described by me[1] last year has been photographed in the visible region. A reference to that paper will show that the visible spectrum of the discharge consists of the first-negative and the first-positive bands of nitrogen, with only a trace of the second-positive bands. The normal spectrum of a nitrogen discharge under the pressure and excitation conditions of my experiment consists of the second-positive and the first-positive bands. The striking change in the spectrum of the discharge itself is carried over to the afterglow.

The afterglows of nitrogen heretofore reported consist mainly of the first-positive bands which originate on the $v' = 10$, 11 and 12 vibrational levels. The present afterglow is made up of bands which arise on much higher vibrational levels such as 18, 19 and 20, etc. In addition to the first-positive bands in this afterglow, there is a strong excitation of the first-negative bands. These bands are emitted by N_2^+. It may be recalled that these bands and the auroral green line compose, for the most part, the

auroral spectrum. They are so strong in the afterglow that it is very easy to observe them in a direct-vision spectroscope.

The intensity distribution of the first-negative bands in the afterglow is different from that in the discharge, so that we have in this fact a guarantee that none of the light of the discharge was photographed during the experiment. Furthermore, while there is some excitation of the second-positive bands in the discharge, these bands are completely missing in the spectrum of the afterglow.

L. A. Sommer[2] has pointed out that in addition to the green auroral line, the light of the night-sky contains the negative bands of nitrogen, thus making it similar to the aurora borealis in its spectrum. The present experiment indicates that Sommer is correct, and furthermore that the excitation of the light of the night-sky is like that of a nitrogen afterglow. The above fact is suggested also by my excitation of the aurora green line in active nitrogen[3]. This experiment and the one reported here show that it is possible to reproduce completely the light of the night sky in the nitrogen afterglow.

The discharge in which the above afterglow has been photographed varies in colour with very small variations in current. These colours are green, greenish-white, white and bluish-white, and they correspond in a most remarkable manner with the actual colours of the aurora.

At the present time the afterglow is being photographed in the ultra-violet on a small quartz spectrograph. It is expected that the new b'-series, observed by Vegard[4] in the luminescence of solid nitrogen and recently in the aurora, will be present in the afterglow. These bands, as well as a new group, which corresponds with Vegard's η-series in solid nitrogen, have been observed in the spectrum of the discharge. Attention has been directed to this discovery elsewhere[5].

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University of California,
Los Angeles.
Nov. 20.

[1] Kaplan, *Phys. Rev.*, **42**, 807; 1932.
[2] L. A. Sommer, *Z. Phys.*, **57**, 582; 1929.
[3] Kaplan, *Phys. Rev.*, **33**, 154; 1929.
[4] Vegard, *Skrifter Utgitt av det Norske Videnskamps Akad. i Oslo*, **2**, 24; 1930; and NATURE, **132**, 682, Oct. 28, 1933.
[5] *Phys. Rev.*, in press.

A Band System of Ionised Aluminium Hydride

IN a recent paper[1] we have reported on some new band systems of AlH. One system was shown to belong to a $^3\Sigma \rightarrow {}^3\pi_i$ transition, and a full analysis of these systems has been given[2]. The further band system at 3600 A. has now been analysed, and is shown to belong to a $^2\pi_i \rightarrow {}^2\Sigma$ transition that accordingly must be attributed to the ionised aluminium hydride AlH^+. Only the (0,0) band of these systems has been found. Perhaps this is due to the predissociation which occurs in the band at $k = 28$ for the upper state.

This predissociation is like that of the $^2\pi \rightarrow {}^2\Sigma$ system of MgH earlier shown by R. d. L. Kronig. The R and P branches break off at $k = 27$ and $k = 29$ while the Q branch has been measured up to $k = 31$.

A perturbation occurs in the Q branches at $k = 18$. From the Λ-type doubling it is evident that the $^2\pi$ state is inverted. The spin doubling constant, A, is 39 cm.$^{-1}$. For the $^2\Sigma$ state a spin doubling given by $\Delta\nu = 0{\cdot}05(k + \frac{1}{2})$ has been found from the divergence in the Δ^2F values.

The following constants have been found:

$^2\pi_i\frac{1}{2}$	$^2\pi_i1\frac{1}{2}$	$^2\Sigma$
$\nu_0 = 27{,}752{\cdot}2$ cm.	$\nu_0 = 27{,}673{\cdot}6$ cm.	
$B = 6{\cdot}650$	$B = 6{\cdot}800$	$B = 6{\cdot}566$
$D = -0{\cdot}000409$	$D = -0{\cdot}00047$	

A full analysis will be published elsewhere.

Two new band systems have been found at 2700 A. and 3380 A., and will now be analysed.

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Nov. 25.

[1] NATURE, **132**, 207, Aug. 5, 1933.
[2] *Z. Phys.*, **86**, 338.

Possible Chemical Nature of Tobacco Mosaic Virus

IN a series of observations, Vinson and Petre[1] claim that the virus disease of tobacco mosaic behaves as a chemical compound. We have repeated this work in detail and confirmed it in every particular, and we are also of the opinion that the virus in this case behaves as a chemical compound and not as a living organism.

In our own investigations, we have employed Johnson's so-called No. 1 mosaic and we are indebted to Dr. Bewley, of the Cheshunt Research Station, for our source of the disease. The disease was transferred to *Nicotiana Macrophylla* by juice inoculation.

We have particularly examined the mixed phosphate eleuate described by Vinson and Petre. This was found to be highly infectious (plants inoculated, 10; plants diseased, 10). The eleuate was found to contain protein (xanthoproteic and biuret test). On gently warming, the protein was precipitated. It could also be precipitated by saturated, but not by half-saturated, ammonium sulphate solution. Contrary to the statement of Vinson and Petre, we found that when the eleuate was brought to *p*H 5 and acetone added (two volumes of acetone to one of eleuate) a heavy white precipitate fell. The acetone precipitate was found to contain protein and proved to be infectious (plants inoculated, 5; plants diseased, 5).

It was observed that the acetone precipitate could be separated into two fractions, a white crystalline solid and a gelatinous portion which proved to be protein. The question arose as to whether the virus was present in the protein fraction or in the white crystalline solid, or whether both were needed to bring about infection. Infection with protein alone induced disease (plants inoculated, 5; plants diseased, 5). We were quite unable to free the protein from virus.

The white crystalline solid was purified by repeated precipitation with acetone, washed with ether and dried in a vacuum desiccator. It proved to be mainly composed of phosphate, but considerable organic matter was also present as it charred on heating. It was found to contain *no* nitrogen and proved infectious (first inoculation: plants inoculated, 5, plants diseased, 5; second inoculation: plants inoculated, 8, plants diseased, 8). The protein fraction apparently plays no part in infection. The following experiments confirm the fact that protein plays no part in bringing about the disease. The addition of 1 per cent solution

of safranin to the phosphate eleuate produced a slow precipitate. This was separated on the centrifuge, suspended in water and the safranin removed with normal amyl alcohol. The aqueous solution was found to be infectious and contained no protein, phosphate or nitrogen.

As a control, sap from healthy plants was treated in exactly the same way as that from diseased plants. The behaviour of the mixed phosphate eleuate with acetone was quite different. Instead of the heavy white precipitate described above, a faint opalescence appeared which did not settle for many hours.

That plant viruses are not living organisms has been previously suggested. It has been stated that they are possibly enzymic in nature. Vinson and Petre are of the opinion that tobacco mosaic virus is of the nature of a simple protein. The isolation by us of a white crystalline compound which contains no nitrogen and yet is highly infectious appears to us to preclude the possibility of tobacco mosaic virus being of the nature of a living organism. In its precipitation with safranin it shows affinities with the proteolytic enzymes, but until we have made further investigation of the substance we can make no definite statement as to whether or not it is enzymic in nature.

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Research in Plant Breeding.
Corstorphine, Edinburgh, 12.

[1] *Contrib. Boyce Thompson Instit.*, **1**, 479; 1929. **3**, 131; 1931. See also Vinson, *Phytopath.*, **23**, 35; 1933.

Wasting Disease of Eelgrass (*Zostera marina*)

IN a report by Dr. Harrison F. Lewis of the Department of the Interior, Canada (referred to in NATURE of August 19, p. 277), it is mentioned that Dr. E. Silver Dowding has found in one blackened portion of the cortex of the rhizome "a coarse mycelium", "but as it could not be found in any other samples examined, it was not considered to be a cause of the disease". On account of this, I wish to communicate here that during last summer I have studied this disease, which now is widespread in Danish waters, and that I have always in the blackened spots seen the mycelium of a fungus as a constant feature.

I have examined principally leaves; only in a few cases have I seen infected rhizomes. I can say that I have never found a black spot without a mycelium. This mycelium consists of septate and branched threads a few μ broad, which when young are colourless, in the older stages dark brown. In the rhizomes it lives mostly in the outer cortex, in the leaves in the cells of the mesophyll, often growing for a long distance from cell to cell through the long air-spaces and creeping along the cell-walls. I have tried to isolate this fungus with the result that I have got a fungus of the group Hyphomycetes, which resembles the fungus growing in the leaves and in the rhizomes. As this pure culture has only been obtained once, I cannot say with certainty if the fungus I have isolated is identical with that of *Zostera*. Yet it is able, when growing in agar-agar blocks in sea-water, to infect the leaves and produce the dark spots.

Another question is whether the *Zostera* fungus really is the cause of the disease; it might be a saprophyte accompanying the disease caused by another organism such as a bacterium. The isolated mycelium produces conidia in great number in sea-water; in the *Zostera* fungus I have only seen a few this summer.

In conformity with the foregoing, I believe that the observation of Dr. E. Silver Dowding concerning the occurrence of a mycelium in Canadian material deserves further investigation. In the coming year I hope to complete my own observations.

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Foundations of the New Field Theory

THE new field equations proposed recently[1] can be derived from either of two principles, the first being a rather obvious physical statement, the other an equally obvious mathematical postulate.

(1) Einstein's mechanics is equivalent with the Lagrangian $m_0c^2\{1-(1-v^2/c^2)^{\frac{1}{2}}\}$. Historically, it has been derived from the idea of relativity[2]; but it could just as well have been found from experiments which show that electrons can not be arbitrarily accelerated. From this follows the existence of an upper limit for the velocity c; and the new Lagrangian is the simplest expression which is real only for $v<c$ and gives for the limit of small velocities the classical value $m_0v^2/2$.

The problem of finding the exact law of the electromagnetic field can be attacked in a similar way. The classical Lagrangian $L=\frac{1}{2}(H^2-E^2)$ allows infinitely large values for the strengths of the field. But experience leads to the *principle of the finite field*. For the use of the classical function L gives infinite values of self energy and other physical quantities which are, in fact, certainly finite. From this follows the existence of a limit of the field, b (formerly called a^{-1}); and by the same reasoning as in mechanics, one constructs the new Lagrangian

$$L=b^2[1-\{1-b^{-2}(E^2-H^2)\}^{\frac{1}{2}}] \qquad (1)$$

(2) The same result can be obtained by the mathematical postulate of the *invariance of action*.

Using the tensor notation, the classical Lagrangian is $L=\frac{1}{2}f_{kl}f^{kl}$, where $f_{kl}=-f_{kl}$ represents the field (H,E). The integral $\frac{1}{2}\int f_{kl}f^{kl}d\tau$ ($d\tau$ element of space-time) is invariant for linear orthogonal, but not for general, transformations.

If a_{kl} is any tensor and $|a_{kl}|$ its determinant, then $\int\sqrt{|a_{kl}|}\,d\tau$ is an invariant[3]. Now every tensor can be split up into a symmetrical and antisymmetrical part: $a_{kl}=g_{kl}+f_{kl}$; $g_{kl}=g_{lk}$, $f_{lk}=-f_{kl}$. The symmetrical part g_{kl} should be identified with the metrical and f_{kl} with the electromagnetic tensor. If we demand that the actions should be not only invariant, but should also take the form of the well-known expression $\frac{1}{2}\int f_{kl}f^{kl}\,d\tau$ in the case of small electromagnetic fields and cartesian co-ordinate systems, we obtain

$$L=(-|g_{kl}|)^{\frac{1}{2}}-(-|g_{kl}+f_{kl}|)^{\frac{1}{2}} \qquad (2)$$

This expression is entirely equivalent to the expression (1) for a statical field and a cartesian co-ordinate system. In the general (not statical) case an additional term, namely, $b^{-4}(EH)$ in the square root appears. One can get rid of this by choosing another but also invariant expression for L.

M. BORN.
L. INFELD.

[1] NATURE, **132**, 282, Aug. 19, 1933; *Proc. Roy. Soc.*, in the press.
[2] Compare G. Levi-Civitá, "Absolute Differential Calculus" (1927), Chap. xi, pp. 286–301.
[3] A. S. Eddington, "The Mathematical Theory of Relativity" (Cambridge, 1923), 107.

A Simple High Resistance

WITH reference to Prof. W. Burbidge's letter[1], it is necessary to point out that the characteristics of carbon film and non-metallic resistors differ greatly from those of the wire wound type. All carbon and carbon-insulating mixtures have negative temperature coefficients, that is, as the temperature increases the resistance decreases. It has been found that the temperature coefficient varies for different grades of carbon, but if a particular carbon be mixed with an insulating material, such as clay, in order to obtain a higher resistance value, the temperature coefficient of the mixture, within certain limits which are determined by the kind of insulating substance used, remains the same as that of the pure carbon. I have found the resistance value of carbon insulating mixtures above 0° C. to be given by :—

$$R_0\left(1-\frac{tk}{(t+c)^2}\right),$$

where R_0 is resistance measured at 0° C., t is new temperature and k and c are constants depending upon the grade of carbon and kind of insulating substance.

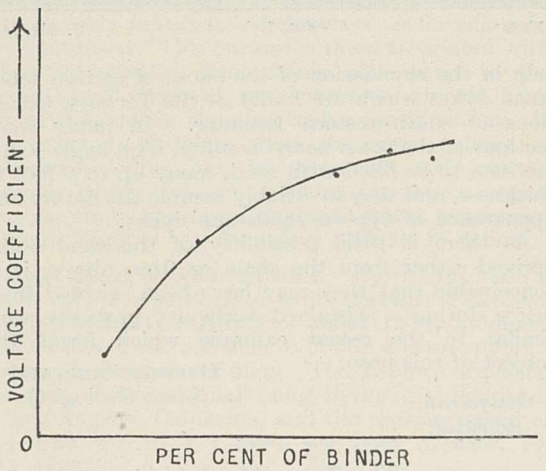

FIG. 1.

When solid resistors made by compressing carbon and insulating binder together are allowed to heat up, the resistance at first decreases, but as the temperature rises towards dull red it begins to increase, and at bright red it suddenly drops to a value which is only a fraction of the cold resistance. During the sudden change there is a marked resemblance, both physically and mathematically, to the breaking down of an insulator by an arc. If the carbon mixtures are not compressed, arcing occurs intermittently between the particles, and the behaviour of the resistor is so erratic as to make it impossible to obtain any useful figures. Carbon, either deposited loosely (smoky flame method) or compressed with 'binders', has a negative voltage coefficient. The value of the change in resistance per unit of resistance per unit change of potential difference across the resistor depends on the density of the carbon film, or on the kind and amount of 'binder' present in the resistor. The curve (Fig. 1) shows how this voltage coefficient varies with the quantity of insulating material for solid, compressed resistors. It is, therefore, necessary to state the potential difference across the resistor at the time of making the resistance measurement.

Another curious property associated with carbon resistors, when under load, is the continuous minute fluctuations of voltage which take place across them. These fluctuations may amount to several hundred microvolts in high value resistors, and seem to be due to particles of carbon becoming heated and making intermittent contact with their neighbours, thus causing a slight change in the overall resistance. Carbon resistors are affected very much by atmospheric humidity, and the only way to guard against changes of this nature is to impregnate them with a good quality wax or varnish, or enclose them in an evacuated tube. The former method suffers from the disadvantage of changing the resistance to a higher value ; the wax or varnish soaks in and acts as a 'binder'.

Making good electrical contact with carbon resistors is very difficult, especially if they are to carry a load and liable to heat up. Mr. J. C. Jones in his letter[2] points out that he has experienced this trouble even when the metallic contact is covered with carbon as specified by Prof. Burbidge. Bad and noisy contacts are due to the resistance material having a slightly different density at and around the place where it makes contact with the metal. In the above case it is probable that the carbon did not settle evenly at the place where the metal met the insulator. Slight oxidisation of the metal between the surface of contact will also give rise to variations. It is interesting to find that some metals make better contact with carbon than others ; gold appears to be one of the best in this respect. Carbon resistors are now manufactured extensively by a number of leading electrical firms. They are either of the solid rod type or consist of a thin film of carbon deposited on an insulating tube. The former is made by mixing finely ground carbon and various ceramic substances. The mixture is then compressed into shape and baked at a high temperature. Contact is made by spraying the ends of the baked resistors with molten copper. This kind of contact gives no trouble.

The thin film type, which seem to possess the least extreme characteristics of the two, are made by coating rods of insulating material with liquid carbonaceous compounds, and stoving them in a non-oxidising atmosphere until a layer of conducting carbon results. Contact is generally made by allowing lead alloy to solidify on the ends.

A mixture suitable for making resistance from a few thousand to several millions of ohms can be prepared by mixing colloidal graphite (Aquadag) and phenol-resin colloid. The resistance of the mixture varies directly as the amount of resin colloid present. This mixture should be painted on a rod of insulating material and baked at 300° F. for two hours. Contact is made by dipping the ends of the baked rod in thimbles filled with molten Wood's metal and allowing the metal to set hard. The resistance value may be adjusted by touching up the surface with fine emery-cloth. This type of resistor can be made variable by arranging for its immersion to any desired extent in mercury.

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Nov. 24.

[1] NATURE, 132, 677, Oct. 28, 1933.
[2] NATURE, 132, 823, Nov. 25, 1933.

Polarisation of Electrons

RUPP, working with Szilard, has reported[1] a peculiar form of asymmetry in the scattering of electrons. He finds that fast electrons when scattered through 90° and then passed through a thin gold foil show asymmetrical diffraction rings. The rings were strongest when the diffraction turned the electrons in the same way as the original scattering and weakest at 180° to this direction. The effect became marked at 150 k.v. and increased with the energy of the rays.

I have repeated these experiments, but have failed to find the effect. Rupp used a thick target for the original scatterer. In the hope of intensifying the effect I used one thin enough to make the scattering predominantly single; this resulted in a considerable diminution in intensity, and the holes limiting the scattered beam had to be made rather large, so that the rings were rather broad. No appreciable effect could be observed on eight plates taken with three films, which were reversed between each exposure to eliminate asymmetry in the film. The mean voltage determined from the size of the rings was 152 k.v. which was the limit my generator could safely give. Rings up to and including that corresponding to $\sqrt{35}$ and $\sqrt{36}$ could be clearly seen. Photometric as well as visual comparisons were made. As it seemed possible that the effect might have been obscured by the broadness of the rings, I took two plates with a thick target and small holes giving sharp rings, but here also no difference between the two sides could be detected. The voltages were 153 and 154 k.v.

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Dec. 13.

[1] Rupp, *Phys. Z.*, **33**, 158, 937; 1932.

Small Sand Craters of Seismic Origin

IN connexion with the earthquake of October 2, which was felt throughout the coastal zone of Ecuador, I was fortunate in being able to photograph several examples of unusual structures which were formed directly after the seismic disturbance. The craters were found in a dry lagoon close to the seashore and were associated with pronounced fissures in the alluvium, these being orientated from north-east to north-west. The fractures occur near a major fault which separates the Eocene and Oligocene formations, and thus it appears that there was movement along this fault at the time of the earthquake.

According to the version of the inhabitants, the cracks in the ground appeared immediately after the first tremor, and at the same time numbers of jets of fresh water, two feet or more in height, were observed issuing out of the fissures. Large quantities of sand were brought up by the water and this material was precipitated in the form of the small craters which are illustrated in Fig. 1. The cones were occasionally fused into groups, whilst in other examples the structures were elongated along the apertures of the respective fissures. The largest craters measured about four feet in diameter and varied from six to twelve inches in height. After a short interval of time, which probably corresponded to the duration of the initial tremors, the activity of the springs ceased, and the water which had temporarily inundated the area disappeared underground through the open fissures.

It is evident from the above, therefore, that the land surface in the vicinity of the faulted zone in the Tertiary rocks subsided at first, and this movement caused the ejection of the fresh water, which resulted in the crater-like structures of loose sand. After the earthquake, however, the surface of the ground was restored to its original level.

Apart from the geological interest which is attached to these recent seismic phenomena, they probably

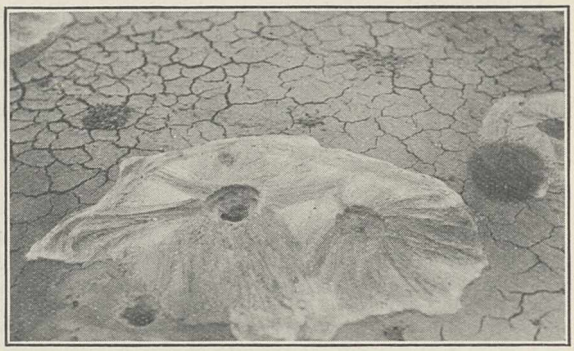

Photo FIG. 1. *G. Sheppard*

help in the elucidation of the cause of certain sandstone dykes which are found in the Tertiary formations of south-western Ecuador. In many shale sections of the coast near Chanduy, high angle joints are seen to be filled with sand, many up to a foot in thickness, and they invariably assume the nature and appearance of typical sandstone dykes.

As there is little possibility of the sand being derived either from the shale or from above, it is conceivable that they may have been injected from below during a seismic disturbance, probably very similar to the recent example which forms the subject of this note.

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The Term 'Mesolithic'

ARCHÆOLOGISTS, of whom I am one, are really quite remarkable people. It is notorious that the nomenclature of their study is already in a sad condition, yet, recently, they have gone out of their way to make confusion more confounded. It has now become the practice to describe early neolithic flint implements by the term 'mesolithic', a term which means, of course, 'Middle Stone Age'. Some misguided individual, however, evidently possessing, in full measure, the common archæological flair for promoting the use of a misleading terminology, has applied it to relics referable solely to the end of the Stone Age, and to make matters worse, the practice is becoming widespread. I find it necessary to remind myself that I am writing to the editor of a highly reputable scientific journal, and this knowledge, I confess, somewhat cramps my style. I would like to say many other things about the term 'mesolithic'. But if archæologists wish to retain a vestige of a reputation for reason, let them drop this word now, and for evermore.

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Research Items

Indians of Virginia. When English settlers reached Virginia early in the seventeenth century, they found the country from the river falls to the mountains was claimed by tribes of the Monacan confederacy belonging to the Siouan stock, who were at enmity with the Algonquian tribes, some of whom they had displaced not long before and whose villages lined the shores of the James from its mouth to the Monacan borders. The country west of the Blue Ridge was claimed at a later date by the Iroquois, but they do not appear ever to have settled there. The evidence of occupation of Albemarle County, documentary and archæological, has been examined by Mr. David I. Bushnell, Jr. (*Smithsonian Miscellaneous Collect.*, 89, No. 7), who describes a number of stone implements and the sites on which they were found. A large part consist of stone arrow-points from hunting-grounds. The marked weathering of some of the implements is contrasted with the unchanged condition of others which have been exposed to identical conditions for two centuries and a half, pointing to the high antiquity of the former. There were evidently two periods of occupation, of which the earlier may be connected with an early culture found elsewhere, as for example, in Connecticut. This culture is there associated with soapstone mines. Such mines also occur in the piedmont of Virginia, but soapstone objects have not been found in the area under consideration. It is suggested, therefore, that the early culture of Albemarle County may be part of an early culture complex which once extended widely over a region ranging from the New England States southward through Virginia to a boundary difficult to define.

Flight Speed of White Pelicans. By pacing, with a motor car, a large flock of white pelicans (*Pelecanus erythrorhynchus*) consisting of about 120 individuals, Ronald Case Ross was able to obtain a close approximation to their rate of flight. The distance of pacing was some three and a half miles, in the neighbourhood of Los Angeles, California, and the cruising speed of the flock was 31 ± 1 miles per hour (*Condor*, 35, 70; 1933).

Eradication of Bovine Tuberculosis. The results of a large-scale experiment, promoted by the Medical Research Council, on the eradication of bovine tuberculosis, are reported by Dr. L. Jordan, of the Hannah Dairy Research Institute (Med. Res. Council, Special Rep. Series, No. 184. London: H.M. Stationery Office). An area of about nine square miles, which included 30 farms participating in the experiment, was selected in Ayrshire. The method was to apply the tuberculin test to the herds; reactors were then housed and grazed separately so far as possible from non-reactors, buildings that had contained infected stock were disinfected, and common water supplies were eliminated. Reacting cows were disposed of when practicable, and precautions taken to prevent infection of young stock. Herds were re-tested at six-monthly intervals and necessary adjustments made; throughout, the ordinary farm routine was interfered with as little as possible. At the end of the three-year period of the experiment, of the 30 herds participating, 20 were free from infection (compared with 8 at the beginning), and 8 showed a substantial reduction in the number of reactors.

Epithecal Scales of Fossil Corals. Dr. Louis B. Smyth has recently published two short papers on fossil corals ("On *Cleistopora geometrica* (Milne Edwards and Haime)". *Proc. Roy. Irish Acad.*, 41, Sect. B, No. 12. "On Certain Carboniferous Corals with Epithecal Scales." *ibid.* No. 13. September 1933). In the second paper, two new species of coral from the limestone of Tournai, Belgium, are described. Both are small massive forms with a granular upper surface and a wrinkled epitheca; both may bear peculiar scale-like epithecal structures. Because of these the author believes that the two species must be closely related, but owing to the great difference in other respects he assigns them to separate new genera, *Squameophyllum* and *Stratophyllum*. The nature of these scale-like bodies is obscure. They are reminiscent of the foreign fragments cemented upon the shell of the gastropod *Xenophora agglutinans*, and in view of the habit of some sea anemones, it might be suggested that the corals covered themselves with foreign objects in such a way that the bodies near the base of the exosarc sometimes became incorporated in the epitheca. He rejects this, however, as unlikely, since the bodies are so minute and all of one kind. He therefore regards them as a direct product of the coral, perhaps as a reaction to disease, as they are not present on all the specimens and an abnormal form has the most complete clothing of scales. They are not peculiar to one locality. Lindström has described epithecal scales in silurian species of coral, *Tryplasma loveni* and *Syringophyllum organum*, in the latter somewhat similar to those from Tournai, in the former more regular and of a different shape, which he regards as being probably homologous with the opercula of such genera as *Goniophyllum* and *Araeopoma*.

Culture of Tissues of *Ptychodera*. Included in the report of the Tortugas Laboratory in Year Book No. 31 of the Carnegie Institution of Washington is a report on tissue culture by Dr. L. R. Cary, who has studied the behaviour *in vitro* of tissues of *Ptychodera bahamensis*. Details of the work are given in Publication No. 435 recently issued by the Carnegie Institution. The technique for sterilising the piece of tissue by repeated washing in 10 per cent by volume of hexylresorcinol in sterile sea-water or by ultra-violet irradiation from a mercury vapour lamp is described. A peptic digest of entire *Ptychodera* was used as a nutrient medium in the preparation of all cultures and the growth of bacteria in the culture was minimised by addition of hexylresorcinol, which had no deleterious effect on the tissue. A small fragment of tissue from the dorsal side of the middle region of the body contains ectodermal epithelium, nerve cells, cells from the digestive cæca, muscle cells and connective tissue cells. Particular attention was devoted to the endoderm cells of the digestive cæca, which migrate from the tissue in culture as flask-shaped bodies; other cells to which they are attached move out successively from the mass of tissue so that a chain of ten or more endoderm cells extends outwards. When these endoderm cells divide, their characteristic pigment granules may be passed on entirely to one daughter cell, the other cell having clear protoplasm. When freed in this way from their large granules, the cells exhibit unusual amœboid

activity, and when maintained in culture the activity of these cells remains constantly at a higher level than that shown by related cells in which the granules are retained. Meantime many muscle cells become separated from the tissue; some become greatly elongated and show marked amœboid activity.

Crossing-over with Inversions and Translocations in *Drosophila*. Six dominant mosaic eye-colour allelomorphic mutants from the brown locus in the second chromosome of *Drosophila melanogaster* have been produced by X-rays. They have been investigated by Dr. H. B. Glass (*J. Genetics*, 28, No. 1), who finds that two of them are associated with inversions of particular chromosome segments, the other four with mutual translocations, the chromosome break occurring in every case close to the locus concerned. A dominant mutant from pink eye in chromosome III was also studied, and two dominant mosaic eye colours (called Moiré) in the left arm of III, one associated with an inversion and the other with a mutual translocation. By using flies with a series of mutant genes, the nature of the transposition in each case is investigated. The conclusion that after a mutual translocation of chromosome segments the crossing-over is increased in one chromosome and inhibited in the other is confirmed. It is also concluded that crossing-over need not always begin either at the spindle fibre or the distal end of the chromosome, but in certain cases two chromosomes appear to have undergone synapsis in the form of a ring. This introduces new configurations into the possible rearrangements resulting from different forms of crossing-over.

Chromosomes of Cotton and its Relatives. Recent investigations of cotton and its relatives are throwing important light on the origin of the genus *Gossypium* and the relationships of its species, information which is of value in unravelling the genetics of this important economic plant. A study of the somatic and meiotic chromosomes in nine genera of the Malvaceæ, by Dr. J. H. Davie (*J. Genetics*, 28, No. 1), leads to significant results bearing upon the evolution of cotton. Polyploidy on a basis of $n = 7$ is shown to have played a considerable part in the family Malvaceæ, leading to hexaploid species ($2n = 42$) in *Malva*, *Pavonia* and *Kitaibelia*, and hypohexaploidy in *Lavatera olbia* ($2n = 40$), probably through subsequent fusion of two pairs to give one very long pair of chromosomes. *Hibiscus africanus majus* is octoploid ($2n = 56$). In *Gossypium*, the presence of secondary pairing of certain chromosomes in meiosis and the existence of one larger pair leads to the conclusion that the number $n = 13$ has been derived from an ancestral number $n = 7$. The 'diploid' cottons would then be really modified tetraploids. From these the cotton species with $2n = 52$ have probably been derived through amphidiploidy, that is, doubling of the chromosomes in a sterile interspecific hybrid. The recent discovery that certain wild cottons in Lower California have $2n = 26$ chromosomes indicates that this doubling process to give the valuable Sea Island and other cottons probably took place in America, and possibly during cultivation by the Indians. The various 'tetraploid' cottons ($2n = 52$) therefore appear to be really modified octoploids, the different species not necessarily having the same ancestor. It is clear from these and other results that a fuller investigation of the temperate Malvaceæ is likely to throw further light on the origin and genetics of cotton.

Mechanism of Spontaneous Expulsion of *Wistaria* Seeds. In a recent paper, Tirada, Hirata and Utigasaki (*Sci. Pap. Inst. Phys. Chem. Res.*, Tokyo, 440–1, 233–241; 1933) attempt an explanation of the spontaneous expulsion of *Wistaria* seeds. The immediate mechanism is the dehiscence of the leguminous pods, which takes place with some violence and can expel the seeds, each weighing about 0·5 gm., to a distance of more than 11 m. Under dry conditions, the pods split open longitudinally and eject the seeds, while the two halves of the pod coat assume a helical form. Under the condition that the whole of the elastic potential energy of the two halves of the pod coat is converted into the kinetic energy of the seeds ejected, and making other arbitrary and rather doubtful assumptions, the authors calculate the initial velocity of the seeds at the comparatively enormous figure of from 40·7–61·3 m. per sec., which gives a range of from 17·6–22·6 metres. X-ray photographs of the three principal layers of the pod coat are given. In the same volume (*loc. cit.*, p. 242) Hirata gives measurements of the rigidity of various layers of the pod coat, and records an undoubted hysteresis effect in the relation of rigidity to humidity. A complete determination of the effect of desiccation on the flexure of the tissues concerned, which is doubtless a complicated function of the rigidity, and also of the amount and direction of swelling, of the various layers, presents a problem requiring even fuller treatment.

New Genus of the Ascomycetes. Two new fungi have recently been described by Miss E. S. Dowding ("*Gelasinospora*, a new Genus of Pyrenomycetes with Pitted Spores". *Canad. J. Res.*, 9, No. 3, 294–305. Sept. 1933). The fungi produced ascospores with dimple-like pits, and have been included in a new genus, *Gelasinospora*. Both species produce perithecia, and are therefore Pyrenomycetes. *G. tetrasperma* is a coprophilous fungus with four spores in the ascus, as the name implies. The ascospores may be either dwarf, with two nuclei, normal, with four nuclei, or giant, with six nuclei. Normal and giant spores give rise to homothallic mycelia and perithecia, whilst dwarf spores produce mycelia of different sex, which must unite before perithecia can be produced. *G. cerealis* occurs on wheat and oats, and bears eight ascospores, each of which is binucleate and gives rise to a homothallic mycelium.

Die-back of Apple Trees. The fungus *Valsa ambiens* (Pers.) Fr. causes the death of small twigs of apple and other trees. It has been connected with a species of *Cytospora*, and mycologists have recognised the fact that the two names were given to different stages of the same fungus. Mr. Lawrence Ogilvie has studied the disease ("Canker and Die-Back of Apples associated with *Valsa ambiens*". *J. Pomol. and Hort. Sci.*, 11, No. 3, 205–213, Sept. 1933), and finds that wedge-shaped cankers at the base of the tree and on the branches are also a feature of the disease. Inoculation to healthy branches did not induce disease, but the introduction of the fungus to wounds or burned areas resulted in infection. The *Cytospora* stage was identified as *C. ambiens*, Sacc. Damage to trees does not appear to be extensive, and apples show a tendency to recover from the disease.

North-Westerly Winds of Iraq. Knowledge concerning the vertical extent of the north-westerly winds over Iraq in the summer is of importance in the study of the general circulation of the atmosphere during the time when there is an inflow of surface air to southern Asia. It has also a more directly practical importance, for these winds, known locally as the Shamal, prevail over a wide area including the Persian Gulf, and it is of importance to know to what extent aircraft can avoid them by high flying. In Prof. Note No. 64 of the Meteorological Office (London: H.M. Stationery Office) an analysis is made of many soundings with pilot balloons that have been made at Hinaidi (Baghdad) and at Shaibah near Basra. In discussing the results, S. P. Peters points out that monthly normal isobars above sea-level, published by the India Meteorological Department, suggest that from June to September inclusive the gradient for north-westerly winds over Iraq will have practically disappeared when a height of 10,000 ft. has been reached. It is found that out of the occasions in July at Hinaidi when the wind at 1,500 ft. is from between 290° and 360°, with speed 20 miles an hour or more, a backing of the wind to beyond 270° or a veer to beyond 20° may be expected to occur at some height not above 10,000 ft. once in four occasions, and for the Tigris-Euphrates Valley generally from June to September inclusive, at least once in five times. It is believed that the actual frequencies based on more complete and evenly spaced information with which there would be no element of selection, such as is introduced for example by the tendency for the balloon to be lost to view at a comparatively low level on very windy days, may be as high as one occasion in two. An important point is that the wind above the height where the change occurs rarely reverts to the north-westerly direction; in general, the speed at the level of change is much less than at 1,500 ft.

Physical and Chemical Conditions in the Great Barrier Reef Lagoon. The physical and chemical investigations carried out by A. P. Orr in the Great Barrier Reef lagoon (Great Barrier Reef Expedition, 1928–29. Scientific Reports, vol. 2, No. 3: "Physical and Chemical Conditions in the Sea in the Neighbourhood of the Great Barrier Reef". London: British Museum (Natural History), 1933. 5*s*.) throw considerable light on the coral reef problem and are the first to be made in the tropics throughout a complete year. No significant seasonal changes were found in phosphate, nitrate or hydrogen ion concentration, or in percentage oxygen saturation, which was between 90 and 100 per cent for most of the time. It is clear that the frequently expressed opinion that corals on the windward edge of a reef grow more vigorously because of the higher oxygen content of the water is no longer tenable. Conditions are suitable for plant growth throughout the year but the concentration of phosphate (around 5 mgm. phosphorus per cubic metre) and nitrate were never sufficient to allow an outburst comparable with that found in temperate and polar latitudes in spring. During the rainy season, surface salinity fell and the effect of heavy rainfall was very apparent. In the dry season the south-east winds kept the water very well mixed, but at no season did a well developed thermocline form inside the Barrier. Some work was also done outside the Barrier; except for lesser turbidity due to the absence of mud, conditions were similar to those found inside at the same depth. A sharp rise in salinity occurred between 50 metres and 100 metres, agreeing with changes in other conditions and showing this to be the limit of vertical mixing. The biological applications of the results are briefly discussed but are to be elaborated in later reports.

Viscosity of Pitch. One of the most important uses of pitch is in the manufacture of briquettes of powdered coal. The effectiveness of the pitch in covering the coal particle is probably dependent on the viscosity—the property which governs the empirical tests now applied to pitch. The viscosity of typical pitches has been measured by A. B. Manning (Fuel Research Technical Paper No. 39. London: H.M. Stationery Office) using three different methods to cover the range 30°–110°. The results show that all the coal-tar pitches examined behaved as truly viscous liquids. Experiments made with bitumen, that is, petroleum pitch, showed anomalies analogous to those of colloids such as gelatine, rubber, etc. Bitumen appears to have the structure of a gel and this may be responsible for the different behaviour in use.

Atomic Weight of Uranium Lead. A recent determination of the atomic weight of lead from cyrtolite by Baxter and Alter (NATURE, 132, 285, Aug. 19, 1933) gave Pb = 205·94 and of lead from Katanga pitchblende 205·97 − 206·00. Hönigschmid, Sachtleben and Baudrexter (*Z. anorg. Chem.*, 214, 104; 1933) have made atomic weight determinations with lead from Morogoro uranium ore, Katanga curite, Katanga pitchblende and ordinary lead. The last, used as a control, gave Pb = 207·21. The values for the specimens of uranium lead were: (1) Morogoro, 206·035; (2) curite, 206·032; (3) soluble extract from Katanga pitchblende, 206·022. The three values are regarded as identical, and the conclusion is drawn that the leads from the three pure African uranium ores have the same isotopic composition and the same atomic weight, 206·03. The Katanga pitchblende was the same material as that used by Baxter, and the discrepancy between the results remains unexplained.

Electric Clocks from Direct Current Mains. In certain parts of England the direct current supply is obtained by means of mercury arc rectifiers from a three-phase time-controlled fifty-cycle system. In this case it is well known that there is a pronounced third harmonic ripple in the D.C. supply. The frequency of this ripple is 150. According to the *Electrical Review* of December 15, a consumer in Devon recently connected a standard synchronous clock designed for 230 volts at 50 cycles across a supply of this kind. He had previously put in a three to one reduction gear so that the seconds hand should rotate one revolution per minute. As the amplitude of the ripple voltage was only about one fourth that for which the clock was designed, a transformer of one to ten ratio was installed between the supply and the clock coil and a condenser was put in series with it to block out the direct current. It was found that the clock worked satisfactorily. Mr. Geoffrey Ghey, of the Royal Naval College, Dartmouth, who brought this interesting application of the ripple to the notice of Messrs. Ferranti, Ltd., has now clocks of this type operating on the direct current mains. The advantage of perfect time-keeping can thus be obtained from what many think is a defect in the mercury arc rectifier.

Recent Excavations in the Near East

IN a paper read on September 12 before Section H (Anthropology) of the British Association at Leicester, Miss D. A. E. Garrod outlined the results of the season's work carried out by a joint expedition of the British School of Archæology in Jerusalem and the American School of Prehistoric Research at Mugharet et-Tabun in Palestine. The cave is the last of the group of the Wady el-Mughara, at the foot of the western slope of Mount Carmel, to be examined. Of the caves previously excavated, the Mugharet el-Wad yielded a prehistoric culture sequence ranging from Natufian through three Aurignacian horizons down to Mousterian; the Mugharet es-Skhūl is purely Mousterian, the industry corresponding very closely in type to that found at the base of the Mugharet el-Wad. Skeletons found in Skhūl differ in many respects from those of the Neanderthal race, notably in the greater height of the cranial vault and in the presence of a well-defined chin.

At Mugharet et-Tabun were found the final stages of the Lower Palæolithic. The sequence is :—

(1) Bronze Age to Recent.

(2) Upper Mousterian.

(3) Lower Mousterian, an upper layer, in which were found teeth of *Hippopotamus* and *Rhinoceros Merckii*. Like that of the Upper Mousterian, the flint industry is in the Levalloisian tradition, but differs from it in that the individual pieces are larger and the proportion of unworked to worked pieces greater. The characteristic form is a large oval Levallois flake. The lower layer of the Lower Mousterian yielded remains of *Rhinoceros* and a Levalloisian industry with abundant narrow triangular points and flakes, but no large oval flake.

(4) Acheuleo-Mousterian. From this layer downward the change in the flint industry is fundamental. The upper layer contains scrapers and flakes more or less Clactonian in type, Chatelperron points, narrow blades with fine edge—retouch, and hand-axes. The industry of the next layer is similar, but smaller in size; in the next the flake implements are still of High Lodge type, but the characteristic tool is the fine pointed Micoquian hand-axe; in the fourth, La Micoque forms are absent and the industry resembles that of the second layer.

(5) Upper Acheulean, characterised by a hand-axe, generally pear-shaped, rather thick and on the whole roughly made.

(6) This contains small rough flakes, much utilised, but no hand-axes, no points and only a few scrapers. This industry is identical with that found by Peyrony at the base of La Micoque, well below the level of the typical Micoquian hand-axes: the name Tayacian has been suggested for it.

The most important human remains found are a complete lower jaw from the base of the Lower Mousterian, and a nearly complete skeleton from the upper part of the same layer. Sir Arthur Keith reports that the skeleton is that of a woman of 25–30 years of age and about 4 ft. 11 in. in stature. The limbs show all the peculiarities of the Neanderthal type of Europe. The massive curved supra-orbital ridges are in shape and size almost identical with those of the Galilee skull, and the supra-orbital width is greater than the greatest width of the frontal bone, a feature not observed in European Neanderthal skulls. As in the case of the child's skull found at Mugharet es-Skhūl, the temporo-mandibular region is modern in type, though the mastoid process and digastric region are Neanderthaloid. The lower jaw is receding and chinless. The portion of the jaw which gives attachment to the muscles of the tongue shows a transitional state between that of a young gorilla and that of modern human jaws. The metatarsal bone of the great toe is much flatter than in any modern race and in this respect resembles the grasping great toe of the gorilla.

The characters of the Tabūn skeleton are predominantly those of the Neanderthal race, but it also shows those modifications first seen in the Galilee skull and in the child's skeleton from the Mugharet es-Skhūl. It may therefore be assigned to that branch of the Neanderthal genus for which Keith and McCown proposed in 1932 the name *Palæanthropus Palestinus*.

The isolated lower jaw, unlike that of the skeleton, possesses the long eminence which constitutes a true chin, yet both jaws must be attributed to the same race, for the teeth and mental foramina are similar.

Though further excavation remains to be done at Tabūn and the study of the material already excavated is by no means complete, a new and important chapter in the prehistory of Palestine has already been opened.

Later in the same day, Section H heard a paper entitled "Ur: The Archaic Period" in which Dr. C. L. Woolley outlined the present state of knowledge of the sequences at Ur. Recent discoveries in Mesopotamia, beginning with Dr. Campbell Thompson's work at Eridu, have produced at Eridu the early painted pottery later called al 'Ubaid ware; at al 'Ubaid the ornate temple of the First Dynasty of Ur; at Kish the predynastic Palace and the "A" cemetery; at Jemdet Nasr the characteristic polychrome pottery and semi-pictographic tablets; at Ur the Royal cemetery. The question was to correlate these various cultures and epochs.

Stratification at the four main sites, Ur, Tello, Warka and Kish, gives homogeneous results and establishes beyond question the general sequence thus :

(1) Al 'Ubaid, the culture of the earliest settlers in the Lower Valley, with its painted geometric pottery.

(2) Uruk, characterised by burnished red and grey wares.

(3) Jemdet Nasr, with polychrome pottery.

(4) The Plano-convex period.

Excavations at the foot of the Ziggurat at Ur have given a complete plan of the First Dynasty buildings of *c.* 3000 B.C. These rested on remains of buildings dating to the moment of transition from Jemdet Nasr to the Plano-convex period. Then came the buildings in 'Riemchen' associated, the first with small decorative cones of coloured clay, the second with large cones having hollow ends. The stratification was then picked up at Warka, which gives First Dynasty and Jemdet Nasr remains, and below these, solid temple constructions of which the second is contemporary with the late 'Riemchen' building at Ur, but preserves intact the elaborate decoration of mosaic by coloured clay cones. The Ur building with hollow-ended cones is not represented at Warka, but instead there is an older building, dating to just after the al 'Ubaid period, the walls of which are decorated with clay pots inset in the mud plaster.

This building is a ziggurat, and thereby is proved the continuity of Sumerian architecture from the Third Dynasty of Ur back to the close of the al 'Ubaid period.

A more detailed stratification was again found at Ur, where a cutting showed an unbroken rubbish layer dated by seal impressions of Mesannipadda to the First Dynasty of Ur, overlying the Royal cemetery : this has given for the cemetery a *terminus ante quem*. Below the cemetery is a stratum rich in seal impressions and inscribed tablets older than the royal graves, but demonstrably later than Jemdet Nasr. Below this were found graves of three sorts, differentiated by level and by content :

(1) Graves with clay pots of 'reserved slip ware'.

(2) Graves with pots having simple decorations of pinkish-red paint on light clay.

(3) Jemdet Nasr graves with three-colour pottery, characteristic stone vessels, etc.

These graves were cut into soil rich in al 'Ubaid potsherds which continue, except for a break of clean flood deposit, down to virgin soil. At Warka the section shows 19 metres of al 'Ubaid stratified culture underlying the period Archaic VI to which the early ziggurat belonged.

The sequence thus is :—The Plano-convex period, starting about 2700 B.C. It includes the Second Dynasty of Ur, the First Dynasty, the Cemetery period, the "reserved slip" ware period and that of the pinkish-red paint on a light ground. It must have been a very long period. The Jemdet Nasr period seems at present more important for its character than its length. The Uruk period, with its succession of great buildings at Warka, must represent a considerable lapse of time, as also that of al 'Ubaid, with its tremendous deposit.

Short dating is impossible : the finds are spread over the whole period between 2700 B.C. and the beginning of human occupation of the Lower Valley. Throughout this, in spite of marked changes, there is a link of continuity which can only be due to the presence of Sumerians in the land from the very outset. The changes seem to be due to incursions by people of similar stock but in different phases of the kindred culture, differently evolved beyond the borders of Mesopotamia, and there is, therefore, modification but no revolutionary change : the history is continuous and through it all can be traced the development of the great Sumerian civilisation.

The Spherical Pendulum*

By CYRIL H. H. FRANKLIN, Electrical Engineering Department, University of Birmingham

A PENDULUM which is free to swing over a segment of a sphere has possible paths which vary from a rotation resembling an engine governor ball to the swing of a simple pendulum in a plane ; which plane appears to rotate very slowly but really indicates the rotation of the earth beneath it (Foucault pendulum effect).

The intermediate orbits between the circular and the linear paths are ellipses, which latter precess at a rate dependent on the maximum and minimum angles of the pendulum and corresponding ratio of major and minor elliptical axes (see Fig. 1). This precession of the ellipse produces a pattern which it will be seen resembles that produced by two opposed rotations having a ratio near unity (such as 100 : 101, with appropriate amplitude) ; which may be drawn by harmonograph, etc. Virtually, the pendulum behaves as if it had two frequencies ; which is in agreement with the facts that the effective length of a pendulum swinging in a circle is $L \cos \alpha$, where α is the angle of the swing maintained and L is the length of the pendulum ; and that in tracing a single ellipse a maximum and minimum angle and corresponding minimum and maximum effective length are reached twice.

It will be seen that the greater the angle reached, the greater the variation of effective length of the pendulum ; and it is found that the rate of precession increases rapidly as the angle increases. Also, if the ratio of major and minor axes of the ellipse is high (which, in the limit, becoming infinite, means the pendulum swinging in a plane), the rate of precession is small, in the limiting case becoming zero. As the ratio of the major and minor axes approaches 1, the rate of precession becomes a maximum for the angles involved.

When the pendulum is capable of swinging over a hemisphere, and is oriented to a maximum and minimum angle of 180° and 90° (which is a 2 : 1 ellipse), the vertical projection of the orbit becomes a five loop figure, corresponding to the 3 : 2 figure with opposed rotations as produced by the twin-elliptic pendulum, etc., with appropriate amplitudes.

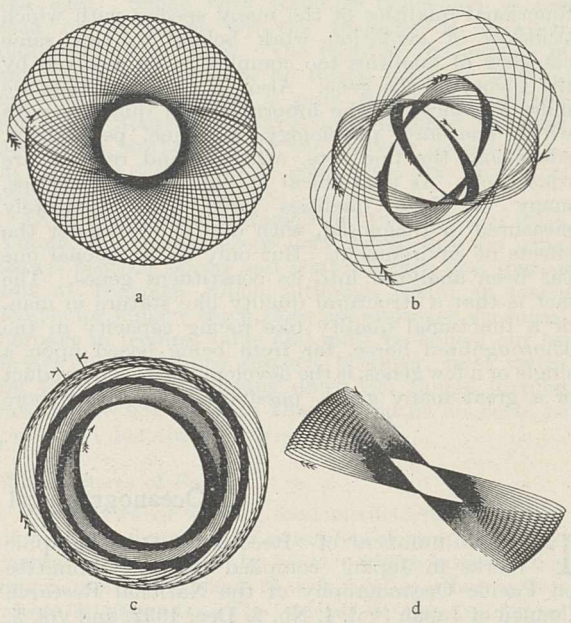

FIG. 1. Paths traced by a spherical pendulum.

a, ellipse axes, 1 : 3 ; major angle, 41° ; precession, 5°.

b, ellipse axes, 1 : 2 ; major angles, 44°, 32°, 24°, 19° ; corresponding approximate precessions, 9°, 4°, 2½°, 1¼°.

c, ellipse axes, 13 : 15 ; minor angle, 33° 50′ ; major angle, 39° 20′ ; approximate precession, 10° per cycle.

d, ellipse axes, 1 : 10 ; minor angle, 4° 20′ ; major angle, 44° 22′ ; approximate precession, 2°.

* Demonstration before Section A (Mathematical and Physical Sciences) of the British Association at Leicester on September 12.

If the pendulum is taken above the equator of its sphere of rotation, a further reduction in the number of possible loops in the orbit appears to occur, but this is deceptive because there is now a loop above and a loop below the equator, which correspond. Also the figuring can now be dependent on velocity, the angle of initial swing not necessarily deciding the pattern, as in small spherical angle orbits.

If the speed of projection of the pendulum is high, the orbit tends to become a great circle on its sphere, which orbit precesses in the same direction as would be the case with a gyroscope.

It follows that if the orbit is nearly in the horizontal plane, precession occurs rapidly for any given mean velocity of pendulum; and as approaching the vertical plane precession becomes relatively slow, it should, in the limit, become zero again when the pendulum rotates completely in a vertical plane.

The rate of precession for any given inclination of great circle orbit now depends on the velocity of the pendulum bob, in the same way that the rate of precession of an unbalanced gyroscope at a given slope depends on the velocity of rotation.

A sphere rolling in a hemispherical saucer can be shown to have orbits resembling those of the hemispherical pendulum, but modified by the unavoidable gyroscopic rotation of the sphere as it rolls. These orbits can be modified by giving an initial spin to the sphere, causing it to run up or down the slope and form open or closed loops accordingly.

Spinning the pendulum bob will, of course, also modify the orbits.

Probably the orbits of electrons in the structure of the atom will be found to display similar phenomena.

Mathematics of Inheritance

AS an outcome of his prolonged and elaborate studies of the inheritance of racing capacity in the thoroughbred horse, Dr. Harry H. Laughlin has put forward a mathematical expression termed "The General Formula of Heredity" which he has discussed in a recent paper under the same title (*Proc. Nat. Acad. Sci.*, 19, 787; 1933). He remarks that the majority of characters in which practical men are interested are too complex genetically for their inheritance to have been analysed in terms of genes:

". . . Practically all of the structural and functional qualities of the many species with which students of evolution work belong to this same category of qualities too complex to be resolved by the theory of the gene. Also, in the same class we must list most of the inborn human qualities with which anatomy, physiology, medicine, psychology, education, the fine arts, athletics and religion are concerned. As anatomical or physiological entities, many of these qualities have been accurately measured or diagnosed, with due allowance for the effects of environment. But only an occasional one has been analyzed into its constituent genes. The fact is that a structural quality like stature in man, or a functional quality like racing capacity in the Thoroughbred horse, far from being based upon a single or a few genes, is the developmental end-product of a great many genes, possibly a score, but more likely a thousand. In the course of development these genes interact, some accelerating their fellows, others cancelling what otherwise would be plus-values in the individual. The result is that the offspring from a given antecedent type often possess the subject-quality in end-values ranging over a scale from very low to very high."

The practical procedure which Dr. Laughlin advocates is to find a formula which shall give in terms of the antecedent information available as to parents or more remote ancestry, the frequency among the offspring not of the different possible genotypes, but of the different values for the measurable character in question. He rightly stresses, and illustrates from his racing data, both the difficulty and the possibility of arriving at a satisfactory basic measure. The general formula given involves fifteen 'basic constants' which are to be fitted to the data.

Such a formula, though very laborious to construct, should on good data give a satisfactory basis for practical prediction. The difficulty which most geneticists will feel lies in deciding whether Dr. Laughlin's formula is better than others equally complicated which could be constructed, and in discussing the genetic interpretation of its ingredients. However, the first step is clearly for Dr. Laughlin to explain his actual procedure and this he has done in some detail in this condensed paper. R. A. FISHER.

Oceanographical Research in Japan

IN recent numbers of "Records of Oceanographic Works in Japan" compiled by the Committee on Pacific Oceanography of the National Research Council of Japan (vol. 4, No. 2, Dec. 1932, and vol. 5, No. 1, Jan. 1933) a list of researches is given showing that a large amount of important work has been done on various subjects. A classified list of papers and reports bearing on oceanography published in Japan during 1930 and 1931 is included. These are entered under the heads "Physical and Chemical Oceanography" and "Fundamental Marine Biology".

In the December number there is a short abstract of a paper by E. Sawano read before the twenty-fifth meeting of the Committee on the Progress of Researches on the Biology of Corals carried on in the South Sea Islands, Zappu and Palau. This includes studies of growth by T. Tanura and Y. Hada, classification of corals at Palau Island by Y. Hada, respiration of corals by T. Mimura, and the digestive enzymes of corals by E. Sawano.

In the January number, besides a paper by K. Okamura on the Algæ from Alaska collected by Y. Kobyashi, there is a long report by F. Hiro on the Cirripedia collected on the continental shelf bordering Japan by the surveying ships of the Imperial Fisheries Experimental Station. This is fully illustrated and contains descriptions of twenty-five species belonging to thirteen genera, the greater part of which were obtained on the Pacific Ocean side while only a few came from the Japan Sea. They

are mostly widely distributed species, chiefly tropical and cosmopolitan, boreal species being only scantily represented.

The interesting little barnacle *Heteralepas* (*Paralepas*) *minuta* (Philippi) described by Darwin (1851) and Broch (1927) from the Mediterranean and by Weltner (1922) from West Africa was reported as doubtful from the Java Sea by the last-named worker. It is now recorded from the Japan Sea from five stations; all the specimens but one were attached to the spines of sea-urchins (*Cidaris*). The peduncle is very short and strongly contracted towards the basal part of the capitulum and the base is usually divided into two "finger-like projections" clasped around the spine of the sea-urchin.

University and Educational Intelligence

THE Commonwealth Fund of New York is offering in 1934 twenty-five Commonwealth Fund Fellowships for research, tenable by British subjects at certain American universities. A fellowship is awarded for two years, but may be extended for a third year. Further information can be obtained from the Secretary to the Committee, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1.

THE Royal Technical College, Glasgow, publishes in its report on the session 1932–33 a valedictory notice of the thirty-four years' service of its retiring director, Dr. H. F. Stockdale. Among the developments that have taken place under his direction are the merging in the College of the former Weaving College of Glasgow, the inception of the Schools of Navigation, Pharmacy and Bakery, and the formation of the Glasgow School of Architecture conducted jointly by the College and the Glasgow School of Art. During this time the number of full-time members of the teaching staff has increased from 29 to 83. Dr. Stockdale's successor is Sir Arthur J. C. Huddleston, who recently retired from the Sudan Government Service. The report shows that in spite of the serious industrial depression that prevailed in Glasgow in the year 1932–33, the decrease in the number of students was slight (from 3,625 to 3,427), while the number of student-hours worked actually increased. Classes for unemployed youths were inaugurated by the College this year in co-operation with the Education Department and the Labour Exchanges and are reported to have been justified by results. The instructors gave their services gratuitously.

THE International Federation of University Women has been interesting itself in the plight of members of its affiliated German federation who have recently been discharged from their posts either on account of Jewish ancestry, for their political opinions or on the ground that they are women. In Bulletin No. 15, the International Federation directs attention to their needs and to the fact that it is working on their behalf in co-operation with the international committee for securing employment for refugee professional workers, which has its headquarters at 4 rue de Monthoux, Geneva. At the same time, it is pointed out that discrimination against women is increasing in other countries besides Germany. The bulletin records a heavy falling off in the number of exchanges of teachers between Great Britain and the United States from eleven in 1931–32, to three in 1932–33, and one in the current year. Among publications promoted by the Federation, the bulletin makes announcements regarding a comparative study (in French) of secondary education for girls in many countries by Dr. A. Arato, a study by Mrs. Skonhoft of types of university training in different countries and a report by her on the standards in those countries of the degree of doctor. The Federation is considering the compilation of a dictionary of the academic terms which are current in various countries.

Calendar of Nature Topics

Frost on the Farm

The rather early incidence of heavy frosts this winter affects the farm in several ways. There is of course little anxiety about potatoes and mangolds in store, for it is only in exceptionally cold weather, when frost is accompanied by wind, that clamped roots suffer damage. Roots in the field are not free from danger at these times, although swedes and sugar beet standing undisturbed in the ground can resist quite heavy frost, the latter in particular with their heavy covering of leaves and high concentration of sugar in the sap being relatively immune from damage while still unpulled. Kales on the other hand, being quite exposed to the weather, lose much leaf in severe frost, and in this way the loss falls on the part of the plant of highest nutritive value. Moreover, if frozen roots or kale are fed off by stock, a considerable amount of energy is required to raise the food to body temperature, so that more supplementary food is required than would otherwise be the case. Sugar beet standing uncovered in the field or in heaps by the roadside is in most danger at these times. The roots at the outside of the heaps are liable to be frozen, and on thawing out the roots fall to a pulp and decomposition sets in. Roots that have been touched by frost should be worked up at the earliest opportunity; in any case they tend to complicate the process of extraction in the factory.

Even grass is not immune from the effects of frost. Young, short grass keeps very green, but the older leaves become tipped and winter burnt, and form a sort of 'froggage' which, although useful as coarse fodder for hungry stock, does not approach succulent herbage in feeding value and must be helped out by better food. In one respect, however, frost works for the farmer, mellowing down the plough furrows into a fine natural tilth that should at all costs be preserved for the spring seed beds.

Winter Stores of Food

The device of storing food against the hardships of winter is favoured by a number of temperate zone mammals, but seldom by birds, perhaps because they find it more convenient to seek food in other regions where it abounds. The storing of the Californian woodpecker (*Melanerpes formicivorus bairdi*) is as exceptional as it is remarkable. In the trunks of pine trees, less frequently of oaks, the woodpeckers drive thimble-shaped hollows during the autumn when acorns are ripening, and into these hollows, which are of two sizes, they place, according to their size, the acorns of the black and the live oak. As many as 31,800 holes have been estimated to occur on fifty feet of a pine tree; as many as 13,200 acorns have been counted on a bole twenty feet high and eleven feet in girth. The acorns are generally

gathered from the ground just after they have fallen and are almost invariably placed in the holes with their basal end outermost. The storing affords a useful supply of food during a period of scarcity, and, according to Dr. William E. Ritter, who has made a careful field study of the subject, two vital results have been that the California woodpecker has been able to extend the range of its favourable environment, compared with neighbouring species, and that it has been able to reduce its rate of mortality relative to neighbouring species as shown by its increased ratio of adult population to reproductive capacity.

Possible Origin of Woodpecker's Storing Habit

That the storing habit is not yet perfected is shown by several curious features to which Ritter directs attention. Such are the making of holes at seasons when there are no acorns to store, the making of hundreds of holes which are left unfilled though acorns and birds are abundant, the occasional storing of small pebbles instead of acorns, the neglecting of stored acorns until they are unfit for food.

Perhaps the English great spotted woodpecker gives a hint as to the origin of the storing habit. In *British Birds* (117, Oct., 1933), N. Tracy describes this woodpecker as cutting off fresh cones and fixing them in clefts so that they could be more easily split open, and Edmund Selous in his "Evolution of Habit in Birds" (1933) records careful observations of the storing of spruce cones in Scots pine trees by the Continental great spotted woodpecker in Sweden and Germany. There was no trace here of the deliberate making of storage holes, but the smoothness of the sides of the natural crack in the tree trunk suggested that the crevice had been used over and over again as a receptacle.

Hibernation and Heart-Beat

The cold weather of December must have driven the most dilatory of our hibernating mammals to their winter retreats, there to exist upon the lowest metabolism consistent with continued survival. In most of these small mammals the pulse-rate during normal activity is very high; in the dormouse, Dr. Frances Buchanan found it to reach 700 beats a minute, in the long-eared bat 600–900, in the pipistrelle varying from 100 to 800 and from 230 to 972 on different occasions, in a hedgehog 280–320 a minute. Constant features of the state of hibernation are loss of warmth and reduction of heart-beat, and under such conditions electrocardiograms of the four species mentioned recorded for the dormouse 12–30, long-eared bat 76–77, hedgehog 48, and a pipistrelle exposed to artificial cold and cold itself to the touch, though extremely active, had a pulse frequency of only 30 a minute.

A curious feature of deep hibernation, in some if not all species, appears to be a dissociation of auricle and ventricle. Thus when a dormouse was very torpid, showing no sign of respiratory movements for several consecutive minutes and having a pulse-frequency of 12–30 a minute, the records showed nothing but ventricle effects. But when auricular effects became more frequent, at about 40 a minute, well-marked auricular effects appear at quite irregular intervals. Dr. Buchanan concluded that when the dormouse is in its deepest sleep the ventricles only are beating.

In sese vertitur annus.

Societies and Academies

PARIS

Academy of Sciences, November 13 (*C.R.*, 197, 1073–1160). E. GOURSAT: A problem of the theory of congruences of straight lines. L. CAYEUX: The submarine alteration of the phosphatic nodules of the Albian of the Paris basin. A. BIGOT and RAOUL FORTIN: The boring at Incarville, near Louviers (Eure). A summary of the geological results obtained by a trial boring for petroleum. E. J. GUMBEL: The limiting distribution of the smallest value amongst the greatest. PAUL DIENES: The deformation of spaces with general linear connexion. ARNAUD DENJOY: Integration along rectifiable cyclic continua. C. KURATOWSKI: The prolongation of homeomorphy. ANDRÉ CHARRUEAU: Remarks on certain movements of a viscous fluid mass, isotropic and heterogeneous. P. DUMANOIS: Concerning detonation in internal combustion motors. Reply to some criticisms by Dufraisse and Chaux. MLLE. F. BLOCH, J. ELLSWORTH and S. P. LIAU: Photometric observations of the star *RS* Ophiuchi. Results of visual and photographic determinations are given. The oscillations found are characteristic of the light curves of novæ. CH. BERTAUD: The correlation between the velocity of ensemble of the *A* stars and their distance to the galactic plane, and on the rotation of the galaxy. FRANCIS PERRIN: The possibility of the materialisation by interaction of a photon and an electron. TH. V. IONESCU: The working of a Crookes radiometer in the high-frequency discharge. The Crookes radiometer is as sensitive to electric waves as to light waves. This has been applied to the study of the energy consumed in an ionised gas. JEAN GENARD: The magnetic extinction of the fluorescence of iodine vapour. Photometric measurements in magnetic fields varying from 0 to 42,600 gauss gave a curve in good agreement with the theoretical formula of Van Vleck. ALBERT TURPAIN: Remarks on the discovery of the molecular diffusion of light by pure liquids. Historical. Directing attention to the early work of A. Lallemand in this field. He established a reflection by the molecules of a pure liquid and predicted a part of the Raman effect. GEORGES ZIELINSKI: The polarisation of the fluorescence bands of mercury vapour. W. GENTNER: The absorption of the penetrating γ-rays. Criticism of recent work by C. Y. Chao. GEORGES I. COSTEANU: Batteries with liquid ammonia and with ammoniacal solutions. Studies of the effect produced by the gradual addition of water on the E.M.F. of batteries made up with dry liquid ammonia. The changes in E.M.F. are small. N. THON: The electrolysis of solutions of metallic salts with a cathode of rarefied gas. Discharge through a gaseous cathode does not lead to a deposit of metal except in the case of the three metals silver, platinum and gold. R. ETIENNE: The displacement of equilibrium. H. MURAOUR and G. AUNIS: Verification of the law of combustion of colloidal (explosive) powders. E. DARMOIS: The Lambert-Beer law and the nature of absorbing particles in solution. JEAN SAVARD: The ionisation potentials and energies of formation of non-polar molecules. ANTONIO DE PEREIRA FORJAZ: Modifications of chemical reactions under the influence of oscillating circuits. E. ELCHARDUS and P. LAFFITTE: The constitution of the magnesium-zinc-silicon alloys rich in magnesium. CHARLES DUFRAISSE and PAUL CHOVIN: Research on substances related to the

rubenes. MLLE. DENISE SONTAG: Primary β-naphthyl ethyl alcohol and β-vinylnaphthalene. H. UNGEMACH: Some new minerals. E. CHAPUT: The anthracolithic in Central Anatolia. P. DELEAU: The presence of the lower Cretaceous at Djebel Safia, province of Constantine. MAURICE BLUMENTHAL: The tectonic relations between the betic, penibetic and subbetic zones of the south-west of Andalusia. R. DELABY, R. CHARONNAT and M. JANOT: New researches on the radioactivity of the waters of the Ballon d'Alsace massif. P. IDRAC: Records of long duration by photography of phosphorescent materials. To do away with the friction of the writing point in a recording instrument, the author suggests the use of a fragment of phosphorescent material, with a lens focusing the phosphorescent light on to photographic paper. JEAN CHEVRIER: Observations of the atmospheric electric field at the Observatory of Ksara (Liban) during the eclipse of the sun of August 21, 1933. GEORGES DUBOIS and MME. CAMILLE DUBOIS: The submerged forest of Léon since the middle Flandrian and the genesis of some peat bogs in this district. The results of pollen analysis have given a fairly complete history of these peat bogs, which are exposed at low tide, from the Neolithic to the present time. ANDRÉ DAUPHINÉ: Intercellular punctuations. J. CHAZE: A new example of exudation and of volatilisation of alkaloids in plants. In previous papers it has been shown that in tobacco plants under certain conditions the alkaloids can be exuded and volatilised into the air. Hemlock plants have now been examined and have been found to exhibit the same phenomena as regards the conine. DE CONDÉ and HEUDEBERT: Contribution to the study of the baking value of bread. M. RAUCOURT and B. TROUVELOT: Researches on the constituents of the leaves of *Solanum tuberosum* determining the feeding of the larvæ of *Leptinotarsa decemlineata*. The leaf principles attracting the beetle are localised almost exclusively in the green part. They are soluble in certain organic solvents, and are not volatile or destroyed by dry heat. RAOUL LECOQ: The rôle of the D vitamins in the utilisation of glycides by the organism of the pigeon. The comparative influence of some hexoses and of some disaccharides (holosides) incorporated in diets containing 66 per cent of glycosides. THÉODORE POSTERNAK: The phosphorus of the fecula of potatoes. G. MOURIQUAND and M. BERNHEIM: Dietotoxics and protection of the liver by food equilibrium.

CAPE TOWN

Royal Society of South Africa, Sept. 20. W. A. JOLLY: Retinal currents. M. R. DRENNAN: (1) Some artefacts in Bushman skulls suggesting trepanning. (2) A witch doctor's outfit from German South-West Africa. F. G. CAWSTON: Climatic changes and their effect on fresh-water molluscs. The number of pond-snails in the Union has been lessened by the recent drought in the mountains and by anti-malarial measures at the coast. The dearth of rushes and other large water-plants has discouraged the breeding of *Bulinus*, *Lymnæa Natalensis* and *Physopsis africana*. To-day one finds *Ancylidæ* and *Lymnæa truncatula*, small species which can readily resist desiccation and are dependent on light. Though allied *Lymnææ* may carry *Fasciola* infection, *Lymnæa truncatula* is the favourite host and is found in the Union at very high altitudes especially in mountain marshes. Desiccation and frost will destroy many species of molluscs without destroying *Lymnæa truncatula*, which is therefore likely to become more prevalent. J. B. CUTHBERT: Further notes on the physiology of *Teloschistes Flavicans*.

ROME

Royal National Academy of the Lincei, June 2. F. SEVERI: (1) The theory of correspondences to valency on an algebraic surface: the principle of correspondence (3). (2) Functional significance of the virtual group of the points united in the valency correspondences on a surface. U. CISOTTI: Further consideration of a translocirculatory current in presence of a circular obstacle furnished with an indefinite rectilinear appendix. A criticism by Murnaghan of the author's recent paper is refuted. A. BEMPORAD: Stellar currents about 16^h R.A. + 54° Decl. The earlier notes on this subject recorded substantially concordant results concerning the distributions of the proper motions as regards order of magnitude and direction. The distribution of the moduli according to the curve of probabilities is now confirmed, but a law markedly different from that previously given for the directions is now deduced. P. RONDONI: Influence of thymus diet on neoplastic growth. The effects of the administration of relatively large amounts of thymus fail to indicate the presence in this organ of active anti-neoplastic principles. C. AGOSTINELLI: Differential relations for Riemann's homograph. L. FANTAPPIÈ: Solution with quadrature of the Cauchy-Kowalewsky problem for equations of parabolic type. S. GENNUSA: Integration by quadrature of the differential equation $\frac{d^3z}{dx^3} + a\frac{dz}{dy} = f(x, y)$. I. J. SCHWATT: The general term of a finite recurrent succession of the second order. B. SEGRE: The characteristic series of a surface on an algebraic variety of four dimensions. A. TONOLO: Formulæ representing the integrals of the Maxwell-Hertz equations for uniaxial crystalline media. L. S. DA RIOS: Further considerations on rotating vortex rings. G. KRALL: The motion of a planetary system of $n + 1$ rigid bodies. G. D. MATTIOLI: A 'wall' condition for the equation of the turbulence in tubes. According to the theory of turbulence recently developed, viscosity acts only in the very thin layer adherent to the walls. For cylindrical tubes of circular cross-section, an expression is now deduced for the interaction between this skin layer and the bulk of the flowing material. LUISA PELOSI: The fundamental formula of the kinematics of rigid systems. A new and simple demonstration, based substantially on the condition of integrability of a certain differential expression, is given for this principle. L. GIALANELLA: Elliptical elements of the orbit of the spectroscopic double τ Persei. From a series of 21 observations made at the Lick Observatory between October 26, 1898, and October 21, 1907, the value $P = 26{\cdot}02$ is derived for the period of revolution. Corrected values for the elliptic elements of the orbit have thence been calculated. G. CONTINO: Observations on the latitude of Campidoglio by Talcott's method. The mean value $\lambda = 41°\ 53'\ 33{\cdot}06''$ is found. NELLA MORTARA: A simple method for determining the coefficient of diffusion of radium emanation. A new method described leads to the value 0·11 for this coefficient, this being in good agreement with those

obtained in different ways by other experimenters. G. PICCARDI: The spectrum of red stars of types *M* and *N*. Behaviour qualitatively comparable with that exhibited by red stars is shown by TiO and C_2 in a flame. P. PRATESI: Condensation products of isatin with pyrroles (pyrrole blue). The behaviour of various mono-, di-, tri-, and *N*-substituted pyrroles towards isatin is described. The bearing of the results on the constitution of pyrrole blue is to be discussed later. L. PATANÉ: The behaviour of *Littorina neritoides*, L. kept in subaerial surroundings and in other experimental conditions. L. CATTANEO: The choline of the human uterus during non-pregnancy, pregnancy and confinement (relations between the choline content of the human uterus and the uterine contraction). Results are given which indicate that the hypothesis that choline is regarded as the hormone of uterine peristalsis is not justified. V. ZAGAMI: Observations on the relation between nutrition and lactation.

Forthcoming Events

Monday, January 1

ROYAL GEOGRAPHICAL SOCIETY, at 3.30.—Miss Cynthia Longfield: "Trail-riding in the Canadian Rockies" (Christmas Lecture for Young People).

Friday, January 5

ROYAL GEOGRAPHICAL SOCIETY, at 3.30.—E. E. Shipton: "The Mount Everest Expedition" (Christmas Lecture for Young People).

CONFERENCE OF EDUCATIONAL ASSOCIATIONS, January 1–8. To be held at University College, Gower Street, London, W.C.1.

Dr. G. Dyson: "Education for Life" (Presidential Address on Jan. 1).

Discussion on "The Failure of Modern Science Teaching to Develop an Adequate Cultural Background to Life" (Jan. 4).

G. W. Olive, J. W. Stork (and others): "Biology and the School Curriculum" (Jan. 1).

Dame Helen Gwynne Vaughan: "Experimental Work on Heredity" (Jan. 2).

BRITISH ECOLOGICAL SOCIETY, January 2–4.—Annual general meeting to be held in the Botany School, Cambridge.

SCIENCE MASTERS' ASSOCIATION, January 2–5.—Annual meeting to be held at the Imperial College of Science and Technology, South Kensington, London, S.W.7.

Discussion: "School Certificate Science".

GEOGRAPHICAL ASSOCIATION, January 3–6.—Annual conference to be held at the London School of Economics, Houghton Street, Aldwych, London, W.C.2.

Prof. P. M. Roxby: "China as an Entity—the Comparison with Europe" (Presidential address, Jan. 3).

Discussions: "The Place and Problems of Local Geography" and "Suggestions for a First School Certificate Geography Syllabus".

MATHEMATICAL ASSOCIATION, January 4–5.—Annual meeting at the Institute of Education, Southampton Row, London, W.C.1.

Prof. G. N. Watson: "Scraps from Some Mathematical Notebooks" (Presidential address).

Discussions on: "Mathematics in Central Schools" and "Teaching of Differentials" (Jan. 5).

Official Publications Received

GREAT BRITAIN AND IRELAND

The Pharmaceutical Society of Great Britain: Codex Revision Committee. Report of Dressings Sub-Committee: Summary of the Principal Standards for Surgical Dressings recommended by the Dressings Sub-Committee and accepted, provisionally, for inclusion in the British Pharmaceutical Codex, 1934. Pp. 13. (London: Pharmaceutical Press.) 1*s*. 6*d*.

National Laboratory of Psychical Research. Bulletin 6: Official Science and Psychical Research. Pp. 47+2 plates. (London: National Laboratory of Psychical Research.) 2*s*. net.

Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland, and Ministry of Agriculture for Northern Ireland. Reports on the Work of Agricultural Research Institutes and on certain other Agricultural Investigations in the United Kingdom, 1931–1932. Pp. 395. (London: H.M. Stationery Office.) 6*s*. net.

Institute of Industrial Administration. Papers of 1932–1933 Session. Pp. 55. (London: Institute of Industrial Administration.) 5*s*.

Borough of Cheltenham Public Library, Art Gallery and Museum. Forty-ninth Annual Report of the Public Library Committee and the Thirty-fourth Annual Report of the Art Gallery and Museum Committee, 1st April 1932 to 31st March 1933. Pp. 24. (Cheltenham.)

Amgueddfa Genedlæthol Cymru: National Museum of Wales. Twenty-sixth Annual Report, 1932–33, presented by the Council to the Court of Governors on the 20th October 1933. Pp. 44+3 plates. (Cardiff.)

The Journal of the Board of Greenkeeping Research. Vol. 3, No. 9, Autumn. Pp. viii+57–112+vi+7 plates. (Bingley: St. Ives Research Station.) 2*s*. 6*d*.

OTHER COUNTRIES

Scientific Papers of the Institute of Physical and Chemical Research. No. 454: The Influence of a Magnetic Field on a Glow-Discharge. By Toshio Takamine, Taro Suga and Asao Yanagihara. Pp. 69–96. 35 sen. No. 455: Researches on the Cutting Action of Planing Tool by Microkinematographic, Photoelastic and Piezo-electric Methods. By Makoto Ōkoshi and Shinji Fukui. Pp. 97–166. No. 456: On Dendrite Figures produced in Liquid Films, I. By Toshimasa Tsutsui. Pp. 167–187+21 plates. No. 457: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 11: Versuche über den Co-Cu-Th- und Co-Cu-U-Katalysator. Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 189–197. No. 458: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 12: Versuche über den Co-Cu-Th-U-Katalysator. Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 198–201. No. 459: On the Dispersion Theory in Metallic Conductors, 2. By Yoshio Fujioka. Pp. 202–215. No. 460: Studien über den Feinbau der Seide, 5: Quellungserscheinungen an Fibroinfäden. Von Kametaro Ohara. Pp. 216–232+plates 22–27. No. 461: Studies on the Thermo-Luminescence Spectra of Fluorites, Part 1: Thermo-Luminescence Spectra of Fluorites from Obira. By Eiichi Iwase. Pp. 233–241+plates 28–30. No. 462: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 13: Untersuchung über die Nickel-Katalysatoren (1). Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 242–247. No. 463: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 14: Untersuchung über die Nickel-Katalysatoren (2). Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 248–253. No. 464: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 15: Untersuchung über die Nickel-Katalysatoren (3). Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 254–258. No. 465: Über die Benzinsynthese aus Kohlenoxyd und Wasserstoff unter gewöhnlichem Druck, 16: Untersuchung über die Nickel-Katalysatoren (4). Von Kenji Fujimura und Shunzo Tsuneoka. Pp. 259–263. No. 466: On a Simple Apparatus for the Determination of Melting Points, Boiling Points, Transition Points, Ignition Temperatures, etc., specially convenient for Use with a small Quantity of Sample. By Satosi Watanabe. Pp. 264–268. No. 467: On the Physical Properties of the Photoelastic Material "Phenolite". By Masataka Nisida. Pp. 269–283. (Tokyo: Iwanami Shoten.)

Bernice P. Bishop Museum. Bulletin 101: Manual of Hawaiian Mosses. By Edwin B. Bartram. Pp. 275. Bulletin 102: New and Critical Plants from Raiatea. By John William Moore. Pp. 53. Bulletin 103: Tuamotuan Religion. By J. Frank Stimson. Pp. 154+3 plates. Bulletin 104: Archæology of Oahu. By J. Gilbert McAllister. Pp. iii+201+12 plates. Bulletin 105: Geology of Tahiti, Moorea and Maiao. By Howel Williams. Pp. 89+8 plates. Bulletin 106: Report of the Director for 1932. By Herbert E. Gregory. Pp. 49. Bulletin 107: Pearl and Hermes Reef, Hawaii; Hydrographical and Biological Observations. By P. S. Galtsoff. Pp. 49+5 plates. Bulletin 108: Jungle Fowls from Pacific Islands. By Stanley C. Ball. Pp. 121+7 plates. Bulletin 109: Native Music of the Tuamotus. By E. G. Burrows. Pp. 107. Bulletin 110: Geology of Galapagos, Cocos and Easter Islands. By Lawrence John Chubb. With Petrology of Galapagos Islands, by Constance Richardson. Pp. 67+5 plates. Bulletin 111: The Cult of Kiho-Tumu. By J. Frank Stimson. Pp. 63. Bulletin 112: Revision of the Hawaiian Species of Peperomia. By Truman George Yuncker. Pp. 131. (Honolulu.)

India: Meteorological Department. Scientific Notes, Vol. 5, No. 54: A Note on Fog and Haze at Poona during the Cold Season. By Dr. L. A. Ramdas and S. Atmanathan. Pp. 89–96+6 plates. (Delhi: Manager of Publications.) 1.2 rupees; 2*s*.

CATALOGUES, ETC.

Rain Gauges and Recorders. (List 583.) Pp. 16. (London: C. F. Casella and Co., Ltd.)

"Caprokol" Brand of Hexylresorcinol. Pp. 4. Radiostol. Pp. 13. (London: The British Drug Houses, Ltd.)

Galvanometers: Photographic Recording Apparatus; Galvanometer Accessories. (Galvo 33.) Pp. 24. (Delft: P. J. Kipp en Zonen.)

Calendar for 1934. (London: F. E. Becker and Co.)