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CONTENTS

Water Supplies and Emergency Legislation

THE time-honoured adage that 'It's an ill wind that blows nobody any good' may possibly receive a further exemplification of its truth and appositeness if the moral to be drawn from the lesson of the recent drought in Great Britain is brought home to the national conscience. Even if it were not a matter of common knowledge, and, it may be added, of harsh experience in many parts of the country, the serious admissions and warnings of the Minister of Health during the debate in the House of Commons on April 12 on the Water Supplies (Exceptional Shortage Orders) Bill would be more than sufficient evidence of the unpreparedness of the authorities to cope with a general shortage of water such as is now prevalent, and although an endeavour is being made in a nationally characteristic way to 'muddle through' the emergency, the situation is one which cannot be regarded with indifference and unconcern. In moving the second reading of the measure, Sir E. Hilton Young made a scriptural reference to 'the writing on the wall'. He could scarcely have chosen an illustration of graver import or more sinister significance.

Water is one of the most vital requirements of a community, whether for domestic or for industrial purposes. In Great Britain, happily, supplies are as a rule reasonably plentiful : in fact, their abundance under normal conditions has rendered us oblivious of their value and careless in their use. With apparently unlimited resources at disposal, consumption has tended to become prodigal and in many cases to be swollen by waste. For generations past, water supply has been a matter of purely individual or local concern. Undertakings have been promoted and administered by private companies and by municipalities, without reference to the larger needs and requirements of the country as a whole. The number of water undertakings in Great Britain is well over one thousand, each of them a separate entity and independent of adjacent concerns, however contiguous the boundaries of their respective jurisdictions. In addition, there are, at least, another thousand private proprietors.

Amid all this medley of interests and authorities, apart from the formation within recent years of a few regional committees the functions of which are purely advisory and directed towards the attainment of a common policy among local undertakers, there has been no attempt at

co-ordination or organised control—nothing beyond the casual supervision of Parliamentary committees at times of legislative enactment for new undertakings and the occasional inquiries of the Ministry of Health or the old Local Government Board when sanction has been sought by local authorities for raising loans for expenditure on works.

It cannot be claimed that the country has been taken unawares in the matter, or that the evils of this haphazard procedure have not been pointed out. During the last half-century, Royal Commissions and Departmental Committees, as well as scientific bodies, have reported time after time on the need for systematic investigation and administration of the national water resources. One outstanding instance is the (1921) Final Report of the Water Power Resources Committee, which contains the following pregnant passage :

"We find that the difficulty in fairly allocating the natural sources of water is becoming greater year by year in England and Wales, and the evidence we have heard proves beyond doubt the urgent necessity in the national interests of some measure of control of all water, both underground and surface, in order that the available supplies may be impartially reviewed and allocated, and may be made to suffice for all purposes in the future. In consequence of the increase of population, the improvement in the conditions of life and the growing requirements of industry, the demand for water is steadily increasing, and the problem of meeting future needs is giving rise to anxiety in many parts of England and Wales."

The recommendation is clear and unmistakable. Other instances might be cited with equal force. It will be within the recollection of readers of NATURE that only last autumn a special research committee of the British Association reported to the meeting at Leicester, after a careful and painstaking investigation extending over a period of twelve months, "that the position of inland water survey in the British Isles is far from satisfactory and that a systematic survey of the water resources of Great Britain is urgently required". The Committee pointed out that the consumption per head of population for domestic purposes has a steady tendency to increase, due to improved standards of sanitation, such as the laying on of piped water supplies into houses in rural areas, the substitution of water-closets for privies, and the provision of baths and hot-water supplies. Furthermore, while the amount of water required is increasing and large volumes are being allowed to run to waste, supplies are becoming more and more restricted, the most conveniently situated sources having been to a large extent already appropriated. Accentuating the growing paucity of available supplies is the fact, mentioned by Sir Hilton Young, that improvements in drainage have resulted in the more speedy draining away of surplus water and so rendered the effects of a drought more serious. It is not perhaps generally realised that the rapid spread of building operations during recent years, more particularly in urban districts, together with road-making, has brought about a considerable extension of the area of impervious surface, causing an appreciable augmentation of the run-off after rainfall.

The Bill just passed by the House of Commons is merely an emergency measure with the inseparable evils of inconvenience and expense. It has been forced on the Government by circumstances and, as such, is simply a temporary palliative and not a permanent cure for a state of affairs which, having risen in the past, is equally likely to recur in the future, if matters are left as they are. What is needed, and has been needed all along, is carefully considered legislation on the lines of the Water Power Resources Committee's Report, namely, the establishment of a controlling Water Commission the primary duty of which would be to compile proper records of the water resources and to make provision for the present and future water requirements of the country and, thereafter, to supervise the administration of these resources to the general benefit.

At the present time, records of available supplies are sadly incomplete, and an efficient survey is the only means of rectifying the deficiency. It is true that excellent records of the incidence and extent of rainfall have been, and are being, kept by the British Rainfall Organization, but this is only part of the scheme of a survey, which, in order to be effective, must cover the whole field of observation from the first arrival of water in the form of rain or dew to its final disappearance into the ocean. At present, as is pointed out in the British Association Report, there is no official department dealing with the direct hydrological measurements of the amount of water derived from rainfall, which is the really essential feature of the matter from a utilitarian point of view.

Hand-to-mouth methods are out of place in the economy of a properly administered community, and the conditions revealed in connexion with the present emergency should compel the attention

of the Government and bring home to it the necessity of taking steps without further delay to inaugurate an adequate service for the scientific measurement and impartial control of the water resources of the country. By so doing, it will bring British water administration into line with the practice in other leading countries, where an example in the matter has been set which can be followed with advantage to everybody concerned.

Faraday's Diary

Faraday's Diary: being the various Philosophical Notes of Experimental Investigation made by Michael Faraday, D.C.L., F.R.S., during the Years 1820–1862 and bequeathed by him to the Royal Institution of Great Britain, Now, by order of the Managers, printed and published for the first time, under the editorial supervision of Thomas Martin. Vol. 3: *May 26, 1836–Nov. 9, 1839.* Pp. xii+466. Vol. 4: *Nov. 12, 1839–June 26, 1847.* Pp. xii+448. (London: G. Bell and Sons, Ltd., 1933.) 7 vols., £12 12*s.* 0*d.* net.

THE printing of Faraday's diary pursues its stately and regular course, and two further volumes are before us covering a productive period of eleven years—from the summer of 1836 to the summer of 1847. Once again we are privileged to toil after the amazingly versatile processes of Faraday's mind. It is the story of much less than a decade which is compressed into some nine hundred printed pages if we bear in mind that the diary is a significant blank between September 1840 and June 1842, and between February 1843 and February 1844. Moreover, when we remember the comparative paucity of the resources at Faraday's disposal and his propensity—indeed a necessity of his nature—to do everything for himself, so that it was impossible for him to depute work of even minor responsibility to a student or assistant, we feel that we have surveyed a record of single-handed achievement of which any great school of research might be legitimately proud. Think of it; Cavendish had, years before, measured specific inductive capacities entirely for his own satisfaction and, *more suo*, had left his results unpublished and unknown to his and to Faraday's generation. It was Faraday's part in this period to rediscover this property and to make those measurements which are quoted and misquoted in most elementary textbooks. Here, too, we find the story of the liquefaction and solidification of various gases by compression and cooling in closed tubes. It is interesting to note—and the remark may bring some small consolation to the amateur glassworker—Faraday's comment on his own glass-bending that "the two bends were not very good; one was a little puckered"; interesting, too, to see that Faraday is consistently faithful to the spelling 'guage'.

At a later date, we have the record of the discovery of diamagnetism, and the immortal entry which runs: "A piece of heavy glass, which was 2 inches by 1·8 inches, and 0·5 of an inch thick, being a silico borate of lead, and polished on the two shortest edges, was experimented with. It gave no effects when the *same magnetic poles* or the *contrary* poles were on opposite sides (as respects the course of the polarized ray) nor when the same poles were on the same side, either with the constant or intermitting current—BUT, when contrary magnetic poles were on the same side, there *was an effect produced on the polarized ray*, and thus magnetic force and light were proved to have relation to each other. This fact will most likely prove exceedingly fertile and of great value in the investigation of both conditions of natural force."

Over and above these prime discoveries and their consequences, we have records of experiments on discharge in air and in gases, on regelation, on electrification by steam and air jets. . . . The effect of lightning on a tree in Greenwich Park is set down, as is an account of the aurora borealis seen at Brighton. The Gymnotus at the Adelaide Gallery is put under observation, and the unhappy animal ("probably very languid, though he gives good shocks when one's hands are well disposed") in the presence of Mr. Bradley, Mr. Watkins and Mr. —— deflected galvanometers, decomposed iodide of potassium and (at a later séance) gave "a spark across a striking distance" and did "burn or deflagrate gold leaves in a very striking and effectual manner".

As in the earlier volumes, so here personal, social and political topics pass unnoticed. A queen comes to the throne; In-i-go Jones sets Buckingham Palace in an uproar; the first Education Act is passed; and the voices of the protagonists of the Anti-Corn-Law League are loud in the land. No trace of these alarums penetrates the peaceful atmosphere of the Royal Institution, and the nearest approach to personal gossip is chronicled in the last entry in volume four: "AT OXFORD. Sir William Hamilton and self talked over the relations of two electric currents at right

angles to each other when, according to Ampère, they have no mutual action. I have expected some effect between them analogous to that state of magnetism which must be the equivalent of static electric induction, but could never discover any: Sir William Hamilton, I find, expects an effect on mathematical principles. Must try again in various ways."

The scientific world is heavily indebted to the managers of the Royal Institution and to Mr. Martin, and it were an ungracious task to seek to increase that debt. In publishing the "Diary" they are indeed raising to the memory of Faraday a monument more enduring than brass. But how much more noble would be the monument were it completed by a similar worthy edition of Faraday's works and his letters, and crowned by that critical biography, of which science and letters still stand in need?

Allan Ferguson.

Industry and Leadership

Management of Tomorrow. By L. Urwick. Pp. xvii+205. (London: Nisbet and Co., Ltd., 1933.) 8*s*. 6*d*. net.

THERE are few graver problems that confront industry and society alike than that of securing competent leadership under the difficult conditions of our time. Important attempts have been made at training for management, as exemplified in the Department of Business Administration at the London School of Economics, or the Institute of Industrial Administration, as well as in the courses in industrial administration arranged by the College of Technology, Manchester; but hitherto industry as a whole has made little use of such experiments, nor can it be said that it has given the matter the systematic study and attention which it deserves.

On the reasons for this position Major Urwick's thoughtful and stimulating book throws a flood of light. Despite the voluminous literature in this field of the last thirty or so years, he makes a definite contribution to management literature which commands attention by the vivacity of its style as well as by the clarity of its thought. Discussing first the scientific approach to business management, Major Urwick suggests that what is required is the application of the scientific method of thought to economic activity, as it has already been applied to a large extent on the production side. He has a wide and well-balanced conception of management as a science in which an analysis and a basis of fact is substituted for opinion to the limits of our power and knowledge. The book abounds in shrewd observations which deserve to be pondered by all who hold, or aspire to, administrative responsibility.

The mere review of the field of management which Major Urwick supplies in brief compass is in itself challenging, and reveals how much might be done to remove causes of industrial friction and inefficiency. This is notably true of research into management problems, where Major Urwick does much more than emphasise the opportunities for co-operation between different industrial units and industries or the value of what are known as management ratios. He directs attention to the growing influence of professional ideals in industry and their power to stimulate such research, as well as to the way in which the elucidation of the principles which should govern the administration of large-scale combinations would assist in their efficient administration even without organising genius.

On such matters as organisation and distribution, Major Urwick writes in a way that should arrest the attention of scientific workers, noting, for example, how industry has yet to utilise the store of experience of organisation acquired by military institutions or the Church, as well as presenting a highly suggestive programme of market research worthy of the attention of all concerned with distribution. In dealing with this difficult field, he conveys a clear conception of what rationalisation really is, as well as exposes some of the muddle-headed thinking which has foundered a good deal of industrial enterprise, large and small.

If, in this section of his book, Major Urwick gives us a hopeful picture of the possibilities which may attend the application of scientific thought to the problems of distribution, the section on training for management will probably be that most appreciated by scientific workers. Whether discussing the training of foremen and supervisors or of administrators, Major Urwick has a keen eye for essentials. He reveals the defects of our present lack of system, our failure to grasp that, in education of foremen, leadership and co-operation are the only two ends which matter, and adds one more powerful plea for industry to consider just what it demands of its leaders and recruits and to co-operate with educational authorities to secure an adequate supply of the requisite quality.

No part of the book is indeed more thought-

provoking than this. Major Urwick emphasises industry's responsibility for collaboration in completing the training of its recruits; he directs attention to the dangers of departmentalism and suggests that the naval and military practice of requiring those aspiring to high command to devote one or two years to advanced theoretical work at a staff college at an intermediate stage of their career might be studied in industry. Courses of instruction in industrial administration may well find their natural place in industry at some such stage as this. Major Urwick's most readable book abounds in constructive suggestions for the utilisation and development of that capacity for leadership in the best sense which is too rare and valuable to be neglected wherever found. R. BRIGHTMAN.

A Digest of Clinical Medical History

A Short History of some Common Diseases. By divers Authors. Edited by W. R. Bett. (Oxford Medical Publications.) Pp. vii+211. (London: Oxford University Press, 1934.) 10*s*. 6*d*. net.

SOMEONE has said that to know the history of a subject is already to know more than the half of that subject, or words to that effect. Mr. W. R. Bett, formerly honorary secretary of the Section of the History of Medicine, Royal Society of Medicine, has saved all future inquirers into the development of knowledge regarding common diseases a great deal of labour by editing the volume just published. Each chapter is written by a different author, someone specially qualified to write on the subject assigned to him, as the following list of contents will show:—Acute infectious diseases by Sir John Broadbent, Bt.; tuberculosis by Prof. John Fraser; venereal diseases by Sir D'Arcy Power; pneumonia by E. M. Brockbank; rheumatism by F. J. Poynton; rickets by Leonard Findlay; endocrine disorders by Sir H. Rolleston, Bt.; Bright's disease by Prof. J. A. Nixon; heart disease by Robert O. Moon; epilepsy by James Collier; arthritis by John D. Comrie; gall-stones by Prof. D. P. D. Wilkie; tonsils and adenoids by Lionel Colledge; malignant disease by Harold Burrows; and malingering by Sir John Collie.

Mr. Bett assigned to himself the subject of appendicitis, though, in truth, he might have taken any of the other topics under his wing, of whose quills for literary purposes he has an inexhaustible supply.

It is an immense convenience to be able to have condensed within the compass of a few pages, in each case respectively, a complete synopsis of the references to a disease or a function from the earliest mention to the present day.

The essays on rickets, epilepsy, gall-stones and malignant disease may be singled out for special praise. Much of the ground traversed in these articles is far from the beaten tracks of medical history, and they must assuredly have given their authors no little trouble to compose.

Sir Humphry Rolleston's chapter is characterised by a meticulous regard for the earliest occasion on which a particular term was used, and it is conspicuously well provided with dates and with the Greek roots of physiological and medical terms. Amongst many other things, we learn from this valuable summary of knowledge that Pierre Marie, who first described acromegaly, is now eighty-one years old, and that the status lymphaticus is no longer considered to be a pathological entity.

Some of the chapters bring home to us vividly the unsatisfactory nature of our knowledge concerning the real source or cause of certain common clinical conditions, for example, rheumatism. The absence from this discussion of the rheumatic diseases of the name of R. Llewellyn J. Llewellyn is difficult to understand. Llewellyn, the writer of widely-known works on rheumatism, arthritis, gout and fibrositis is an authority of international reputation who has lately introduced the vitamin-cum-sunlight deficiency theory of rheumatic conditions. Dr. Poynton does not once quote from him nor does Dr. Comrie in his chapter on "Arthritis". What is still more inexplicable is that Llewellyn's name is omitted from the index, otherwise a very full one. As is right, Llewellyn is quoted on "Malingering".

Further, when lactic acid as a possible factor in the etiology of rheumatism is being referred to (p. 66), no mention is made of the late Dr. Percy Wilde of Bath, who devised a valuable 'pyretic couch' for the cutaneous elimination of the (hypothetical) lactic acid.

On page 148, and again in the index, the name of Vallisnieri is misprinted.

The statement on p. 192 that Galen in *1538* narrated the instance of an orator who simulated an attack of colic to avoid making a speech is interesting in more ways than one. Either the date should be A.D. 153 or Galen is, in a certain sense, still with us. D. F. F.-H.

The Genus *Lilium*

A Supplement to Elwes' Monograph of the Genus Lilium. By A. Grove. Part 1. Pp. v+viii+12+4 plates. (London: Dulau and Co., Ltd., 1933.) 52*s.* 6*d.*

NO more worthy memorial to the late Henry Elwes could have been devised than the magnificent supplement to his monumental "Monograph of the Genus *Lilium*", the first part of which has just been published. The supplement has very wisely been produced in the same form as the original monograph, published in 1880, and the plates by Miss Lilian Snelling are as faithful and as well-reproduced as could be desired.

Dame Alice Godman, who is responsible for the publication of this supplement, points out in her foreword how fortunate it is that Mr. Grove, who had collaborated with Mr. Elwes in the preparation of material for such a supplement, has been able to carry out the work to completion.

Botanists and horticulturists alike join in congratulations to Mr. Grove, who modestly quotes the words of Elwes in the first paragraph of his introduction, and applies them to himself; but they will not allow that these really apply to Mr. Grove, who has devoted so many years to a detailed study of the lilies, and as a result of careful work is now rightly regarded as an authority on the genus.

The supplement is to be issued in six or seven parts, and this first part contains a very informative introduction by Mr. Grove—unfortunately on the dedication page his Christian name is given as Alfred instead of Arthur—in which he gives many interesting historical facts in addition to much valuable botanical information.

Then follow the four plates included in this first part: *Lilium Sargentiæ* Wilson, from Western China, with its lovely funnel-shaped, pinkish-white flowers, which are rosy-purple on the outside—one of the few species which bear bulbils in the leaf axils; *Lilium Henryi* Baker, with its orange-coloured, nodding flowers with recurved petals—a species found in the Ichang Gorges, Central China, by the late Prof. Augustine Henry; *Lilium rubellum* Baker, the lovely rose-petalled lily from Japan, and *Lilium cernuum* Komarov, from Korea and Manchuria, distinct among lilies for its nodding lilac-coloured flowers and numerous linear leaves.

The fine plates are accompanied by full descriptions both in Latin and in English, and following these Mr. Grove has given a very complete and lucid account of our knowledge of these lilies and the history of their introduction to cultivation.

Short Reviews

An Introduction to the Study of Map Projections. By J. A. Steers. Third edition, revised and enlarged. Pp. xxiii+227. (London: University of London Press, Ltd., 1933.) 8*s.* 6*d.* net.

Mr. Steers's useful little book on map projections, the third edition of which has recently been issued, is written for those students of geography who have only the most elementary knowledge of mathematics, and avoids all analysis and any mention of the calculus. Subject to this self-imposed limitation, the author succeeds, in general, in presenting to the beginner an accurate view of most of the useful projections, with some outline of recent work in this field of study. The illustrations are good and some are ingenious, notably the plate showing a comparison of five zenithal polar projections. The third edition differs from the second chiefly in the addition of two new chapters; one dealing with Col. Craster's parabolic projection of the whole sphere and with related projections; and the other describing briefly some other new, or unusual, projections, such as Craig's retroazimuthal group, or Maurer's orthodromic or two-point azimuthal projection.

The method of presentation is most successful in describing the zenithal and conical groups and equal-area world maps such as Mollweide's. It is, of course, least happy in dealing with Mercator's and other orthomorphic projections. There are a few expressions which might be corrected in a fourth edition: on page 5 it is stated that "the azimuths will coincide with the meridians"; and on page 110, with reference to Mercator's projection, there is the remark that "the sum of the secants from the Equator to that parallel must be found". The note on page 2 wrongly includes Fig. 16.

The book is well got up and is amply illustrated by plates and diagrams; the issue of a third edition, within six years of the first publication, shows that there was an undoubted need for a book of this type and that it does meet the requirements of the non-mathematical geographer.

Reports of the Progress of Applied Chemistry. Vol. 18, 1933. Pp. 770. (London: Society of Chemical Industry, 1933.) 12*s.* 6*d.*; to Members, 7*s.* 6*d.*

This important annual volume is modelled on the familiar plan of the series and fully maintains the customary high standard. Not only is it almost indispensable to workers in the domain of techno-

logical chemistry, but also it offers to other scientific workers, and indeed to many whose work is not scientific at all, an excellent review of progress in one of the greatest of the world's industries. The opening paragraphs of the chapter on fuel, for example, show how the chemist, in effecting economies and developing alternative sources, is quickly brought into contact with reverberations in the form of social problems and the incidence of taxation. It is satisfactory to read that precautions taken in British gas works in regard to waterless gasholders are adequate to prevent another such disastrous explosion as that which occurred in Germany at Neunkirchen.

In the chapter on textiles, reference is made to the ignorance displayed by the general public, including some newspapers, about the conduct of the chief manufacturing industry of Great Britain; this industry is engaged in a struggle of serious national significance, and appreciation of its position can be based only on knowledge of its mode of existence. Fortunately, in certain other branches of chemical industry, steady improvement is reported. Thus in the iron and steel industry there is "quiet optimism"; in the glass industry "improving tendencies"; in the rubber industry "encouraging aspects" despite instability; in the leather industry "improvement". The report on the food industry refers with concern to the unpleasant fact that a very large proportion of the world's inhabitants are seriously undernourished, and indicates the chemist's part in remedying this state of affairs. But a few references such as these cannot adequately reflect the interest which the report provides. A. A. E.

Technique of Modern Welding. By Prof. P. Bardtke. Authorized translation from the second German edition, with additions and revisions by Prof. Bardtke, by Harold Kenney. Pp. xi+299. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1933.) 15*s.* net.

IN recent constructional engineering there has been no more notable development than the application of welding. Welded joints, to-day, are used in bridges, boilers, ships, roofs, motor-cars, aeroplanes and many other structures. At first carried out by rule of thumb methods, a rational technique has been developed, symbols and codes have been introduced, standardised tests established and there is already an extensive literature on the subject. To this literature this translation of a book by the works manager of one of the German State Railways is a valuable addition. The main chapters deal with fusion welding, pressure welding, the applications of welding and the economics of welding. There are also chapters devoted to testing, to accident prevention and to gas-cutting. Descriptions of the various types of plant are included and many useful hints are given on the welding of both ferrous and non-ferrous metals. The book is well printed and illustrated and contains an adequate index.

Outlines of Organic Chemistry: a Book designed especially for the General Student. By Prof. F. J. Moore. Revised by Prof. William T. Hall. Fourth edition. Pp. xiv+338. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 16*s.* 6*d.* net.

THIS book was written "merely to serve as an introduction to organic chemistry and to serve as a guide especially to those who study the subject from a non-professional point of view". It provides a coherent and straightforward treatment of the subject, but considering the particular aim in view it is remarkable that the work conveys no sense at all of the historical or chronological development of the subject. The account is formal and singularly impersonal, so that, for example, the fundamental account of stereochemical theory contains no mention of Pasteur, Le Bel, or van 't Hoff. The experimental aspect of organic chemistry also receives little attention. The book is well printed but sparsely illustrated; British students will consider it expensive. J. R.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated "The Year Book of Photography and Amateurs' Guide" and "The Photographic Annual", 1934. Edited by George E. Brown. Pp. 684+64 plates. (London: Henry Greenwood and Co., Ltd., 1934.) 2*s.* net.

THIS almanac has been published as a book since 1861. Mr. Brown has edited it since 1906. Year by year he has made it a very worthy 'daily companion' for the photographer. While it contains, in each issue, brief working details of most of the common processes of photographic technique, it seems to keep thoroughly up-to-date. By means of good indexes, which cover advertisements as well as text, it has been possible to make the long series of volumes into a kind of encyclopædic work from which not only details of technique may be learned, but also the development of photography may be followed. It can be recommended confidently to all who use photography.

Das Problem der Gleichzeitigkeit. Von Dr. Karl Vogtherr. Pp. 196. (München: Ernst Reinhardt, 1933.) 5.50 gold marks.

ALL who desire to acquaint themselves with the attitude of a serious and well-informed critic of relativity theory from the philosophical point of view may be recommended to read this book. The author examines the postulates and axioms of geometry, time-theory and kinematics, and the principles underlying measurements of space, time and motion, and then discusses the determination of the simultaneity of events. Although his conclusions are certain to be challenged by geometers and relativists alike, nevertheless his book will be found very interesting and stimulating, whatever may be the reader's opinions on the many contentious questions raised in it.

Lord Avebury (1834–1913)

THE centenary of the birth of Sir John Lubbock, afterwards Lord Avebury, occurs on April 30, and the occasion should not be allowed to pass without grateful tribute to his memory. It is perhaps difficult for the younger generation to realise the distinguished position which that great Victorian held in the scientific world of his day. In the present era of specialisation many may underrate the claims to greatness of one who was an amateur naturalist and a popular writer. But a more careful consideration of his work and aims will show that he helped to lay those foundations of science and scientific education which has given the present generation of professional scientific workers the opportunities they now enjoy.

We must remember that in the days when science was not included in the ordinary school curriculum, and was a negligible part of a university education, the advance of science was largely due to the work of amateurs, such as Charles Darwin, Sir John Lubbock the banker, Sir Joseph Prestwich the wine-merchant, and Sir John Evans, a paper manufacturer. Not that there was anything amateurish in the work of these pioneers. They were capable of intensive and fundamental researches, and Lord Avebury's "Monograph on the Collembola and Thysanura", published by the Ray Society, is sufficient proof of his capacity for thorough and detailed investigation, and will remain an authoritative and standard account of these groups of insects. It was the wideness of his interests, and not any lack of thoroughness, which both prevented Lord Avebury from continuing his researches in one branch of science and at the same time caused him to become an all-round naturalist of remarkable attainments.

Lord Avebury's love of natural history dated from his infancy, and his mother, who for many years charged herself with his education, noted in her diary that his taste for natural history made him an acute observer. His father, an able mathematician and a fellow of the Royal Society, took an equally careful share in the early education of his son, and when the latter was at Eton repeatedly urged the authorities to include some science in the curriculum. Both parents had very definite views on education, and dissatisfied with John's progress at Eton, he was withdrawn at the early age of fourteen and a half and at fifteen years of age began life in the family bank, of which he became afterwards the head. But in spite of the exacting commercial duties, by working early and late, throughout his long business career he devoted himself to the acquisition of new knowledge, both literary and scientific. Thus, though Lord Avebury never went to a university, he acquired a wide culture and a deep insight into Nature. Living in the country and being a keen observer he devoted himself wholeheartedly to the study of botany and entomology. His residence at Down gave him the inestimable advantage of a close personal intercourse with Darwin, who appreciated the ardent and inquiring mind of his young friend and always held him in high esteem. There is no doubt that Darwin's kindly help was a great stimulus to young Lubbock, who frequently expressed his gratitude for the inspiration he received from Darwin. That he became one of the staunchest supporters of the "Origin of Species" is not to be wondered at, and Darwin valued his support, for writing to him in 1860 he says: "I settled some time ago that I should think more of Huxley's and your opinion, from the course of your studies and from the clearness of your mind, than that of any other man in England".

It was Darwin who urged Lord Avebury's father to get his son a microscope, with the help of which his earliest researches on freshwater and marine Entomostraca and on *Daphnia* were carried out. On the strength of these investigations Lord Avebury was elected to the Royal Society in 1858 at twenty-four years of age. With the encouragement of Darwin and Huxley he commenced his investigations on insects, which he carried on for many years and which culminated, after a series of important papers, in the publication of the monograph of the Collembola already referred to, and of two books, one on "The Origin and Metamorphoses of Insects" and the other on "Ants, Bees and Wasps". His work on the senses and habits of these insects was based on definite experiments and on observations carried out for many years in succession on ants imprisoned in earth between glass plates. His own observations on the habits of insects, and the stimulus of Darwin, who was engaged in his studies of self- and cross-fertilisation of flowers, directed Lord Avebury's attention to the visits of insects to flowers, which resulted in the publication of his "British Wild Flowers considered in Relation to Insects". This was the commencement of a series of botanical books on "Flowers, Fruits and Leaves", on "Buds and Stipules", and lastly the comprehensive "Contribution to our Knowledge of Seedlings". In all three books he showed a keen insight into the morphological problems involved, and they will continue to be of the greatest help to botanical students.

Long before he had completed his entomological and botanical researches, Lord Avebury's active mind had been turned for a time into other channels, and his intimacy with Galton, Prestwich and John Evans had directed his thoughts to problems connected with the antiquity of man. A series of visits to France, Denmark and Switzerland gained him a sound and extensive knowledge of prehistoric mounds and implements which

enabled him to become one of the leaders of anthropological research in Britain, as his "Prehistoric Times" and "The Origin of Civilisation and the Primitive Condition of Man" amply testify. Anthropology, indeed, became an abiding interest with him, and he did much to preserve the destruction of prehistoric remains by introducing into Parliament the Ancient Monuments Act of 1882. It is largely due to his energy and foresight that the monumental stone circle at Avebury was preserved from further destruction, and it is characteristic of his deep interest in the latter, that when he was elevated to the peerage he took the name of Lord Avebury.

For most business men, three absorbing hobbies, including the writing in connexion with them of important books, which ran into many editions, would have been more than sufficient to occupy their time and energy, but from boyhood Lord Avebury made systematic use of his time and worked early and late to forward the aims he had set before himself. Thus, when invited to become a candidate for Parliament he accepted the invitation, much to the dismay of Darwin and Hooker. The latter wrote to Darwin: "I gnash my teeth when I think of Lubbock going into Parliament. I grudge so good a man from Science." Darwin, who had been reading Lubbock's "Prehistoric Times", wrote to congratulate him on the book, and added: "I do sincerely wish you all success in your election and in politics, but after reading this last chapter you must let me say: 'Oh dear! Oh dear! Oh dear!' "

Lord Avebury had, however, set himself several definite aims as Member of Parliament. They were: to carry a measure to prevent a rapid destruction of ancient monuments, to promote the study of science in schools, to secure some additional holidays and to shorten the hours of labour in shops. We have seen how successful he was in the first of these aims. The others he was happily destined to see eventually realised. A year after entering Parliament he was successful in getting the Bank Holidays Act. How many, we wonder, of those who have recently enjoyed the relaxation of a fine Easter Monday realise to whom they owe this boon. His warm heart for those less favourably placed than himself led him to introduce successively and successfully the Shop Hours Regulation Act of 1886, limiting the hours of labour of young persons under eighteen years of age, an Open Spaces Act, a Public Library Act and a Shop Hours (Early Closing) Act. His effort to promote the study of science in schools did not lead to the promotion of any parliamentary measure, but nevertheless his persistent agitation led to the appointment of several Royal Commissions dealing with educational problems of elementary schools, public secondary schools and the universities.

On all these Commissions Lord Avebury voiced the growing need of scientific training, and there is no doubt that many changes in this direction resulted from the evidence given and the reports of the Commissions. Particularly in relation to the Royal Commission on Scientific Instruction at the Universities, the Commission recommended substantial capital as well as annual grants towards the cost of maintenance of the universities, and the grants now given by the Treasury to the universities may be traced to the report of this Commission and to the persistent efforts of Lord Avebury. By his numerous scientific publications on anthropological, entomological and botanical subjects he did much to diffuse an understanding and love of science among the general public, and the widespread interest which he created can be gathered from the numerous editions, often reaching double figures, which were called for. His energy in this respect was ceaseless. Darwin wrote to him once: "How on earth you find time is a mystery to me". But his business had made him methodical and he knew how to economise his time. Once when remonstrated with by his family for wearing elastic-sided boots, he explained that one could learn a language in the time people took to button or lace their boots.

Lord Avebury felt driven to write and publish both his scientific and also his more popular books because of the intense enjoyment he personally got out of all his studies and of his keen desire that others should share in his pleasures. Even at home, when he had prepared a particularly good microscopic slide, he delighted to show it to the inmates of his house, including the maids and the page-boy. No one had a keener appreciation of natural surroundings, and he desired that the minds of others should be awakened to this. Hence his publication of "The Beauties of Nature" and "The Wonders of the World we live in". Similarly in "The Scenery of Switzerland" and "The Scenery of England" he explained how it was based on the geology and physical geography of these countries. Lord Avebury had also a real love of good literature, and after addressing the Working Men's College on "The Choice of Books" he published his essay on "The Hundred Best Books" which excited much interest and comment and resulted in the publication of cheap editions of many books which were out of print. His aim was ever to promote the national culture of his fellow citizens. He wanted the general public as well as the schools to enjoy a stimulating intellectual atmosphere "charged with the oxygen of science", as Sir Michael Sadler has so aptly put it. It may truthfully be said that he succeeded in a great measure in effecting this by his personal efforts. The ever-present benevolent urge combined with the simplicity and modesty of his bearing made him a most lovable character. The contentment of his life, so full of good deeds, radiated a serene charm, which was felt by all with whom he came in contact. Scientific societies and educational institutions were eager to secure his services, and he probably held a record number of presidencies of learned societies and scientific institutions.

It is not possible within the limits of an article such as this to do more than touch upon some of the activities of so many-sided a man. Happily there is a good biography of him by H. G. Hutchinson, and "The Life-Work of Lord Avebury" edited by his daughter, the Hon. Mrs. Grant Duff, contains appreciations of his work by leading authorities of the various branches of science which Lord Avebury has enriched by his researches and publications. When reading these we shall gratefully remember how much we owe to this great Victorian naturalist. F. E. W.

Stabilisation of Radio Frequencies

AMONG the problems which the rapid and extensive growth of radio communication has presented, is that of keeping the frequencies of all transmitting stations steadily at their assigned values. The success of the various international plans which have been formulated in recent years, particularly for the control of broadcasting, must ultimately depend upon the ability of radio engineers to adjust and maintain a wireless transmitting station at its correct frequency or wave-length. At the present time the primary standards of frequency, which utilise either a tuning fork or a piezo-electric crystal, are amongst the most accurate of our physical standards. With the aid of suitable equipment, there is no difficulty in maintaining and using an accuracy well within one part in a million, while the frequency standards of different countries are in substantial agreement to within a few parts in ten million. Similar types of crystal or tuning fork oscillators can be employed to control the frequency of transmitting stations of appreciable power, by the aid of somewhat elaborate power-amplifying and, if necessary, frequency-multiplying equipment. This arrangement admirably serves the purpose of those stations operating on a single wave-length, and is used with conspicuous success in broadcasting stations and those used for long-distance telegraphic and telephonic communication.

There are, however, many cases, particularly in connexion with ship and aircraft communication, where it is necessary that the transmitting station shall be able to operate on a large number of different wave-lengths and still maintain a high degree of accuracy and stability on each of these wave-lengths. It is usually an accompanying condition of such circumstances that the whole of the transmitting and frequency controlling apparatus must be much simpler than that which is employed at fixed land stations. It is to meet such a demand as this that the Radio Research Board of the Department of Scientific and Industrial Research is at present studying the problem of developing a suitable valve oscillator which will provide frequency stability at a transmitting station without the necessity for elaborate equipment.

As a preliminary to the experimental work, which is now being conducted by the Radio Department of the National Physical Laboratory, a thorough survey of the available information on the subject was made and this has recently been published*. This résumé of the literature has been drawn up in two parts. The first part consists of an essay on the subject as a whole, and comprises in effect a brief textbook of the fundamental principles of this branch of radio science illustrated by reference to typical circuit arrangements used in practice. The second part consists of abstracts of papers representative of the most important published work on the subject, with commentary notes which are intended to bring each particular contribution into perspective with the whole.

In attempting to classify the causes of frequency variations in simple valve-maintained oscillators, a distinction can be drawn between frequency variations due to changes of a purely electrical character and those due to changes of the physical configuration of the system. A simple and admittedly inadequate analysis of the valve-maintained oscillator indicates that frequency variation due to incidental changes in the valve and its circuits can be minimised by meeting certain conditions. Various special circuit arrangements have been developed on these lines and the consequent frequency stabilities obtained are variously estimated at between one and one hundred parts in a million. A more exact analysis shows that it is very difficult to maintain electrical oscillations by means of a valve without producing harmonics which have a detrimental effect upon the steadiness of the fundamental frequency. Experimental data are lacking as to the quantitative significance of this effect, which, however, may be minimised by means of circuits designed to reduce so far as possible the potential differences due to the harmonics generated. Recent investigations have shown that the inter-electrode capacitances of thermionic valves may be expected to vary with the space-charge conditions of the valve, which in turn will vary with supply-voltage and oscillation conditions. Since these inter-electrode capacitances are included in the electrical circuit which determines the frequency of oscillation, any variation in this capacitance will produce a corresponding variation in the frequency.

An ideal valve oscillator is probably one in which the frequency of oscillation is determined solely by the inductance and capacity in the external oscillatory circuit. In this case, however, it is evident that the frequency will be directly

* Department of Scientific and Industrial Research. Radio Research, Special Report No. 13: Valve Oscillators of Stable Frequency: a Critical Survey of Present Knowledge. By F. M. Colebrook. Pp. vii+56. (London: H. M Stationery Office, 1934.) 1s. net.

dependent upon any changes in the physical configuration of this circuit due to changes in atmospheric conditions. For example, changes in temperature of the inductance coils and condensers in the circuit will produce changes in the electrical values of these components to an extent depending upon the coefficients of expansion of the materials used in their construction. The limited experimental evidence so far available indicates that changes of frequency resulting from temperature variations may exceed fifty parts in a million per degree centigrade. To a lesser, but by no means negligible, extent, changes in atmospheric pressure will produce a change in capacitance of an air condenser by virtue of the alteration in the dielectric constant of air. A further factor to be taken into account in a complete study of the subject is the effect of the load circuit, which is coupled to the oscillator and by means of which the oscillations generated are put to practical use. A brief consideration of the relevant conditions indicates that in order to minimise the effect of the load circuit on the oscillation frequency, this circuit should be slightly detuned by an amount which depends upon its effective resistance.

In conclusion, the possibility of securing frequency stability in radio transmitting stations by the use of an automatic monitoring arrangement is discussed briefly in the report recently published. The scheme provides for the frequency of the transmitter to be adjusted directly to agree with that of a small power valve oscillator designed for a high-degree of frequency stability under no-load conditions. If such a scheme can be developed successfully without undue complication of equipment, it may provide one solution to the problem of stabilising the frequency of a simple transmitter which has to be operated over a wide range of frequencies. The whole subject is, however, being investigated in a comprehensive manner, since more than one solution may ultimately be necessary to meet the conditions of practical radio communication.

Physiology of the Blue Whale

By Prof. AUGUST KROGH, Laboratory of Zoophysiology, University of Copenhagen

RATE OF GROWTH

IN the paper by Mackintosh and Wheeler, "Southern Blue and Fin Whales" ("Discovery Reports", I, 1929), a graph is given showing the growth in length of the Blue whale from the fœtal state to maturity. In Laurie's paper, "Some Aspects of Respiration in Blue and Fin Whales" ("Discovery Reports", VII, 1933), graphs are given showing the relation between length and weight of Blue whales, and since this relation is remarkably constant, it becomes possible to calculate the weight of the young whales at different stages.

Such a calculation shows the new-born Blue whale of 7 m. length to weigh about 2,000 kgm., while at weaning seven months later, the length has increased to 16 m. and the weight to 23,000 kgm. When the whales become sexually mature at two years of age, the females are on an average 23·7 m. in length and weigh 79,000 kgm. The period from weaning to maturity includes two summer seasons (about twelve months) in antarctic waters with abundant food, and one winter in more northern waters where food is scarce. The increase from 23,000 kgm. to 79,000 kgm. therefore takes place mainly or exclusively during the twelve months when they are in the antarctic. Laurie gives a table showing the composition of a 20 m. Blue whale. Assuming the same composition during the period of growth, the 56,000 kgm. increase should be distributed as follows :

			Fat		Protein	
	per cent	kgm.	per cent	kgm.	per cent	kgm.
Meat and entrails	59	33,000	6·5	2,150	23	7,600
Blubber ..	18·6	10,400	88	9,200	4	400
Bones	19	10,600	45	4,750		
		54,000		16,100		8,000

Calories : 150 mill. + 44 mill. = 194 mill.
Calories per day in 365 days = 540,000
" " " " 518 " = 380,000

It may be of some interest to compare this rate of growth with that of a pig. The new-born pig weighs about 1 kgm. After seven weeks' lactation, the weight is about 6 kgm. and, feeding with about 200 kgm. of skim milk and 300 kgm. of grain, it attains the weight of 90 kgm., at which it is converted to bacon at the age of six months. The food consumed corresponds to a little more than 1 million calories, and the increase in weight from weaning to 320,000 calories, or 2,600 cal. per day. Assuming an average weight for the growing pig of $\frac{6 + 90}{2}$ = about 50 kgm. and for the growing whale of $\frac{23{,}000 + 79{,}000}{2}$ = about 50,000 kgm., it is seen that the growth of the pig per unit weight is about five times as rapid as that of the whale. The comparison should not, however, be made on the weight but on the surface basis, corresponding to the cube root of the square of the weight ($W^{2/3}$). When the whale weighs just 1,000 times the pig, the increase per day should be $1{,}000^{2/3} - 100$ times as large, but it is found to be 540,000 calories instead of 260,000, or just double that of the pig, in spite of the fact that the pig has its food served regularly, while the young whale is left to its own resources. It is a pity that the chemical composition of the crustacean *Euphausia superba* constituting the whales' staple diet is not known. It would be extremely interesting to know if whale fat is mainly derived directly from the food or mainly built up by synthesis.

METABOLISM, CIRCULATION AND RESPIRATION

On the assumption that the surface law is valid for whales and that the normal metabolism is

1,000 calories per sq. m. per day, Laurie arrives at the figure 275,000 calories as the resting metabolism of a 122,000 kgm. Blue whale. It is worthy of note that the assumption, for which good reasons are given by Kleiber ("Die Tierernährung", 5, 1933), that metabolism is proportional to $W^{3/4}$ instead of $W^{2/3}$ with a unit value of 72 cal. per day, would raise the calculated metabolism to 460,000 cal. It might, I think, be possible to arrive at a value for the metabolism by calculating the heat loss from an internal temperature of 35° C., a water temperature of, say, 5° C., measurements of the thickness of blubber and its properties as a conductor of heat. A series of temperature determinations through the thickness of blubber of a freshly killed whale would enhance the value of such a determination.

The metabolism of a whale is increased by its muscular movements in swimming. Prof. Carl Hansen, of the Danish Technical High School, has kindly calculated for me the towing resistance at various speeds of a 122,000 kgm. whale, the surface of which he calculates as 230 m². He finds the resistance and horse power necessary at different speeds to be as shown in the accompanying graph (Fig. 1) where R represents the resistance in kgm. and N the necessary horse power. At 3 knots the necessary power is 1·5 h.p., at 5 knots it is 6·5 h.p. and at 10 knots 46·8 h.p. He assumes 100 per cent efficiency as a propeller for the tail, which he believes to be superior to any screw. If I assume a 22 per cent efficiency for the muscular engine working the propeller, I find as a good approximation 10 litres of oxygen or 50 calories consumed per h.p. per minute. It would be of great interest to have actual determinations of the towing resistance of whales at varying rates of speed, and it should not be very difficult to obtain such figures.

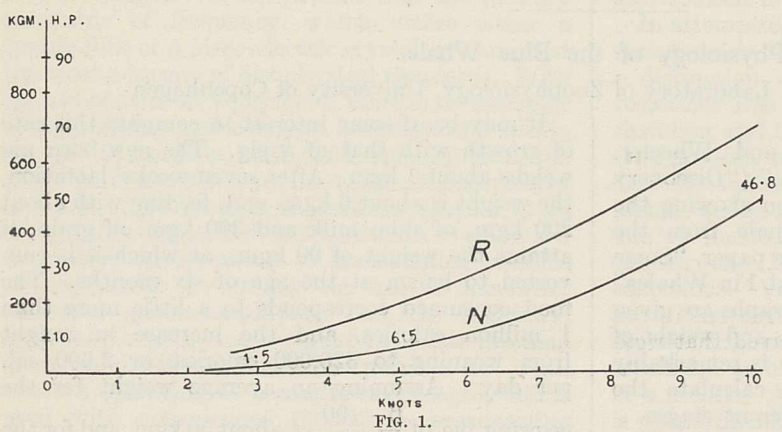

Fig. 1.

The assumed resting metabolism of 275,000 calories per day corresponds to 38 litres of oxygen per minute. Assuming that the whale swims at an average rate of only 3 knots, we have a total metabolism of 53 litres of oxygen per minute. We may suppose in the case of this whale, in accordance with the findings on man and other mammals that, at rest, about 40 per cent of the oxygen capacity (14 volumes per cent) of the blood is utilised, which gives us a circulation rate of very nearly 1,000 litres per minute. A Blue whale can swim at the rate of 10 knots when harpooned. This means a metabolism of a little more than 500 litres of oxygen per minute. With such heavy work the oxygen utilisation may reach 80 per cent and the circulation rate would become 4,500 litres per minute.

The capacity of the lungs is estimated by Laurie from their weight at the very small figure of 3,050 litres. A better approximation is obtained by measurements of the thorax volume, subtracting the heart, and the weight of the lungs. For a whale of 22 m. this was estimated at 7,000 litres and I arrive at 14,000 litres as the most probable figure for the 27·2 m. whale. Careful measurements of the thorax volume of whales are among the chief desiderata for physiological calculation. 14,000 litres of air would provide the whale with approximately 2,800 litres of oxygen, or enough for 50 minutes at the estimated metabolism of 53 litres per minute.

Because the possible thorax volume is evidently approximately proportional to total volume or weight of animal, while metabolism is proportional to some fractional power of the weight (probably between $W^{2/3}$ and $W^{3/4}$), large size is essential for the capability of prolonged diving.

Liability of Whales to Caisson Disease

In deep diving, the blood passing through the lungs becomes supersaturated with nitrogen. About 1 volume per cent is taken up for each atmosphere of excess pressure. Supposing the whale to stay 5 minutes at 100 m., the 1,000 litres of blood passing per minute would take up an extra amount of 100 litres, or 500 litres in all. This is, I believe, unavoidable. It seems to me inconceivable that the circulation should stop during deep dives, and any blood passing through the lungs could certainly not avoid taking up the corresponding volume of nitrogen.

A slow circulation will reduce the rate at which nitrogen is absorbed, and to that extent large size is advantageous, but it will reduce also the rate at which the gas is given off at lower pressures. Supposing the whale to take a series of dives to 100 m., staying at the surface each time only for the few seconds necessary to take one or two breaths, a progressive supersaturation of the blood and the tissues seems unavoidable, and, should the whale choose to stay at the surface for some time afterwards, nitrogen bubbles should appear both in the blood and in the tissues—in other words, the whale would be liable to a severe attack of caisson disease.

The striking evidence presented by Laurie shows (to my mind conclusively) that serious supersaturation of tissue fluids with nitrogen does not supervene, but just how it is avoided is by no means clear. Laurie has made the remarkable discovery of the nitrogen-binding *X*-organisms in the blood of whales, but, admitting everything he claims for them, their nitrogen fixation is far too slow to be an essential factor, the more so as the fixation requires oxygen, and in all probability not less and probably more than 1 volume for each volume of nitrogen. The 100 litres assumed to be absorbed per minute at 100 m. would therefore require 100 litres of oxygen, or almost double the volume necessary for the whale's metabolism proper. This, I think, is outside practical possibilities.

I suspect that the retia mirabilia of blood vessels present in all deep-diving mammals may have something to do with the mechanism for escaping caisson disease, but I must confess my inability to see how. I suggest, however, that our knowledge of these structures, in spite of the valuable anatomical research done upon them, is too incomplete to make speculation worth while, and would point out that a detailed and also quantitative investigation of the retia is highly desirable.

Obituary

Mr. William Barlow, F.R.S.

WILLIAM BARLOW was born in Islington, London, on August 8, 1845, and inherited from his father, Frederick Barlow, a business dealing with estate and building property; by the exercise of notable acumen in affairs he realised the business and thus found himself early in life possessed of ample means. Barlow was educated privately; he had a taste for physical science and marked mathematical talent, but cultivated the latter unsystematically and perhaps almost exclusively.

Barlow thus found himself in his early thirties with an independence, with a genius for handling geometrical problems of a particular kind, and with ample leisure to devote to the study of crystal structure, which had become the subject of his choice. He had not, however, received that rigid disciplinary training through which most students of physics and chemistry acquire a broad sense of contemporary knowledge of the physical universe. In some respects this was a hindrance but in others an advantage; it left a powerful intellect unhampered by authority and led a logical mind to pursue its inquiries into difficult and obscure paths which might intimidate the more conventionally trained. Towards 1888 Barlow came into contact with Prof. H. E. Armstrong, from whom he received much encouragement and help; he also met Mr. (now Sir) H. A. Miers and the writer and acquired from them most of his knowledge of formal crystallography. He then spent some time with his family in Germany and made the acquaintance of Paul Groth, the crystallographer, occupying himself with the geometry of crystal structure; on returning to England he devoted himself to crystallographic work of a theoretical kind until his death at Stanmore on February 28, 1934.

In summarising the work of an unconventional genius, it is not easy to proceed chronologically; Barlow did not attack problems in the order which they would naturally take in a textbook or in the present notice. His work on the homogeneous partitioning of space may therefore be first reviewed.

For a century past the view has prevailed that crystal structure consists in the similar repetition throughout space of identical units without regard to their shape or constitution. Continuing earlier work by Bravais and others, Sohncke in 1879 introduced the idea of a regular point-system as one in which the pencils of lines drawn from each point of the system to all the remainder are congruent with each other; the regular point-systems, if classified according to the position and nature of their axes of symmetry (whether screw-axes or axes of rotation), are 65 in number. The 65 Sohncke systems, if built up of mathematical points, do not account for all the types of symmetry represented by the 32 crystal systems; it will be seen at once that the structure of hemimorphous crystals, in which a polar axis is present, cannot be described by a Sohncke system without some further assumption, such as polarity of the points or of the component atoms or molecules.

The development of Sohncke's work needed to provide a complete geometrical theory of crystal structure was undertaken independently by Schönflies, Fedorow and Barlow; all three solved the problem but by different methods, and the line of attack adopted by Barlow may be now briefly indicated. Each Sohncke system is characterised by certain coincidence movements, these being translations and rotations about an axis of symmetry, which leave its appearance unchanged; further, a number of the Sohncke systems are enantiomorphous, that is, not identical with their mirror-images. Barlow duplicated the enantiomorphous Sohncke systems by intercalating the mirror-image in such a way that the coincidence movements of the two component point-systems coincide; he worked out the geometrical methods, three in number, by which this duplication can be effected. The 65 Sohncke systems thus became increased by another 165 to a total of 230; these are known as the 230 space-groups and represent all the types of symmetry possible in crystal structures. Each of the 32 crystal systems corresponds to one or more of these space-groups. With the proof that the space-groups number 230, the geometrical theory of crystal structure becomes

practically complete and the foundation is provided upon which any mechanical or physical theory of crystal structure must be erected. Whilst the methods used by Barlow in carrying out this difficult and laborious piece of work are perhaps less elegant than those of Schönflies, they offer certain advantages by the lucidity with which they reveal the geometrical properties of the space-groups.

Although Barlow published his work on the space-groups in 1894, he had for long been engaged on the second part of the problem of crystal structure, that of the mechanical nature of the structure (Nature, 29, 186, 205; 1883). He assumed that equilibrium requires that the atoms composing a crystal structure shall be arranged in closest packing and showed that two closest-packed assemblages of equal spheres exist; one of these has cubic symmetry and is known as the face-centred cubic packing whilst the other has full hexagonal symmetry. Modern X-ray analysis has now shown that most of the metals assume these structures, although some are in the looser body-centred cubic packing. The recognition that equilibrium demands that similar spherical atoms shall arrange themselves in one or other of the two closest-packed assemblages, and that these occur in many of the metals, was the first definite success achieved in associating specific geometrical structures with specific crystalline substances; the importance of this result has been but too little appreciated.

In his paper of 1883 in Nature, Barlow discussed the crystal structure of biatomic compounds, and suggested as one possibility for sodium chloride a body-centred cubic arrangement in which one kind of atom lies at the cube centres and the other at the corners; this structure has now been shown by X-ray analysis to belong to cæsium chloride but not to sodium chloride. It is of interest to recall Sohncke's objection to this structure; he says (Nature, 29, 383; 1884): "Thus eight atoms of Na stand in exactly identical manner around an atom of Cl (and also eight atoms of Cl around an atom of Na). The atom of Cl seems consequently to be in equally close connection with eight atoms of Na; it has exactly the same relation to those eight atoms. It appears therefore as octovalent, certainly not as univalent; for it would be entirely arbitrary to suppose any two neighbouring atoms of NaCl in an especially close connection and to take this couple for the chemical molecule of NaCl. By this example we see that from Mr. Barlow's point of view both the notion of chemical valency and of chemical molecule completely lose their present import for the crystallised state." This, which was an objection fifty years ago, is now regarded as one of the merits of the accepted cæsium chloride structure; Barlow's reply to Sohncke (Nature, 29, 404; 1884) states the modern view.

Barlow expanded his earlier notions on crystal structure in a long paper entitled "A Mechanical Cause of Homogeneity of Structure and Symmetry" published in the *Proceedings of the Royal Dublin Society* for 1897 under the auspices of Prof. G. F. Fitzgerald; this provides a great deal of information as to possible symmetrical structures. Later, with the present writer, the conception was introduced that the atoms, supposed spherical, occupy volumes in the crystal structure proportional to their valency and, in papers published between 1906 and 1910, a large mass of experimental crystallographic data was reviewed. It was found possible, with the aid of the closest-packing valency volume hypothesis, to correlate many morphotropic relations with chemical constitution and crystal structure.

In 1912, however, the first observations on the diffraction of X-rays by crystalline substances were made and opened the way to direct methods for determining structure; these, brilliantly handled by W. H. and W. L. Bragg and their followers, have furnished precise experimental data as to the arrangement of the atomic centres in a vast variety of solid structures. It is now clear that Barlow's mechanical theory was stated in too simple a form to be applicable to any but the most simple cases; it seems now impossible that crystal structures are, in general, close-packed assemblages of spherical atoms. In this connexion it is significant to note that if the cubic closest-packed assemblage of equal spheres is symmetrically partitioned into tetrahedral groups of four spheres, the centres of these tetrahedral groups form the well-known Bragg structure for diamond; the diamond may thus be pictured as a close-packed assemblage of atoms which have the symmetry elements of the regular tetrahedron. Although X-ray analysis has increased our knowledge of crystal structure in an astounding way and has proved a most powerful tool, it has not led to a mechanical theory of crystal structure; it reveals the atomic arrangement but offers no reason why the component atoms seem to be closely packed in some crystalline structures and only loosely in others. The required mechanical theory of crystal structure may be found in some kind of generalisation of Barlow's conception of equilibrium conditions.

Barlow was elected into the Royal Society in 1908 and was president of the Mineralogical Society from 1915 until 1918. He was a man of simple tastes, very happy in his family life and happy in his friends; he was an expert cabinet-maker, and this was helpful in the construction of complex models of crystal structures. It was never easy to follow his train of thought because he invented his own ways for attaining results; thus, he rarely used the classical methods of spherical trigonometry in crystallographic calculations, but devised special ones of his own for each case which arose. Whilst Barlow's friends will remember his single-mindedness and his kindliness of heart, he will always rank among the master builders of the geometrical theory of crystal structure.

W. J. Pope.

DR. FRED IBBOTSON

THE death of Dr. Fred Ibbotson on February 5, at the age of sixty-six years, brings a sense of personal loss to many metallurgists, especially to those connected with the steel industry of Great Britain. As senior lecturer in the Metallurgical Department of the University of Sheffield until his retirement last year, he was responsible for training many students in metallurgical analysis, and his skill both as an analyst and as a teacher was largely responsible for the high standard of accuracy now reached in works manufacturing the higher classes of steels. His course of lectures on the theory of analysis was an admirable introduction to the advanced chemistry of the less common metals and their salts.

Dr. Ibbotson made many improvements in analytical methods, and the textbooks in which he collaborated—"Steel Works Analysis" (with the late Prof. Arnold), "Analysis of Steel Works Materials" (with H. Brearley), and "Analysis of Non-Ferrous Alloys" (with L. Aitchison) are widely used. A fellow-townsman of Sorby, he was an early worker in metallography and translated the well-known work of Goerens, whilst the papers of Prof. Arnold in the *Journal of the Iron and Steel Institute* were often illustrated by his exquisite drawings of micro-structures.

Dr. Ibbotson was born in Sheffield, but studied at the Royal College of Science in Dublin, of which he became an associate in 1887. He was a B.Sc. of London and a D.Met. of Sheffield. Of striking appearance, great charm of manner and high character, he was greatly beloved by his students; only a very retiring disposition, which led him to shun meetings, prevented his reputation from reaching a wider circle. C. H. D.

WE regret to announce the following deaths:

Mr. Carsten E. Borchgrevink, the Norwegian antarctic explorer, leader of the first expedition to winter in Antarctica, aged sixty-nine years.

Sir Richard Garton, G.B.E., governing director of the firm of Garton, Sons and Co., brewing sugar manufacturers, one of the founders of the British Empire Cancer Campaign, on April 22, aged seventy-six years.

Mr. Richard Llewellyn Jones Llewellyn, an authority on rheumatism and its allied conditions, on April 19.

Sir Max Muspratt, Bt., president of the Association of British Chemical Manufacturers in 1924, a leading figure in the heavy chemical industry, on April 20, aged sixty-two years.

Prof. John M. Poor, professor of astronomy at Dartmouth College, Hanover, U.S.A., who did much work on the orbits of comets, asteroids and double stars, aged sixty-three years.

News and Views

James Mansergh, F.R.S. (1834–1905)

ON April 29 the centenary occurs of the birth of James Mansergh, the eminent hydraulic engineer, who, both at home and abroad, was well-known for his schemes for water supply and sewage disposal. His most famous work was that by which Birmingham was supplied with water from the Elan and Claerwen Reservoirs in Wales, 73½ miles away, a work which was opened by King Edward VII on July 21, 1904. Mansergh was born in Lancaster. After attending the local schools, he was at Queenwood College, Hampshire, for a short time, where Tyndall and Edward Frankland were among his teachers. At the age of fifteen years he was articled to a firm of civil engineers in Lancaster and afterwards gained experience on railway construction in England, Wales and Brazil. In 1866 he became a consulting engineer in Westminster, and from that time onwards specialised in water supply and sewage schemes. It is said that he appeared more than six hundred times before Parliamentary committees, acted for three hundred and sixty municipalities or local authorities, wrote more than two hundred and fifty reports and gave evidence at about three hundred public inquiries. Among the important schemes he carried out abroad were those connected with the water supply of Toronto and the sewage disposal of Colombo and Melbourne. Entering the Institution of Civil Engineers in 1859 as an associate member, he became a vice-president in 1895 and president in 1900. The following year his services as a hydraulic engineer were recognised by his election as a fellow of the Royal Society. He died at Hampstead, on June 15, 1905.

Presentation to Prof. Karl Pearson, F.R.S.

WHEN the impending retirement of Prof. Karl Pearson from the Galton chair of eugenics and from the directorship of the Biometric Laboratory at University College, London, was announced last year, it was felt desirable that steps should be taken to commemorate the pre-eminent services which he had rendered to University College, to the University of London and to science, during nearly half a century. An influential committee under the chairmanship of Prof. L. N. G. Filon, Vice-Chancellor of the University of London, therefore decided to raise a commemoration fund for the purpose; Dr. Ethel Elderton acted as honorary secretary and Dr. David Heron as honorary treasurer of the fund. As a result of the appeal then made, subscriptions amounting to more than £600 were received and at a dinner in Prof. Pearson's honour at University College on April 23, under the chairmanship of Prof. Filon, attended by some hundred subscribers, there were presented to Prof. Pearson a bronze portrait plaque, a book containing the signatures of all the subscribers and a cheque for the balance of the fund,

£440; a Brunsviga calculating machine for his personal use had previously been presented to him. The bronze plaque, of which a copy is to be presented to University College, and a small reproduction to each subscriber, bears the following inscription: "Presented to Professor Karl Pearson, M.A., LL.D. F.R.S., by students, colleagues and friends on his retirement after having been a Professor of University College, London, for forty-nine years, in grateful commemoration of his research, teaching and inspiration." The balance of the fund is to be devoted to the completion or publication of such work of Prof. Pearson or his pupils as he may select or to the advancement in any other way of the branches of science with which his name will always be associated. Prof. Filon, in making the presentation, paid eloquent tribute to Prof. Pearson's distinction in so many fields, and was followed by Mr. G. Udny Yule, who gave very interesting personal reminiscences of work and holidays with "K. P.".

Joseph Priestley

The recent issue of *Isis* (pp. 81–97) contains an important paper by Mr. W. Cameron Walker on "The Beginnings of the Scientific Career of Joseph Priestley", disposing of the incorrect views expressed by Priestley's biographers, such as, that his "History of Electricity" was suggested by Franklin and that it led to his election as F.R.S., that this distinction was the result of his electrical experiments, and so on. The Canton Papers and certain letters—some facsimiles are given—in the Royal Society's library show that the writing of the "History" was Priestley's own idea, that he was elected F.R.S. prior, not only to its publication, but also to his experiments, and that his friends secured his election with the view of increasing the sale of his book. Priestley's own account, written long after these events, ascribed his election to his original experiments. But the author is probably correct in hinting at a lapse of memory, since there is other evidence of this failing. The most interesting document here is Seddon's letter of December 18, 1765, introducing Priestley to Price and suggesting in a postscript his introduction to Franklin. As a result Priestley met Franklin and Canton, was elected F.R.S., was led to experiment in electricity, thence to the study of the conductivity of 'mephitic air', and thence to his classic chemical researches on 'airs' and to the discovery of oxygen—to the birth of modern chemistry. Few 'postscripts' have had such historic consequences.

Trevithick Memorials

A memorial to Richard Trevithick, the great engineer and inventor, was unveiled at Merthyr Tydfil on Thursday, April 19, by Mr. David E. Roberts, to mark in a fitting manner the historic journey of the first rail locomotive on February 21, 1804. The memorial is situated at Pontmorlais, close to what was then the entrance gate to Penydaren Ironworks, where Trevithick built the locomotive. It ran down to the basin on the Glamorganshire Canal at Abercynon 9¾ miles distant, but the damage to the cast iron rails, which were of course only suited for horse traction, was such that the trials were not followed up. The memorial itself is built of stone sleepers taken from the track, and incorporates also some of the old rails. Its erection is the outcome of local effort backed by help from the Trevithick Centenary Commemoration in London. The event was made a civic occasion, and a concourse of upwards of 3,000 spectators assembled for the ceremony. The unveiling was followed by an address from Mr. Roberts on the work, especially that in South Wales, of Trevithick.

The second of the memorial tablets erected as a result of the commemoration last year of the centenary of the death of Trevithick, was unveiled at University College, London, on April 23, by the Hon. Oliver Stanley, M.P., Minister of Transport. The tablet has been placed on the Gower Street side of the College to mark the site of the track laid down in 1808 over which Trevithick's locomotive *Catch-me-who-can* ran. This was the first rail locomotive to draw passengers, and the exact site of the experiment has only been determined after long inquiry. The tablet, which bears a medallion of the inventor, a representation of his engine and a suitable inscription, is of bronze; it is a bold and striking memorial and one which effectively attracts the attention of the passers-by. Prior to the unveiling, a meeting took place in the College which was presided over by Sir Murdoch Macdonald, M.P., the chairman of the commemoration committee. When asking Major Stanley to unveil the memorial, and the Provost of the College, Dr. Allen Mawer, to accept the custody of it, Sir Murdoch said that often our great benefactors have reaped but posthumous honours and so it was with Trevithick, for although he died in 1833, it was not until fifty years later that his memory was honoured by the erection of a window in Westminster Abbey. Methods of transport have developed greatly since Trevithick's time, but all our steam locomotives, great and small, work on the principle first effectively applied by him.

Cosmic Rays

Prof. P. M. S. Blackett delivered the Friday evening discourse on April 20 at the Royal Institution, taking as his subject "Cosmic Rays". This fascinating subject started more than thirty years ago with the discovery that clean dry air at sea-level is a slight conductor of electricity; it has now grown into one of the important branches of physics, and it perhaps may also be considered as an important branch of astronomy. For whatever the final explanation of the origin of the rays is found to be, it is probable that their origin is of great astronomical significance. The instruments with which the rays have been investigated have been the ionisation chamber, the counter and the cloud chamber, and experiments have been carried out with such apparatus all over the world and at very great heights above the ground and far below the surface. The cosmic radiation is a part, really, of geophysics, to be studied not only in the laboratory but also everywhere that is

attainable. It appears from all these results that the earth is being bombarded by streams of positrons and electrons of very great energy. These appear to come continually from outside our galactic system, but from where, or how they are produced, no one knows. The study of the passage of these rays through the atmosphere has led to the discovery of exciting new phenomena. The positron, first detected by Anderson in a cloud photograph, is now known to be one of the main constituents of the rays; and this new member of the group of fundamental particles has very great theoretical interest, since its experimental detection has shown the validity of Dirac's theory of 'holes'. Very great interest is attached to the behaviour of the very fast cosmic ray particles while passing through matter. The curious and striking phenomenon of the 'showers' still awaits explanation. It is clear that one is here in a region of physics where quite new types of phenomena occur.

Humour and Humanism in Chemistry

UNDER this title, Prof. John Read, of the University of St. Andrews, gave an address to the Alchemists' Club of the University of Glasgow on February 28. One of the chief defects in the average science course or textbook, he said, is the neglect of the human element. He deprecated this omission, which he holds responsible for many of the misconceptions of men of science by their colleagues of arts and letters, "who, from attending a limited number of strictly formal and impersonal lectures on science have often deduced that the man of science is of necessity cold, formal and aloof; narrow in outlook; insensible to the finer human emotions; incapable of expressing himself in the common tongue; devoid of humour and humanism; and a stranger to the humanities." In the course of a picturesque survey of selected aspects of historical chemistry, Prof. Read claimed that the study of chemistry, if approached befittingly, may reasonably take rank beside the so-called 'humanities', as a broadly educative, cultural, and humanising influence. He re-defined humour in various terms as the golden thread running through the whole history of chemistry: the real philosopher's stone—the universal catalyst. The present generation of chemists, he remarked, are inclined to take themselves too seriously; like Liebig, Wöhler, and their more remote alchemical forebears, they should include a large pinch of humour and humanism in their curricula. The narrowness of outlook which is becoming increasingly associated with the ultra-specialistic trend of contemporary chemical research can be combated most effectively by the cultivation of an interest in the broader humanistic aspects of chemistry. Those chemists who aspire to become leaders in the future should cultivate a discerning and sympathetic acquaintance with the past. During the ensuing discussion, in reply to Prof. T. S. Patterson, the speaker threw some new light upon the possible origin and interpretation of the enigmatical seventeenth century illustrations appearing in the *Mutus Liber*.

74-in. Telescope for the University of Toronto

THE issues of *Engineering* for March 9 and 30 and April 20 contain a fully illustrated description of the 74-in. reflecting telescope now being completed by Messrs. Sir Howard Grubb, Parsons and Co., at Newcastle for the David Dunlap observatory of the University of Toronto. An account of the instrument was published in NATURE of October 14, 1933. The observatory, which is being given as a memorial to the late David A. Dunlap, of Toronto, by his widow and son, is being erected on Richmond Hill, 800 ft. above sea-level, a few miles north of Toronto. The circular steel building and the 61-ft. dome for housing the telescope were made by Messrs. The Cleveland Bridge and Engineering Co., Ltd., at Darlington, and these together with the main parts of the telescope were sent to Canada last year. The polishing of the mirror is now in hand. The telescope, the largest in the British Empire and the second largest in the world, weighs about 50 tons, of which the moving parts account for about 35 tons. The polar axis is 22 ft. long and the declination axis 13 ft. long; the driving wheel on the former having a pitch diameter of 8 ft. with 960 teeth of 8 mm. pitch. The article gives details of the driving and controlling mechanisms. The disc for the mirror, of special Pyrex glass, was made by the Corning Glass Works, New York, and when received at Newcastle weighed 2 tons 6 cwt. For grinding and polishing the mirror a special machine has been made which allows the mirror to be tilted for testing purposes without being removed from the machine. The telescope, it may be added, may be used either as a Cassegrain or a Newtonian, for which two mirrors 19 in. and 20 in. in diameter respectively are provided.

THE David Dunlap Memorial telescope is illustrated in the issue of the *Sphere* dated April 21, which also includes photographs of the new 36-in. Yapp reflector at the Royal Observatory, Greenwich. Accompanying these illustrations is an article entitled "Studying the Sun in Calcium Light" and several lunar photographs taken with the 100-in. reflector at Mount Wilson, California.

Scientific Publication and Bibliography

AN ambitious plan for scientific bibliography and publications is described in a memorandum issued by Science Service, Washington. The plan is designed to eliminate some of the defects in our present system, such as the difficulty of publishing research results promptly or completely owing to the financial burden, and the inadequacy of much bibliographic work owing to lack of access to original papers, etc. It is proposed accordingly to centralise all scientific publication, abstracting and similar bibliographic services, and to substitute a photographic type of duplication for printed reproduction of scientific papers or abstracts. Under this scheme a research report, for example, submitted and accepted for publication, would be reproduced from the standard typescript form by some suitable method other than printing, and full copies of the

report or paper would only be supplied to order. The author would, however, also provide a summary abstract, say, two hundred words in length, which after editing, if required, would be reproduced by the most suitable means and the abstract would be included in a weekly or monthly journal issued to all scientific workers desiring information in that particular field.

THIS scheme does not discuss the fundamental difficulty of overlapping, but obviously presupposes that one abstract could serve the needs of several related branches of science or industry. It also proposes to deal with the difficulty of indexing scientific literature by assembling all the necessary subject cards for each published article or report and using an adequate numerical classification together with mechanical finding and sorting devices, thus affording a comprehensive basis for bibliographic work. The scheme visualises a public utility association for the United States of America which could afterwards be developed on international lines. Despite the inherent difficulties in the project, and the fact that the international aspects are among the most important and difficult in the problem of dealing efficiently with scientific literature, it should not be lightly dismissed. Bold treatment on such novel lines may possibly lead to a rational solution of a problem which has so often been attacked half-heartedly.

Bureau of American Ethnology, 1931

IN the forty-eighth annual report of the Bureau of American Ethnology for the year ending June 30, 1931, Mr. M. W. Stirling, chief of the Bureau, in making his usual report on the activities of his staff in the period under review, directs attention to archæological investigations carried out by him in Florida. Among the sites examined on the west coast was a large sand burial mound on Blue Hill Island, south of Key Marco, which was found to be of early post-Columbian Calusa origin. A number of structural features unusual in Floridan sand mounds was disclosed. Among them was a clay floor, six feet above the bottom of the mound, which gave evidence of having been the base of a temple structure. It was surrounded by post holes, in some of which the decayed remains of the wooden uprights were still in place. The "accompanying paper" of the report, which as usual takes up the greater part of the volume, does not on this occasion deal with researches in American ethnology carried out by members of the staff, but is a useful general index of the contents of the annual reports of the Bureau from their inception to date. It has been compiled by Dr. Biren Bonnerjea. Originally intended by Dr. Bonnerjea for his own use, the index has been adopted officially and published by the Bureau. As the early volumes cover the period in the 'eighties of the final resistance of the Indians to white control in the south-western States, they record much valuable material relating to the final stage of independent culture which the index will assist in preserving from oblivion.

Modern Street Lighting

THE characteristic and peculiar colours of the discharge lamps used for street lighting have attracted much interest to this important public service. With the development and research departments of great companies behind it, this branch of lighting has made rapid progress. In a paper read to the Royal Society of Arts by J. M. Waldram on January 17, it was pointed out that the use of these lamps has led to material improvements in our knowledge, leading to a new technique. One of the immediate problems of street lighting is connected with the question of who is to pay for it. It is an anomaly that a national trunk road should be built, drained and maintained at the national expense, and the lighting left to local authorities, each lighting its section according to its own ideas and naturally being sometimes very limited as to the cost. The requirements of the motorist are the most difficult to satisfy. He has when moving at high speed to see every obstruction in the road many feet in advance, whatever the condition of the road surface. Claims have been made that certain lights have more fog-penetrating power than others, but recent experiments throw doubt on this. Experience shows that from the safety point of view, when driving, the spectral colour of the light matters little. In general, recent progress has been made mainly in the direction of lowering the cost of production of the light and thus making more light available, and in distributing it over the road in such a way that it is more helpful to both pedestrians and motorists.

Short-Circuit Testing Station

WHEN an electric generator is accidentally short-circuited, huge currents are developed and unless the 'circuit-breakers' act promptly, serious damage may be done to the generator and there is a risk of fire. Until a few years ago, practical experience was the only guide to the rating of these circuit-breakers. The enormous currents required for testing purposes, in most cases, made the testing costs prohibitive. Proposals were made for a co-operative or national testing plant, but nothing materialised. In 1929 a private company, Messrs. A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, laid down their own testing station, which has proved capable of testing the largest circuit-breakers used in Great Britain. They have erected a miniature power station which has a capacity of 1·5 million kilovolt-amperes. Any short-circuit conditions which might possibly occur in practice can be produced in their testing room. The generators are driven by 5,500 volt motors connected with the public supply mains. Very large transformers are used to produce the heavy currents required. The observation gallery is built of reinforced concrete and has slits in the wall fronting the test bay, through which the behaviour of the apparatus under test can be safely observed. A system of traffic signal lights and alarm bells is installed outside the test bay to give warning when a test is about to be made and when all is clear. Short-circuit phenomena can be observed in time intervals

as short as two millionths of a second. Messrs. Reyrolle's plant is one of the largest and best equipped short-circuit testing stations in the world. A scheme has now been initiated whereby full facilities are provided for utilising this testing plant for the benefit of the electrical industry. A company has been formed which will operate independently and will be in a position to issue national test certificates.

A Piano with no Wires

ACCORDING to a recent report by Science Service, pianos are now being constructed in Kalamazoo, Michigan, U.S.A., with no strings or wires. To produce the tones, strips of steel not more than a few inches long are made to vibrate electrically. The new instrument, called a clavier, uses a piano keyboard to operate the strips producing the notes, which are practically pure tones. These tones, which are almost inaudible, are picked up by magnetic induction and passed through an audio-frequency amplifier. The capacity of the amplifier is about ten times that of the average radio amplifier having a capacity of 30 watts. The player therefore has at his command a tone ranging from a mere whisper to one that would balance an orchestra. The impact noise sometimes audible in a piano is filtered out, and thus the pure tone is produced. The piano was invented by Prof. Lloyd Loar after experiments extending over several years. Through the use of earphones, the piano student can practise his lessons without disturbing anyone, the sound being heard only by himself. The tone volume can be varied over a wide range simply by turning a dial. The operating devices occupy very little space, the clavier consisting of little more than keyboards.

Ipswich Museum

AN appeal on behalf of the Ipswich Museum has been issued by Mr. J. Reid Moir, its president. The Museum is not well provided with exhibits illustrating the culture of the bronze age; but it now has the opportunity of acquiring an exceptional collection of bronze implements, many of which were found in Suffolk, at a cost of £100. The collection is at present on view in the Museum. Mr. Reid Moir, in issuing his appeal, does not confine himself to this immediate object; he takes a long view of the situation. Availing himself of the occasion, he suggests the institution of a body of "Friends of the Museum" who might collaborate in its work in various ways, and might, by subscription, provide a fund for use in emergencies which the provision from municipal funds could not meet for various reasons. The case for the local museum as a centre of regional scientific and historical studies is ably stated in the appeal and needs no further elaboration here. On the question of general principle, however, it may be pointed out that any proposal such as that made by Mr. Reid Moir, which helps to broaden interest among the local public in the function of its museum, deserves every encouragement. Without desiring to relieve the municipality, as the local education authority, from any responsibility that may be imposed upon it for the maintenance of the general intellectual level of its area, it must be admitted that occasions frequently arise in connexion with the work of a museum in which voluntary effort, financial or other, is salutary and expedient, or even necessary, to supplement the official obligation of the municipality.

Grassland and Grazing Research

Two new bulletins in the Herbage Publication Series have been issued by the Imperial Bureau of Plant Genetics at Aberystwyth. The first, entitled "Grazing" (Bull. No. 10. 1*s*. 6*d*.), consists of a collection of papers read at the British Association meeting at Leicester in 1933, each of which approaches the subject from a different aspect. The grazier's problems are put forward from a practical man's point of view, while the effect of the stock on the sward is considered in the light of experimental evidence. The Bureau has for some months been collecting information regarding the technique employed in pasture and grassland research in Great Britain and certain dominions, and the other bulletin ("Technique employed in Grassland Research in New Zealand", Bull. No. 11. 3*s*.) is the first publication on the subject. Questions of strain testing and building in grasses, clovers or lucerne, the breeding methods employed and the necessary corollary—the certification of herbage seeds—form the subject of several of the papers. The measurement of pasture production is considered in detail. A modification of the technique formerly described as 'alternate mowing and grazing' is put forward, while the lay-out of the experiments, the stage at which cuttings should be made, and the technique of stock grazing trials are among other major points dealt with. Reference is also made to two laboratory tests which have proved useful in conjunction with field work. In the first place the prussic acid content has proved valuable as a means of distinguishing between different types of wild white clover, while screened ultra-violet light has been successfully employed in rye grass type determination.

Russian Studies of Crop Plants

THE material collected by Dr. Klinkowski on the ecological distribution of lucerne types has been translated and published in an abridged form as Bulletin No. 12 in the Herbage Publication Series of the Imperial Bureau of Plant Genetics ("Lucerne: Its Ecological Position and Distribution in the World". Aberystwyth: I.B.P.G., Agricultural Buildings. 3*s*. 6*d*.). Lucerne is the oldest forage plant known and originated from a number of regions of a 'steppe' character. The routes along which the plant migrated are traced, and the history of its development and the importance of the crop at the present time described for 45 different countries. The geographical distribution of the types of cultivated lucerne in Europe, Asia and North Africa is also dealt with. A further publication, "Plant Breeding in the Soviet Union", has been

issued jointly by the Cambridge and Aberystwyth Sections of the Imperial Bureau of Plant Genetics (3*s*. 6*d*.).

White Pelicans of Western America

Where formerly there were more than seventy nesting colonies of white pelicans in western Canada and the United States, there are now but seven large colonies. Of these, five are in Government-protected areas, a fortunate circumstance, since although there still exist 20,000–25,000 of these birds in the United States, their continued existence is not so secure as the numbers might suggest. The danger which most threatens the species, according to Ben H. Thompson (Science Service, Washington, D.C.), is the draining of lakes where the nesting islands exist, but there has also to be taken into account the retaliation upon nests and eggs by fishermen who object to the pelicans' destruction of fishes, notwithstanding that in most places the birds have been found to feed mainly upon fishes not good for sport or food. A third line of control was practised for some time in Yellowstone Lake, on account of the part taken by pelicans as carriers of a trout parasite, but that policy has been given up, and the Yellowstone Park birds are now fully protected.

Museums Association

The report of the Council for 1932–33 makes very satisfactory reading. The membership rose to 801, and is now really representative of museum interests throughout Great Britain. Income for the year, at £2,785, was a record, the subscriptions of members exceeding by £268 those of the preceding year, and the net credit balance for the year was £496. The work of the Association has followed the lines of recent years. Co-operation with the Carnegie United Kingdom Trustees in the allocation of museum grants has been continued, and now all applications for grants must be made in the first place to the Association. A successful training course for museum curators was held at Manchester, the annual conference of 1932 at Birmingham, and there is the great venture of an Empire survey of museums, which began in 1931 (*Museums J.*, **33**, 206; 1933). The same number of the *Journal* contains an account of the very successful conference of 1933 at Norwich.

Solar Physics Observatory, Cambridge

The annual report of the Director of the Solar Physics Observatory at Cambridge shows that a satisfactory state of progress obtains at that institution (University of Cambridge: Solar Physics Observatory. Twenty-first Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1932 August 1—1933 July 31. Pp. 3). The 3-ft. reflector is at last being put to regular use, and as a spectrograph will be obtained for it in the near future, we may look forward to a notable addition to the somewhat slender amount of stellar spectroscopy carried out in Great Britain. The Solar Physics Observatory has recently acquired additional solar apparatus in the form of a fine train of prisms by Hilger. There is now a good collection of spectrographs at the Observatory. As in past years, a number of physicists from the Cavendish Laboratory have gone out on the Madingley Road and worked at the Observatory.

Bibliography of Cossar Ewart's Works

Prof. J. H. Ashworth and Dr. F. Fraser Darling have prepared a "Bibliography of the Works of James Cossar Ewart", who died on December 31 last (Supplement to "Animal Breeding Abstracts, vol. 1. Edinburgh: Oliver and Boyd. Separate, 6*d*. net). The list, which contains no less than 141 titles of papers and books by Cossar Ewart alone or in collaboration with others, is a story of a long and active life of scientific investigation covering a wide range of work, from minute anatomy to animal breeding. The last reference is to a letter on "The Coat of Sheep" in Nature of March 19, 1927; it is also of interest to note that nine of Cossar Ewart's papers to the Royal Society of Edinburgh are represented by title only, so that the abstracts published in Nature are the only records of their subject matter.

Academic Assistance Council

Reference has been made in our columns from time to time to the work of the Academic Assistance Council, one of the functions of which is to assist men of science and letters who have been displaced during the political changes in Germany of the past year or so. We understand that the Council has now compiled a list of such displaced scholars, with information as to whether they have succeeded in obtaining temporary or permanent posts. The list is to be revised from time to time and sent to academic committees and appropriate institutions. The Council, the address of which is c/o Royal Society, Burlington House, London, W.1, is prepared to give further information about the movements of those on its lists in reply to responsible inquiries.

The Pasteur Institute of Southern India, Coonoor

The annual report of the Director, Major K. R. K. Iyengar, of this anti-rabic Institute for the year 1932 has recently been issued. Patients treated at the Institute numbered 566, with 4 deaths, a mortality rate of 0·7 per cent. In addition, the anti-rabic vaccine is now issued to 107 centres in the Madras Presidency and elsewhere, and at these 8,452 persons are reported to have received a complete course of treatment, among whom were 34 deaths, a mortality rate of 0·4 per cent. Semple's carbolised sheep vaccine was used throughout the year, and 144,900 doses of this vaccine were issued; in addition to the human patients, 194 animals were also treated. No record of research work appears in this report.

The Apennine Tunnel

On April 22 the King of Italy opened the new railway line joining Bologna and Florence. Known as the "Direttissima", this line is 21 miles shorter than the old line known as the "Porretana". The

total distance is 61 miles, of which 23 miles are underground. Many bridges and viaducts have had to be constructed but the outstanding feature is the Apennine Tunnel, 11 miles 882 yards in length, which is the longest tunnel in the world with a double track. The Simplon tunnel is slightly longer, but this consists of two parallel tunnels each with a single track. The Apennine tunnel is a straight line for the whole length and, half way through, a station has been built with four lines for manœuvring purposes. Electric traction is being used, the locomotives taking direct current at 3,000 volts. The total cost of the line has been about £13,000,000, while the saving of time on the journey between Bologna and Florence is about one hour and a half.

Rothamsted Experimental Station

OF the £30,000 required for the purchase of the land on which stands the Rothamsted Experimental Station, £26,700 has now been given or conditionally promised. The sum of £3,300 remains to be raised before May 12 in order that the Station may claim the generous donation of £15,000 from Mr. Robert McDougall and £5,000 from the Sir Halley Stewart Trust, which will complete the purchase fund. Farmers and all interested in agriculture in its practical, technical or educational aspects are cordially invited to visit the Rothamsted and Woburn plots at any convenient time between the beginning of May and the end of October. Mr. H. V. Garner and Capt. E. H. Gregory will be in charge of the demonstrations, and there is ample material at either of the farms to occupy a full day. All communications and requests to visit the Stations should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

Announcements

SIR ARTHUR EVANS has been awarded the gold medal of the Society of Antiquaries for "his distinguished services to archæology". This is the first award to be made of the medal.

BRIGADIER-GENERAL SIR PERCY SYKES has been awarded the Gold Medal of the Royal Empire Society for his recently published book "A History of Exploration: from the Earliest Times to the Present Day".

PROF. C. V. BOYS will deliver the nineteenth Guthrie Lecture before the Physical Society on May 4 at 5 p.m. The title of Prof. Boys's lecture will be "My Recent Progress in Gas Calorimetry".

THE third Spiers' Memorial Lecture of the Faraday Society will be delivered at the Royal Institution on May 16 at 5.30 p.m. by Sir William Bragg, who will take as his subject "Molecule Planning".

AT an ordinary meeting of the Chemical Society to be held on May 3 at 8 p.m., a discussion on "Unicellular Chemistry" will be opened by Dr. J. Vargas Eyre. Those invited to take part in the discussion include Dr. E. F. Armstrong, Dr. W. G. Bennett, Prof. J. C. Drummond, Dr. H. B. Hutchinson and Miss M. Stephenson.

SIR CHARLES PEERS, chief inspector of ancient monuments in 1913–33, has been appointed by the Lords Commissioners of the Treasury to be a trustee of the London Museum.

DR. R. MADWAR has been appointed director of Helwan Observatory, near Cairo, in succession to Mr. P. A. Curry, who is the Deputy Director General of the Physical Department, Ministry of Public Works, Egypt.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on May 31–June 1. The autumn meeting of the Institute will be held in Belgium and Luxembourg on September 10–14.

W. JUNK, 68 Sachsische Strasse, Berlin, W.15, has just issued Catalogue 85, "Periodica-Iconographiæ-Rara et Curiosa" dealing with books on science and natural history. The first section includes sets of periodicals, mainly foreign. Iconographiæ contains chiefly coloured-plate books, including several botanical rarities. The last section has books on all branches of natural science, both standard modern works and earlier works of historical interest.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in geography in the University of Manchester—The Registrar (April 30). An assistant master to teach mathematics in the School of Art and Technology, Chelmsford—The Clerk to the Governors, School of Art and Technology, Chelmsford (April 30). A chief technical assistant in the Department of Economics, Edinburgh and East of Scotland College of Agriculture—The Secretary, 13, George Square, Edinburgh (May 4). An assistant master to teach practical drawing in the Walton Junior Day Technical School, Liverpool—The Director of Education, 14, Sir Thomas Street, Liverpool 1 (May 4). A lecturer in bacteriology and assistant bacteriologist in the Public Health Laboratory, University of Birmingham—The Secretary (May 10). A veterinary surgeon in the Public Health Department of the Corporation of London—The Town Clerk, Public Health Department, Guildhall, E.C.2 (May 10). A principal of the Central Municipal Technical School, Liverpool—The Director of Education, 14, Sir Thomas Street, Liverpool 1 (May 14). A teacher of mechanical engineering in the Central Municipal Technical School, Liverpool—The Director of Education, 14, Sir Thomas Street, Liverpool 1 (May 14). A demonstrator in physiology in the University of Liverpool—The Professor of Physiology (May 14). A Ramsay Memorial professor of engineering at University College, London—The Academic Registrar, University of London, S.W.7 (May 23). A University professor of pharmacology at University College, London—The Academic Registrar, University of London, S.W.7 (May 25).

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.*]

Production of Positive Electrons by β-Particles

IN a previous note[1] we described some experiments carried out with a weak source of radium placed inside an expansion chamber, and showed that the ordinary β-radiation is accompanied by an emission of positrons. It is quite impossible to ascribe the origin of these positive electrons to the internal conversion of γ-rays or to any other known mechanism by which positively charged particles are created. It seemed to us to be most plausible to assume that the appearance of these positively charged particles is closely connected with the phenomenon of β-disintegration. However, more recent experiments have shown that the number of positrons depends to a large extent upon the nature of the walls surrounding the source examined.

In a series of consecutive experiments with the same source of radium, the latter was alternately enclosed in either a lead or a carbon tube with different thicknesses of wall provided with different slits for the escape of the β-rays. With a carbon tube, the number of positrons observed was two to three times greater than in the case of a lead tube. This would lead to the conclusion that the emission of positrons is due, at least in part, to the bombardment of the walls by β-rays.

We verified this assumption in the following way. The glass tube containing the active deposit, and surrounded by another tube of lead, was filled with pulverised carbon; in this case we observed a three-fold increase in the yield of positive β-rays (each time compared with the yield of ordinary β-rays due to disintegration escaping through the given aperture).

Quite conclusive evidence was obtained by using a lead cylinder with walls 4 mm. thick and internal diameter 6 mm. A window 4 mm. wide in the walls was closed by a carbon filter, 3 mm. thick, for absorbing any positrons emitted by the active source, and for stopping all the ordinary β-rays of energy less than *c.* 1,000 ekv. Under these conditions, the carbon filter emits very fast positrons (12 tracks with an energy between 200 ekv. and 700 ekv.; 7 tracks with an energy between 700 ekv. and 1,200 ekv.) their number constituting 5–10 per cent of the total amount of β-rays which *penetrate* the filter.

If we assume, on the basis of the present data on the absorption of β-rays, that all the β-rays of initial energy above *c.* 1,000 ekv. are able to penetrate the filter, and that these are the only rays which are effective, the results obtained must mean that, on the average, one positron corresponds to every 10 or 20 β-particles and that the radius of the 'effective cross section' is of the order of 10^{-12} cm.

The number of β-particles which strike the filter, and are responsible for the appearance of positrons, may exceed the number of particles which emerge. However, if we take into account the geometry of the experimental arrangement as well as the intensity of the source under examination, we shall be justified in concluding that the percentage yield of positrons is scarcely less than 2 per cent, the critical energy being taken as 1,020 ekv. In this case the radius calculated for the effective cross section is not less than $0{\cdot}5–1 \times 10^{-12}$ cm. per atom, which exceeds the corresponding value for the γ-rays of thorium C″ some ten times.

Thus it is obvious that the above phenomenon has nothing in common with the mechanism considered by Furry and Carlson[2]. We here encounter an entirely new relativistic effect which is outside the scope of the present theory.

It may be added that the above results are in good agreement with previous observations made by one of us[3].

At the present moment it would be premature to decide whether the positrons are emitted by the radioactive substance itself. The observed facts seem to indicate that the output of positrons is greater for the lighter elements. Definite conclusions must be deferred until new experiments have been carried out, since the geometrical conditions up to the present could not be controlled sufficiently.

D. SKOBELTZYN.
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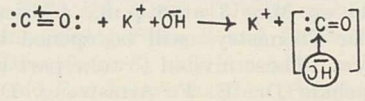
[1] D. Skobeltzyn and E. Stepanowa, NATURE, **133**, 565, April 14, 1934.
[2] W. H. Furry and Y. T. Carlson, *Phys. Rev.*, **44**, 237; 1933.
[3] D. Skobeltzyn, NATURE, **133**, 23, Jan. 6, 1934.

Isomorphism and Chemical Constitution: Constitution of Formic Acid and Formates

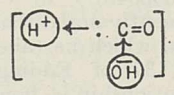
THAT formic acid differs from its higher homologues (acetic, propionic, etc.) in many salient chemical characters is well known to chemists. The break in the serial order as regards the absorption curves of the saturated monobasic fatty-acids has been observed in the case of formic acid by V. Henri, Hantzsch and Wright.

The reducing character of formic acid, generally explained by the presence of an aldehydic group in the molecule, as distinguished from acetic acid and its homologues, the absence of a chloride and anhydride corresponding to acetyl chloride and acetic anhydride, the acid character of its nitride (HCN) differing from the indifferent nitrides of homologous acids, the strength of the acid twelve times stronger than acetic and propionic acids as shown by the affinity constants derived from electrical conductivity (Ostwald), have rightly induced Richter to differentiate it from acetic acid and its homologues. Dr. P. B. Sarkar, working in the inorganic department of my laboratory, has, in continuation of his work on chemical homology and isomorphism[1,2], recently arrived at the conclusion that these discrepancies are to be sought for in the difference in the constitution of the acid itself. In other words, in the case of formic acid, the ionisable hydrogen is not the hydrogen atom of the hydroxyl group, as in the case of other fatty acids, but the hydrogen attached to the carbon atom.

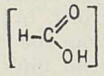
The classical synthesis of formates from CO and KOH is explained by Dr. Sarkar on the modern electronic conception in the following way:



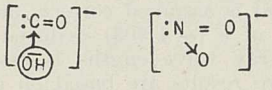
The hydroxyl ion co-ordinates with the group CO to which it imparts an univalent negative charge and thereby forms a complex anion (formate ion). The so-called bivalent carbon atom in this anion has really a 'lone pair' of electrons free. Dr. Sarkar has proved that the undissociated formic acid and its esters are not reducing although they contain the aldehydic group. It is the formate ion that is reducing owing to the presence of a 'lone pair' of electrons in the carbon atom. The undissociated acid, according to him, is of the constitution :



In this form it is indistinguishable from the ordinary formula



as is evidenced by the Raman spectra. On the basis of this hypothesis, Dr. Sarkar deduces that the structure of the formate ion is almost identical with that of the nitrite ion.



These two ions are isosteric and isoelectric and as such should exhibit isomorphic relations.

Though barium formate crystallises anhydrous, and barium nitrite with one molecule of water of crystallisation, Dr. Sarkar has been able to prepare the mixed crystals of

1, barium (formate, nitrite), barium (nitrite, formate), H_2O.

2, Strontium formate with strontium nitrite.

3, Zinc formate with zinc nitrite, though the latter cannot be isolated in the free state.

4, Cadmium formate with cadmium nitrite (miscibility small).

He has also prepared the double salts of the formulæ :

Mg $(COOH)_2$, 2 hexamethylene tetramine, 10 H_2O
Mn $(COOH)_2$, 2 hexamethylene tetramine, 10 H_2O

perfectly isomorphous with the corresponding nitrites of magnesium and manganese prepared by Scagliarini[3]. Further investigation regarding the double and triple formates and their comparison with the corresponding nitrites is in progress.

To corroborate the above constitution of the formate ion, the examination of the Raman effect of barium formate in the solid state has been undertaken and is expected to throw additional light on the constitution.

Detailed investigation will be published in the *Journal of the Indian Chemical Society*.

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March 12.

[1] NATURE, **124**, 480, Sept. 28, 1929.
[2] NATURE, **126**, 310, Aug. 30, 1930.
[3] *Atti. R. Accad. Lincei*, (5), **21**, II, 88–92.

Conductivity-Temperature Curves of Paraffin Wax

IT is usually supposed that the conductivity of dielectric materials increases continuously with increase in temperature. The only recorded exception to this normal behaviour appears to be by Gemant[1], who found that the D.C. conductivity of a heavy cable oil decreased temporarily from − 40° to − 20° C. I have recently observed a similar peculiar phenomenon, together with a hysteresis effect, in D.C. conductivity measurements over the temperature range from 0° to 50° C. on a sample of paraffin wax (melting between 45° and 55° C.). The results of a cycle of measurements under a continuously applied voltage gradient of 500 volts per cm. are shown in Fig. 1. Commencing at the point *A*, the temperature was lowered to *B*, then raised at a rate of about 1° C. in 5 minutes along the curve *BCD*, and finally decreased at the

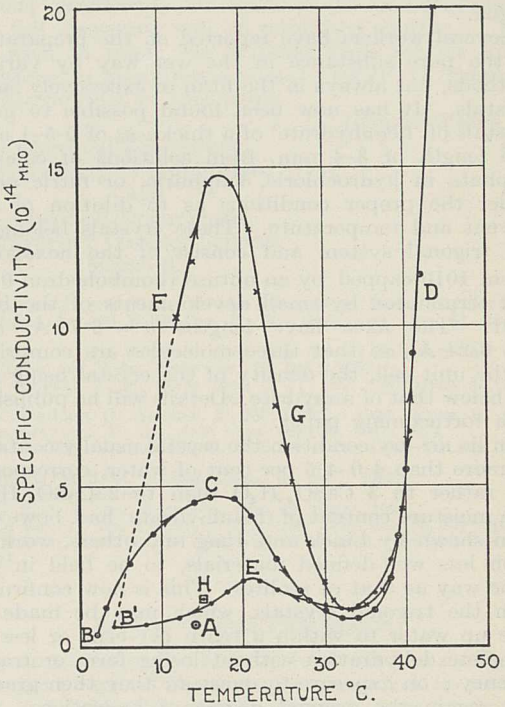

FIG. 1.

same rate along *DEB'*. On regaining room temperature very slowly from *B'*, the conductivity had risen to *F*, and with temperature rise from this point followed the curve *FGD*. On subsequent slow cooling to room temperature, the conductivity attained the value *H*.

A discharge current, characteristic of dielectric absorption, lasting usually for from 1 to 2 minutes, was obtained on condenser short circuit immediately after a period of charge. Measurements at 10 seconds after short circuit showed that the current magnitude at this instant passed through a maximum during temperature rise at 12° C. and disappeared in the region of 55° C.

A satisfactory explanation of the peculiar variations in structure responsible for the phenomena is not possible until further experiments have been carried out, but it is probably concerned with the presence in the wax, at temperatures below the 'solidifying' point, of a solid crystalline network

among which is interspersed a liquid phase. In consequence of adsorbed ions, the boundary surfaces of the two phases would have a greater conductivity than either phase, and where continuous, would form highly conducting bridges between the electrodes.

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March 12.

[1] A. Gemant, *Z. Phys.*, **75**, 613; 1932.

Calcium Sulphate Hemihydrate

MUCH attention has been given to calcium sulphate hemihydrate since it was recognised as the active principle of plaster of Paris, but its characteristics as a crystal species have hitherto remained somewhat vague.

Several workers have reported on the preparation of the pure substance in the wet way by various methods, but always in the form of excessively small crystals. It has now been found possible to grow crystals of 'hemihydrate' of a thickness of 0·5–1 mm. and length of 3–4 mm. from solutions of calcium sulphate in hydrochloric, sulphuric, or nitric acids under the proper conditions as to dilution of the solvent and temperature. These crystals belong to the trigonal system and consist of the hexagonal prism $10\bar{1}0$ capped by an obtuse rhombohedron $01\bar{1}2$ and terminated by small developments of the base 0001. The axes have lengths $a = 6{\cdot}76$ A. and $c = 6{\cdot}24$ A., so that three molecules are comprised in the unit cell, the density of the crystal being not far below that of anhydrite. Details will be published in a forthcoming paper.

In its air-dry condition the crystal usually contains no more than 4·0–4·5 per cent of water, corresponding rather to 3 $CaSO_4.H_2O$ than to 2 $CaSO_4.H_2O$. The moisture content of 'hemihydrate' has, however, been shown by Linck and Jung and others, working upon less well-defined materials, to be held in the same way as that of zeolites. This is now confirmed with the trigonal crystals, which may be made to give up water to within a tenth per cent or less of complete dehydration without losing form or transparency; on exposure to moist air they then gradually regain the original degree of hydration. On 'dead-burning' they are converted into pseudomorphs consisting of ordinary anhydrite.

Brought into contact with water, the crystals yield solutions supersaturated with respect to $CaSO_4.2H_2O$, though the effect is not so striking as with plaster of Paris; in a short time bunches of dihydrate needles are seen growing out of favoured spots on the hexagonal prisms.

It seems, then, that anhydrite is dimorphous; we have the orthorhombic, comparatively inert modification, and a trigonal one stable only up to 200° or thereabouts, which can take up water zeolitically. The behaviour of this latter in contact with water is what causes plaster to set. There may well be no essential difference between the 'soluble anhydrite' and the 'hemihydrate' accepted in the literature of calcium sulphate.

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April 9.

The Value of e/m

EDDINGTON[1] originally proposed the relation $hc/2\pi e^2 = 136$, and later[2] revised this to 137. Still later he proposed[3] a second relation, namely, the ratio of M, the mass of the proton, to m, the mass of the electron, is $1847{\cdot}6$[4]. This second relation, combined with the value of the Faraday and Aston's mass of O^{16} leads[4] to $e/m = (1{\cdot}77031 \pm 0{\cdot}00014) \times 10^7$ E.M. units. If, finally, one assumes the correctness of Bohr's formula for the Rydberg constant, there results[4], $h = (6{\cdot}5490 \pm 0{\cdot}0011) \times 10^{-27}$ erg. sec., $e = (4{\cdot}775855 \pm 0{\cdot}000048) \times 10^{-10}$ E.S. units.

Bond[5] has very recently noted that the best experimental value of e/m, which he takes to be 1·759, is approximately 136/137 of Eddington's calculated value. This new relationship is, however, closer than Bond states, since 136/137 (1·77031) = 1·7574, and the best experimental value is now actually 1·757. Thus Dunnington[6], from a new magnetic deflection method for free electrons, obtains $1{\cdot}757 \pm 0{\cdot}0015$. Gibbs and Williams[7], from the interval of corresponding $H^1\alpha$ and $H^2\alpha$ spectral lines obtain $1{\cdot}757 \pm 001$. Kinsler and Houston[8], from the Zeeman effect of Cd and Zn lines, get $1{\cdot}7570 \pm 0{\cdot}0010$.

The method used by Kretschmar[9] yields not e/m but $e/m \cdot (e^{4/3}/h)$[10]. The observed value of this relation combined with Bohr's formula for the Rydberg constant, leads to $e/m = 1{\cdot}7564$, if the oil-drop value of e (= 4·768) is assumed correct, and to ~ 1·760, if the value of e (~ 4·803) deduced from grating values of X-ray wave-lengths is assumed correct. These last two results are based on a recalculation of Kretschmar's observations by me, using improved auxiliary data. Hence Kretschmar's work leads to a value of e/m entirely consistent with other recent work if one assumes the correctness of the oil-drop value of e, 4·768, but not if the grating value, 4·803, is used.

If the reader will pardon an additional intrusion into the popular domain of numerology[11], it may be noted that $4{\cdot}803/4{\cdot}768 = 137/136$, to one part in 10^5.

R. T. BIRGE.

University of California.
March 22.

[1] A. S. Eddington. *Proc. Roy. Soc.*, A, **122**, 358; 1929.
[2] A. S. Eddington, *Proc. Roy. Soc.*, A, **126**, 696; 1930.
[3] A. S. Eddington, *Proc. Roy. Soc.*, A, **134**, 524; 1931.
[4] See R. T. Birge, *Phys. Rev.*, **40**, 319; 1932.
[5] W. N. Bond, NATURE, **133**, 327, March 3, 1934.
[6] F. G. Dunnington, *Phys. Rev.*, **43**, 404; 1933.
[7] R. C. Gibbs and R. C. Williams, *Phys. Rev.*, **44**, 1029; 1933.
[8] L. E. Kinsler and W. V. Houston, *Phys. Rev.*, **45**, 104; 1934.
[9] G. G. Kretschmar, *Phys. Rev.*, **43**, 417; 1933. See also H. R. Robinson, J. P. Andrews and E. J. Irons, *Proc. Roy. Soc.*, A, **143**, 48; 1933.
[10] K. Shiba, *Sci. Papers, Inst. Phys. and Chem. Res.*, Tokyo, **21**, 128; 1933.
[11] See E. T. Bell "Numerology", reviewed in NATURE, **133**, 80, Jan. 20, 1934.

Reaction Mechanism of Oxidation-Reduction Processes

CERTAIN considerations introduced by Franck and Haber[1], Haber and Willstätter[2] and Haber and Weiss[3] can be developed to give a simple mechanism for oxidation-reduction processes in solution, which reproduces in all cases investigated the experimental observations, both qualitatively and quantitatively. The relation sometimes observed[4] between reaction velocity and electrochemical potential can also be obtained, so that for the first time a comprehensive theoretical treatment becomes possible.

The essential idea is the assumption of electron transfers mainly with ions (in some cases possibly the transfer of H); this loss or gain of electrons always taking place one electron at a time, whereby radicals are often formed. This principle also holds generally for oxidation of more than one step.

For example, the mechanism of the oxidation of a bivalent positive (metal) ion ($Me^{\cdot\cdot}$) by molecular oxygen would be:

$$Me^{\cdot\cdot} + O_2 \rightleftarrows Me^{\cdot\cdot\cdot} + O_2', \quad O_2' + H^{\cdot} \rightleftarrows HO_2$$
$$(2HO_2 \rightleftarrows O_3 + H_2O)^{3} \quad (1)$$

$$Me^{\cdot\cdot} + HO_2 \rightarrow Me^{\cdot\cdot\cdot} + HO_2', \quad HO_2' + H^{\cdot} \rightleftarrows H_2O_2 \quad (2)$$

$$Me^{\cdot\cdot} + H_2O_2 \rightarrow Me^{\cdot\cdot\cdot} + OH' + OH \quad (3)$$

$$Me^{\cdot\cdot} + OH \rightarrow Me^{\cdot\cdot\cdot} + OH' \quad (4)$$

HO_2 and OH are the radicals thus produced. The amount of hydrogen peroxide appearing as a reaction product is determined essentially by the speed of its further interaction by reaction (3). The autoxidation of certain organic compounds (hydroquinones, leuco-dyes, SH-compounds, etc.), some of which are of biological interest[5], seems to proceed in a very similar manner.

Without a metal catalyst, many of these substances are oxidised appreciably only in more or less alkaline media[6], in which the presence of double or at least singly charged anions (R'' or RH') has to be assumed. In such cases we need only consider reactions (1) and (2) (H_2O_2 being formed as reaction product), the anion of the organic compound being substituted for $Me^{\cdot\cdot}$. The formation of the end product then results from the interaction of two radicals:

$$2R' \rightleftarrows R'' + R \text{ or } 2RH \rightleftarrows RH_2 + R.$$

In seeking a relation between reaction velocity and electromotive force, it is first necessary in all these cases to determine whether reaction (1) is to be treated as an equilibrium, practically always existent. If this is so, we get the experimentally observed relation[7]

$$E_t = A_1 + K_1 \log t$$

holding (as a first approximation) during the course of the reaction; E_t being the E.M.F. measured at time t, A_1 and K_1 being independent of E_t and t.

In comparing the rates of oxidation of different substances, a relation has been established experimentally in certain cases[8] between the times (t_p) for a given percentage change and the normal potentials (E_0) of the oxidised substances. This relation is of the form:

$$\log t_p = A_2 + K_2 E_0,$$

A_2 and K_2 being independent of t_p and E_0.

This relation can also be obtained theoretically if we make the plausible assumption that, for the series of substances for which the relation holds, the velocity coefficients of the electron transfer reaction (2) are all about equal.

In more or less acid solutions, many of the above mentioned organic compounds are oxidised only in the presence of metal ions[9]. The oxygen then attacks the metal ion directly (reaction 1) producing HO_2 and $Me^{\cdot\cdot\cdot}$, one of which can then react further as the actual oxidising agent. In the case studied by La Mer and Temple[10], the higher valent metal ion ($Mn^{\cdot\cdot\cdot}$) is evidently the oxidising agent, and thus the relation they obtained between rate and potential can easily be deduced.

There are further oxidation-reduction processes of the type $R'' + Q \rightarrow R + Q''$. The oxidation of a given R'' by different Q and vice versa has been studied[11]. From the mechanism:

$$R'' + Q \rightleftarrows R' + Q' \quad (5)$$
$$R' + Q' \rightarrow R + Q'' \quad (6)$$

a bimolecular velocity coefficient results, in agreement with experiment[11]. If the velocity coefficients for two different oxidising agents Q_a and Q_b, having normal potentials E_a^0 and E_b^0, are k_a and k_b the observed relation:

$$\log \frac{k_a}{k_b} = \text{const.}\,(E_a^0 - E_b^0)$$

follows again on the assumption of roughly equal velocity coefficients for reaction (6) in both cases.

A full discussion will be published shortly.

I wish to thank Sir William Pope for his kind assistance in many respects and Prof. F. G. Donnan for his interest in this work.

JOSEPH WEISS.

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and
Chemical Department,
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March 9.

[1] Franck, J., and Haber, F., *Ber. Akad. Wiss. Berlin*, **13**; 1931.
[2] Haber, F., and Willstätter, R., *Ber. deut. chem. Ges.*, **64**, 2844; 1931.
[3] Haber, F., and Weiss, J., *Proc. Roy. Soc., A* (in the press). See also Haber and Weiss, *Naturwiss.*, **20**, 948; 1932.
[4] cf. Conant, J. B., *Chem. Rev.*, **3**, 1; 1927. Michaelis, L., and Smythe, C. V., *J. Biol. Chem.*, **94**, 329; 1932.
[5] cf. Warburg, O., *Biochem. Z.*, **266**, 1, 377; 1933. Kuhn, R., and Wagner-Jauregg, T., *Ber. deut. chem. Ges.*, **67**, 361; 1934.
[6] cf. La Mer, V., and Rideal, E. K., *J. Amer. Chem. Soc.*, **46**, 223; 1924.
[7] Barron, E. S. G., *J. Biol. Chem.*, **97**, 287; 1932.
[8] cf. Barron, *loc. cit.*
[9] cf. Reid, A., *Ber. deut. chem. Ges.*, **63**, 1920; 1930.
[10] La Mer, V., and Temple, T. W., *Proc. Acad. Sci.*, **15**, 191; 1929.
[11] Dimroth, O., *Z. angew. Chem.*, **46**, 571; 1933. See also Conant, *loc. cit.*

A New Guinea Fish Poison

SOME time ago Dr. Heaslip forwarded to me from Papua a sample of the root of a vine which he stated was "used by the natives for two purposes, one, stunning fish, from which the root receives its local name of New Guinea Dynamite; the other purpose is suicide".

For a time I searched for active poisonous principles in the material, but finally reached the conclusion that the substance was a rotenone containing root: its toxicity towards fish is thus accounted for, but its poisonous action on mammals becomes doubtful. The root gives a strong colour test in the modified Durham reaction[1] and assays[2] of samples show a rotenone content of from four to five per cent. Rotenone extracted from a parcel of the root by carbon tetrachloride, after recrystallisation from amyl acetate had $[\alpha]_D^{22.5}$ − 221·9 in benzene (*c*, 5·582) and had m.p. 164° which was not depressed when admixed with an authentic sample of rotenone.

Dr. Wood, of this University, from an examination of the leaves, flower and fruit was of opinion that the plant was a *Derris*, a view which was confirmed by Mr. White, the Government botanist of

Queensland. A specific determination, however, was not possible on account of the quality of the material, and will have to await the arrival of further specimens this season.

The native name for the root varies with locality, but it is known as *tua* or *tuva* on Dobu and Fergusson Islands. I am informed that whilst *tuva* is used in some places in the Pacific specifically to denote *Derris elliptica*, in other localities it is used as a collective term for fish poisons in general.

Reference is made to the New Guinea *tuva* in general literature[3], and also to the supposedly poisonous properties of the local *Derris* root: but in the latter connexion I am inclined to think that the psychical effect of nauseating draughts on the natives cannot be overlooked.

A. Killen Macbeth.

Johnson Laboratories,
University of Adelaide.

[1] Jones and Smith, *Ind. Eng. Chem.* (*Anal.*), **5**, 75; 1933.
[2] Jones, *ibid.*, **5**, 23; 1933.
[3] Fortune, "Sorcerers of Dobu" (Routledge, 1932), pp. 50, 174.

Polyspermy and the Endosperm

In preparing an account of the life-history of *Acacia Baileyana*, I have found strong evidence of polyspermy in connexion with endosperm formation. The polar nuclei, unfused before fertilisation, have one large nucleolus each. The sperm, which on first contact with the polar nuclei has 13 chromosomes present[1] (presumably telophase) (Fig. 1*a*), proceeds to the resting condition, with a small nucleolus (Fig. 1*b*). In normal cases this group of two large and one small nucleoli is the most prominent feature of the centre of the sac at this stage. Fusion is first between the sperm and one polar nucleus (Fig. 1*c*), the product then fusing with the other polar nucleus to form a nucleus with three nucleoli—one small and two large (Fig. 1*d*). Some instances were found of divergence from the above normal conditions; for example, there would be in the centre of the sac one nucleus with one large and one small nucleolus, and another nucleus with one large and two small nucleoli (Fig. 2*a*); or there might be altogether four or five small nucleoli (Fig. 2*b*, *c*); but always at this stage the large nucleoli numbered two. The inference from the above is that sometimes there are more than two sperms to be found in the sac. There was never any indication that more than one sperm became associated with the egg.

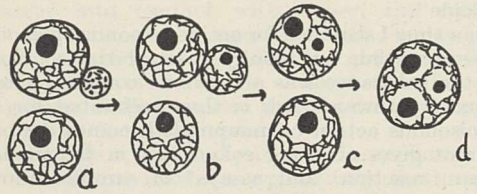

Fig. 1. Triple fusion (diagrammatic). (*a*) First contact of sperm with one of the two polar nuclei; (*b*) sperm attains the resting condition; (*c*) sperm and one polar nucleus fused; (*d*) final fusion with second polar nucleus.

Ishikawa[2], discussing two cases of the presence of three sperms in the embryo sac of *Œnothera*, and other cases of polyspermy reported by other workers, considers that there are two possible sources of the extra sperm: that more than one pollen tube discharges into the sac, or that more than two sperms are produced by the one male gametophyte. The former of these two possibilities is favoured in the case of *Acacia Baileyana*, in view of the following facts.

In several instances two pollen tubes have been seen projecting from one ovule long after fertilisation, and in at least two cases two pollen tubes were traced across the nucellus to the embryo sac at about the time of fertilisation. The pollination unit is a pollinium of sixteen pollen grains. There are from ten

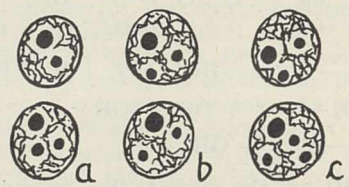

Fig. 2. Multiple fusion (diagrammatic). As stage (*c*) in Fig. 1. (*a*) Two polar nuclei and three sperms; (*b*) two polar nuclei and four sperms; (*c*) two polar nuclei and five sperms.

to twelve ovules (mostly twelve) in the carpel. The ovules at the time of fertilisation are naked. Without the restriction of a micropyle, and with four surplus pollen tubes, it is reasonable to expect that occasionally two pollen tubes would enter an ovule simultaneously. Moreover, two pollinia have in several instances been found germinating on one stigma, their thirty-two pollen tubes providing two tubes for each ovule with a surplus of eight. In one case, three pollinia were seen on one stigma, when the forty-eight pollen tubes would provide four tubes for each ovule. There is every reason therefore to expect polyspermy. Navashin and Finn[3] record in chalazogamous *Juglans* as many as five pollen tubes to one ovule; and three pairs of sperms (one pair having already performed fertilisation) in one sac, with another pair about to be discharged into it!

Search for the extra sperms in the sac of *A. Baileyana* at the time of fertilisation revealed two ovules containing structures that might be so interpreted, and one ovule showing possibly two tube nuclei at a stage after fertilisation was complete.

Further evidence should come from chromosome numbers in the endosperm. The haploid number is 13. In one endosperm a branched metaphase plate is regarded as showing 91 (7*n*), or 104 (8*n*) chromosomes, according to two possible interpretations of the

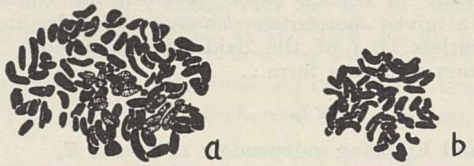

Fig. 3. Metaphase plates in endosperm. × 1680. Drawn from two different endosperms. (*a*) Branched plate. Chromosomes on vertical branch, appearing as 12 pairs of half chromosomes, are stippled. There are about 91 or 104 chromosomes according as to how other paired structures are interpreted. (*b*) 52 chromosomes.

structures (Fig. 3*a*). Only large numbers were seen in the divisions in that endosperm. In another endosperm, were one metaphase of 52 (4*n*) chromosomes (Fig. 3*b*) and a late prophase and early anaphase estimated to represent 13 (*n*) chromosomes each (in this case one of the sperms or a polar nucleus would have divided without fusion).

From what literature is available to me here, it seems that even where polyspermy is recorded or discussed, it is only in connexion with fertilisation of the egg. But in *Acacia Baileyana* I have seen no suggestion of such an occurrence, polyspermy being indicated only in connexion with the endosperm. The problem will shortly receive detailed attention as an abundance of suitable material is available here in the Acacias.

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Feb. 16.

[1] Newman, I. V., *Aust. and N.Z. Assoc. Adv. Sci.*, **21**, 367; 1932.
[2] Ishikawa, M., *Ann. Bot.*, **32**, 277; 1918.
[3] Navashin and Finn, *Mem. Acad. Imp. Sci. St. Petersb.*, **31**, 1; 1913.

Chemistry of the Red and Brown Algæ

IN view of the fact that a study of the literature on the red and brown algæ revealed considerable uncertainty as to whether true cellulose occurs in these plants, the following seaweeds were examined for cellulose by the usually accepted methods :— among the red algæ, *Corallina officinalis*, *Bostrychia scorpioides*, *Chondrus crispus*, *Rhodymenia palmata* ; among the brown algæ, *Laminaria saccharina*, *L. digitata*, *Fucus serratus*, *F. vesiculosus*, *Ascophyllum nodosum*, *Pelvetia canaliculata* and *P. canaliculata*, forma *libera*.

The 'crude fibre' was obtained by boiling alternately with dilute sulphuric acid and dilute caustic soda, washing the product and testing its solubility in cuprammonia, its reaction to iodine and sulphuric acid, and the possibility of obtaining acetyl cellulose. By these tests the presence of cellulose was established in every plant examined. A full report of this investigation will appear in due course in the *Annals of Botany*.

BARBARA RUSSELL-WELLS.
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March 19.

Specific Resistance of the Interior of the Red Blood Corpuscle

MEASUREMENTS of the electric impedance of suspensions of red corpuscles in serum, up to 16×10^6 cycles/sec., give for the specific resistance of the interior of the corpuscle (sheep, rabbit, chicken) 140 ($\pm$ 10 per cent) ohms at 20° C. This value is about twice that of the serum. The value is lower than that previously derived[1] from measurements up to $4{\cdot}5 \times 10^6$ cycles/sec., the difference being due to the inaccuracy of the extrapolation from these comparatively low frequencies. The low value of the resistance of the interior of the corpuscle as compared with that of the serum is chiefly accounted for by the non-conducting bulk of the hæmoglobin.

HUGO FRICKE.
HOWARD J. CURTIS.
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Biological Laboratory,
Cold Spring Harbor, Long Island, New York.
March 22.

[1] H. Fricke and S. Morse, *J. Gen. Physiol.*, **9**, 153; 1925.

Thermal Metamorphism around the Ballachulish Granodiorite

FROM recent studies of the metamorphic rocks lying within the aureole of the Ballachulish granodiorite, it has appeared that there are present there most of the types of hornfelses listed in Goldschmidt's classification. Derived from these are also silica-poor types in which corundum and spinel are common. Hypersthene has, however, not been identified in any of the hornfelses which have been examined up to the present.

There is definite evidence that the contact margin of the granodiorite has undergone some contamination by assimilation of the country rocks. This is shown by the presence of cordierite in specimens of the granodiorite from the contact. It is also noteworthy that hornblende does not appear in these rocks ; biotite is alone present and resembles more the red-brown haughtonite variety of the metamorphics than the greenish-brown variety common to the normal granodiorite. Since it appears that the igneous rock has assimilated material from the surrounding schists, etc., it is probable that the hornfelses have received something in exchange from the granodiorite. From a mineralogical examination of the rocks there are indications that, while the granodiorite has become richer in alumina and potash, the hornfelses have received lime and magnesia. It is proposed to carry out a number of chemical analyses which may definitely establish the details of the suspected interchanges of material.

A. JEAN HALL.
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St. Andrews.
March 15.

The Theory of Vision

THE view that the stimulation of the cones of the retina is indirect and takes place through the photochemical decomposition of the visual purple by light seems to be proved and a fact. How can the colourless transparent cones be directly stimulated by light ? How does this direct stimulation agree with the laws of photo-chemistry ? According to Grotthus's law, no effect can be produced by light unless it is absorbed.

F. W. EDRIDGE-GREEN.
Board of Trade,
S.W.1.
March 23.

Occurrence of the Floating Barnacle in British Waters

ORTON and Rawlinson record, in NATURE of March 17, the occurrence of *Lepas fascicularis* and *L. pectinata* on the Cornish coast in the summer of 1933. As they state that the latter has been recorded only about five times in British waters since 1803, it is worthy of record that several specimens were taken on a box found floating off Port Erin, I.O.M., in April 1933.

H. B. MOORE.
Marine Station,
Port Erin, I.O.M.
March 23.

Research Items

Eskimo Rock-Paintings. Miss Frederica de Laguna in the course of her recent investigations among the Eskimo of Alaska discovered at Cook Inlet in the south-west of Alaska a number of rock-paintings in rock-shelters which she has recently described (*J. Soc. Américanistes*, Paris, N.S., **25**, fasc. 1). No similar rock-paintings are known to occur elsewhere among the Eskimo and they have an individual style which differentiates them from the petroglyphs found among the Eskimo of south-east Alaska and among the Indians of the interior of British Columbia. The paintings here described are from four shelters, of which three are on Kachemak Bay and the fourth in Tuxedni Bay on the western side of Cook Inlet. The drawings are in silhouette in red hæmatite mixed with fat. Some seem to have been made with the finger or a stick, others with a finer instrument. Except in one instance (Sadie Cove), there is no effort at composition, nor are all the figures on the same scale. Among the subjects represented are men, boats with occupants, birds, of which the species can sometimes be distinguished, whales (possibly), animals wounded by lances, seals and a pregnant woman. The object of the paintings does not seem to have been purely artistic as they are never situated near habitations. Various explanations were offered by the Eskimo, such as that they were intended to convey information about game and hence they were made on a small scale and well hidden so that the information should not be available for those for whom it was not intended. Another explanation connected them with the hunting rites of the sorcerer whale-hunters, who use the fat of human victims as poison for their lances. On the other hand, it is pointed out that the Indians of British Columbia make rock drawings as a record of initiation rites or of objects seen in their visions.

Indian Pearl Oysters. Dr. Baini Prashad and Mr. Jnanendra Lal Bhaduri, after a prolonged study of the true pearl oysters of India, recognise five species, all belonging to the genus *Pinctada*; these are *P. margaritifera*, *P. vulgaris*, *P. chemnitzi*, *P. anomioides* and *P. atropurpurea* ("The Pearl Oysters of Indian Waters." *Rec. Ind. Mus.*, June 1933). The chief specific characters used are the amount of convexity of the valves, the length and form of the hinge margin, the presence or absence of teeth and the colour of the shells. Many of Jameson's varieties are done away with, making the classification considerably simpler. There is an enormous amount of variation in each species. Most of them have a very wide distribution, shells from different localities, and even from the same area, often varying much in form, outline, thickness of valves and colour. In addition to the diagnostic characters of the species, measurements of a number of shells from various localities are given to show the range of variability in shape and sizes.

Crabs of the Genus *Parapinnixa*. Steve A. Glassell in a paper, "Notes on *Parapinnixa affinis* Holmes and its Allies" (*Trans. San Diego Soc. Nat. Hist.*, **7**, No. 27; 1933), describes *Parapinnixa affinis*, hitherto only known from a single female specimen found by Holmes and one unpublished record of a male and female by Mr. G. E. MacGinitie, from California. The present author has collected a series of both males and females at San Diego, California. This crab lives as a commensal in the tubes of a marine worm, now being described as a new species of *Amphitrite*. This worm builds a slimy tube of mud and sand among clumps of shells and weeds at about mean low-tide level in situations protected from the full force of the waves. Mr. Glassell recognises three species of *Parapinnixa* from the Pacific: *P. affinis*, *P. nitida* and *P. yokoyai*, and three species from the Atlantic: *P. hendersoni*, *P. bouvieri* and *P. beaufortensis*. In a recent paper by Tune Sakai, however, "A New Genus and some Species of Crabs from Simoda" (*Sci. Rep. Tokyo Bunrika Daigaku* (B), **1**, No. 12; 1933), a new species from the Pacific is described, *Parapinnixa asiatica*, obtained near Simoda attached to seaweed. *Parapinnixa nitida* was found living as a commensal with a terebellid worm. *P. yokoyai*, which is a new name given to the Japanese species called *affinis* by Yokoya, is very like the new species from Japan but apparently differs in certain features, notably the shape of the telson. The first zoeal stage of *P. affinis* hatched from an egg in the laboratory is figured, showing a resemblance to that of *Pinnotheres pisum*.

Detection of Tubercle bacilli. The *Edinburgh Medical Journal* of March (**41**, No. 3) is a 'tuberculosis number', and Dr. Alfred Emslie records attempts made to detect the tubercle bacillus in the blood stream in cases of pulmonary tuberculosis. Contrary to Loewenstein of Vienna, who claims a high percentage of positive results in his cases, Dr. Emslie failed to detect the presence of tubercle bacilli in the blood of 34 known tuberculous patients either by cultures or by animal tests. This negative result accords with the experience of most observers other than Loewenstein who have sought for tubercle bacilli in the blood of tuberculous patients (see Prof. Wilson's critical survey of the literature, Medical Research Council, Special Rep. Series, No. 182, "Tuberculous Bacillæmia").

Revision of the *Ceratopsia*. Prof. R. S. Lull, in a memoir of the Peabody Museum (vol. 3, part 3, 1933), has given a revision of that group of the dinosaurs known as the *Ceratopsia*. Much work, both in collecting and in investigation, has been done since the earlier account of the group by Hatcher published in 1907, a few years after his death, which dealt with the American species. In the present memoir the author brings our knowledge up to date by taking into account not only fresh material found in the United States but also the discovery of *Proceratops* by the American Museum expedition to Mongolia, a form which throws much light on the earlier evolution of the group. Besides the description of the known species and a revision of them, the memoir deals with various other aspects of the family. The history of discoveries, the geographical and geological distribution, the morphology of the skull and skeleton, the brain and the evolutionary changes that have taken place during the course of phylogeny are subjects that receive treatment. A gradual evolution along several parallel lines has taken place, some of short duration, others longer, and culminating in the various species of the genera *Triceratops* and *Torosaurus*. These lines are not all definitely proved and in this the memoir must be considered as an interim report to be

corrected at some future date. The results so far seem to show a similar evolutionary process to that shown by Osborn to have occurred in the Titanotheres, a principle applicable perhaps to vertebrates generally. Works of this kind that bring up to date and summarise our knowledge of various groups of animals are of great use, not only to the specialist but to the general reader as well.

Protein Building in Plants. A problem which continues to excite interest is that of the methods by which proteins may be built up in plants and, particularly, the nature of the raw materials used. The passage of years has not seriously affected the view that asparagine may be either a key substance in protein synthesis and degradation or else closely related to the key substance. O. Loew (*Z. angew. Bot.*, **15**, 518; 1933) now suggests that the process of protein synthesis may start from the reduction of asparagine to the di-aldehyde of aspartic acid, CHO.CH_2.CH.NH_2.CHO. He directs attention to the ease with which a substance of this type could be further condensed, to its lability and to the possible methods by which it could be derived. An essential part of the theory is the formation of labile condensation products, and microchemical evidence is given as to the existence of materials of the type postulated in certain epidermal cells.

Botrytis Disease of Lettuce. A very complete account by Dr. M. M. Abdel-Salam of the severe disease of lettuce caused by the fungus *Botrytis cinerea* has recently appeared (*J. Pom. and Hort. Sci.*, March 1934). It is shown that the disease may produce a variety of symptoms—a collar-rot (red-leg) in spring, lesions on the stem, main veins, or upper leaves (head-rot) through the summer, or outright killing if the plant is also attacked by frost in winter. The disease is most severe on seedlings over-wintered in a cool frame, and higher temperatures diminish its effects. High humidity favours attack. The variety Lee's Immense proved resistant to the fungus, though there was a general tendency to outgrow the damage in spring. Steeping the seedlings in 0·5 per cent Uspulun or Nu-green solutions for half an hour or an hour gave promising results as a means of control.

Sterility in Plants. Prof. R. Ruggles Gates has prepared a concise summary of present-day knowledge of sterility in plants (*J. Roy. Hort. Soc.*, **59**, 141, Feb. 1934). Beginning with the methodical observations of Charles Darwin, the author traces the growth of knowledge on plant sterility until recent times. Investigations by Prof. East provide a reasonable working hypothesis by way of explanation of many problems of sterility. Definite sterility factors have been discovered for various species of *Nicotiana*, and fertilisation can only be effected between germ cells having different combinations of these factors. This discovery has been put to practical use by Dr. A. B. Stout, working with lilies, Messrs. Williams and Slow for red clover and Messrs. Crane and Lawrence for cherries. Gardens must be planned to include more than one "sterility group" if they are to be productive. Recent knowledge seems to confirm Darwin's original observations, for Correns described in 1928 a case of self-sterility in *Tolmiea Menziesii* where each plant was self-sterile, but fertile with every other plant of the species.

Microseisms in Manila. In a recent paper (*Beit. Geoph.*, **40**, 268; 1933), Father Repetti discusses the microseisms recorded in the Observatory of Manila. To a great extent, he finds, they are due to the rhythmical beating of heavy waves on the coast of Luzon, for they appear and disappear with the winds that raise the waves. Sometimes, they are clearly connected with passing typhoons. Partly, the very conspicuous tremors that are then seen are due to the waves raised by the wind of the approaching typhoon. But, when it comes near Manila, the oscillations of the crust produced by the pumping effect at the centre of the typhoon are superposed on those set up by the sea.

A New Recording Densitometer. The Société Genevoise d'Instruments de Physique (address of British agents—5/6, Brettenham House, Wellington Street, W.C.2) has issued a description of a new recording densitometer which is said to show a sensible improvement over all other instruments serving the same purpose. Its main principle is the usual one of allowing a greatly reduced image (in this instrument, so small as to make a primary slit unnecessary) of a glowing filament to travel along the plate to be analysed, the transmitted light, after passing through a slit, being received by a potassium photoelectric cell. Among the special features of the instrument are a very high speed of automatic recording and a sharp response to small details of the plate, made possible by amplifying the photo-electric current so that it can be measured by a sturdy milliammeter of short period instead of an ultra-sensitive galvanometer of long period. The apparatus can be operated in full daylight, and the recordings are absolutely precise, being independent of mechanical parts such as gears or measuring screws. Magnifications of 3, 4, 5, 8, 10, 15, 20 and 50 times are obtainable, and the recording is performed at a speed of 15 cm. per minute on the diagram. The cost of the instrument, which is not given, is said to be considerably below that of similar instruments.

Mean Lives of Excited Atoms. J. H. E. Griffiths (*Proc. Roy. Soc.*, A, Feb.) has investigated the mean lives of several excited states of the neon atom. The atoms are excited in a glass spectrum tube by a high frequency oscillator, and the light is passed through a nitrobenzene Kerr cell between Nicol prisms. To make comparative measurements of the decay times of the different spectral lines, the Kerr cell was excited by the oscillator through a phase-changing circuit, but since the phase relation between current and voltage in the discharge tube is unknown, a different method was employed to determine absolute values. The discharge tube and Kerr cell were connected in series and the light path between them was varied by using a movable mirror. The number of excited atoms and the intensities of the lines are both periodic, with a frequency twice that of the oscillator. From the positions in the maxima of the transmitted light, it was concluded that the lives of the excited states varied from 4×10^{-8} sec. to 20×10^{-8} sec. The experiments on several lives with a common upper state showed satisfactory agreement. With a wide tube it was found that there was an appreciable lag between maximum current and maximum excitation, but this lag was not observed with a narrower tube. At the higher pressures the depth of modulation of the light was small with the wider tube, and it seems that electrons disappear from the discharge mainly by diffusion to the walls.

Evolution in the Expanding Universe

A LECTURE was delivered by the Abbé G. Lemaître, professor of mathematics in the University of Louvain, at Armstrong College, Newcastle-upon-Tyne, on the subject of "Evolution in the Expanding Universe" before a joint meeting of the Durham University Philosophical Society and the Newcastle Astronomical Society on February 12. Dr. R. A. Sampson, Astronomer Royal for Scotland, occupied the chair, and the speaker was welcomed by Sir William Marris.

The age of the universe, calculated from the observed recession of the nebulæ, is about $2{\cdot}4 \times 10^9$ years, whereas the ordinary theory of stellar evolution requires about 10^{13} years. If the matter in the universe were evenly distributed, the density would be 10^{-30} gm./cm.^{3}. The correction of Newton's law given by Einstein may be regarded as equivalent to a density, of negative sign, associated with space, and if accompanied with a positive pressure the system would be invariant in the Lorentz transformation. This density, a cosmical constant, works out at -10^{-27} gm./cm.^{3} and as this is greater than the average density of matter, the effect produced would be, in general, a repulsion.

Taking any point as centre, the motion for a nebula at distance r is represented by

$$\left(\frac{dr}{dt}\right)^2 = -h + \frac{2Gm}{r} + \frac{\lambda}{3}c^2 r^2.$$

The density of a vacuum is $\rho^v = \lambda c^2/4\pi G$, where G is the gravitational constant. Over large (spherical) areas this is to be regarded as a map in which distances normal to the radius vector are real, but those along it are in a scale $\sqrt{1 - h/c^2}$ where h is the energy constant in the equation of motion. (h varies as r^2, and m as r^3.) For some value $h = c^2$, the scale becomes zero and the map ends, but actually antipodal points are the same, like the points at the sides of a map on Mercator's projection.

Suppose now that the universe once consisted of matter with an average density greater than the critical, but with an initial velocity sufficient to carry it over the critical radius, this gives the proper expansion. When r is put equal to infinity in the above equation, only the last term is important, so that the velocity squared is equal to $\lambda/3\ c^2$, from which the cosmical constant may be obtained. Actually, there must have been fluctuating density in the initial state, and areas in which the separation of matter was less than the mean. In these, the matter would eventually fall back producing collapsing regions; more rarely, equilibrium areas would occur which would divide into collapsing regions. The first might produce nebulæ, the second, nebular clusters. If these areas coalesce, some loss of kinetic energy must take place due to encounters, and the original diffuse matter would agglomerate into stars.

A nebula has a mass of about 10^9 suns; its radius at critical density would be 10^5 light-years; the order of diameter is now about 1,000 light-years. The loss of kinetic energy will be

$$\frac{3}{2}G\frac{N^2 m^2}{R}$$

where N is the number of stars, m the average mass of each, R the radius. The gravitation energy of a star is

$$\frac{3}{2}G\frac{m^2}{r}$$

where r is the radius. Multiplying this by N gives the total, and dividing, $Nr/R = 6 \times 10^{-2} = 6$ per cent of the gravitation energy of the stars. This energy becomes heat, and the heat content of stars is of this order.

Regarding clusters, here also the right order is obtained. They should have the same densities, and this should be about the critical density. If N be the number of nebulæ in the cluster, m the mass of each,

$$Nm = c \times D^3\ d^3$$

where D is diameter, and d angular diameter in degrees, and $c = 0{\cdot}155V^2$ where V is the velocity of recession at 1 megaparsec. The observations of Hubble and Shapley give figures of the right order (10^9 suns).

Salmon and Trout Disease

IN the year 1911, cases of a hitherto unrecognised disease, causing death of large numbers of fish of various kinds, were reported from six rivers in the south-west of England. This was the first official record in Great Britain of the occurrence of furunculosis, a bacterial disease that has spread to many rivers in England and Wales and is now prevalent throughout Scotland. Serious outbreaks occurred in the Conway and Coquet districts in 1926 when salmon and migratory trout were attacked, and in the Kennet in 1924 and 1925, when the valuable brown-trout fisheries suffered, and in recent years the disease has continued to spread. While in 1932 there was a considerable abatement in the number of serious outbreaks in English rivers, in Scotland conditions were nearly as bad as ever.

The monetary loss entailed by the spread of this disease must be large, since in one river over a period of six years the estimated loss was £1,400, and in another larger river it was £2,000 in three years. But apart from this loss, there must be a more serious loss in the depletion of the breeding stock. The alarming increase in the number of outbreaks led to the setting up of a Furunculosis Committee in 1929, a copy of the second interim report of which is now before us.* The report indicates the satisfactory progress of research into the problem, carried out by a number of workers chiefly at the Bacteriological Laboratory of the University of Edinburgh, among whom Mrs. Isobel Blake deserves special mention.

Furunculosis is a disease caused by a bacillus, *B. salmonicida*, which infests salmon, trout and coarse fish; in advanced stages of the disease there may be lesions in the muscles, but in many cases death occurs without any obvious external symptoms and

* Second Interim Report of the Furunculosis Committee. (Edinburgh and London: H.M. Stationery Office, 1933.) 2*s.* 6*d.* net.

the cause can only be definitely proven by bacteriological examination.

Once established in any locality, the spread of the disease is practically uncontrollable. Experiments have shown that infection can be water-borne or carried in food, and that the presence of fish that have died from the disease may be a serious source of infection. The disease is not brought in from the sea, and migratory fish may be infected in the fresh water sooner or later after they have left the sea; the fish appear to be highly susceptible when they first enter fresh water.

The most dangerous source for the spread of the disease is the occurrence of 'carriers' in which the bacilli are present in small numbers only and are located in the kidneys. Such fish may live apparently unharmed for a considerable time but generally fall victims themselves in the end, not without, however, infecting other members of the community before their death. It has been found that wounds and scratches render fish especially liable to infection.

It is probable that the disease has been spread over so large an area by the practice of stocking rivers with eggs and fry from other localities and from fish farms. It has now been shown that the eggs can be sterilised with dilute solutions of acriflavine.

Experiments and observations in Nature show that the outbreaks of the disease are controlled by temperature conditions, a temperature within a range of about 55°–66° F. apparently being necessary for its spread and development when the fish are healthy: cases have been reported of the occurrence of the disease at lower temperatures among fish in poor condition after spawning. Overcrowding is a further predisposing cause for outbreaks, and it is noticeable that where barriers occur to cause the congregation of fish awaiting flood water the disease is prevalent; where possible, therefore, such difficulties in the paths of the fish on their upstream migrations should be removed. The reporting of suspected outbreaks as soon as possible is of the utmost importance, as is also the quick removal of all dead infected fish.

Of even greater importance at this stage is the necessity for the passing of legislation whereby action may be taken to reduce risk of further dissemination to a minimum. In December 1929 an interim report was submitted in which a system of control was urged so that importation of live fish might be controlled and notification of outbreaks of disease made compulsory, and that there might also be power of control both over fish farms and over open rivers declared to be infected. It is to be hoped that the necessity for such action in the near future will receive serious consideration before the plague has assumed such alarming proportions as has been allowed with the musk-rat. It is, however, evident that one of the main difficulties in controlling the disease is that the symptoms are not always obvious and that identification necessitates sending the corpses to bacteriological laboratories for examination, and furthermore, that they should arrive before decomposition has set in.

A New Experimental Phonetics Laboratory

WITH the advent of the talking film, the recording of speech has recently received considerable attention, but, as at the time of the invention of the phonograph, more interest is shown in commercial circles in the entertainment possibilities of the new electrical methods of speech recording and reproduction. In experimental phonetics the older mechanical methods still predominate. At Armstrong College, Newcastle-upon-Tyne, with the support of Prof. W. E. Curtis and Prof. W. L. Renwick, an investigation was undertaken by Mr. R. O. L. Curry, Noble Memorial Scholar, of the available methods of speech-recording, with the object of seeing how far these were suitable for classifying speech sounds, particularly those of local dialects. The work of making and testing different types of apparatus has been so successful that the Council of the College, mindful of the importance of the investigation, has granted space in a newly-acquired building for a phonetics laboratory to house the apparatus, and in which records may be taken under conditions free from noise and vibration.

The laboratory looks out upon an empty court, and the windows on this side are sealed and provided with dark blinds. The floor is of concrete and the partition walls are 1 ft. thick, so that it was thought unnecessary to introduce sound-insulating material except on the door, which is faced on the inside with a layer of Newall's Asbestos Blanket. A ventilating shaft in the thickness of the wall leads out to the roof at a point sheltered from street noise. To make doubly sure that no 'ground noise' shall reach the recording apparatus, the microphones are placed in a double-walled insulated kiosk of the telephone-cabinet type. There is also provision for the development of photographic plates.

The recording devices which are at present available in the laboratory are as follows:

(1) A kymograph, namely, an instrument in which the pressure variations which occur in the mouth, nose and throat during speech can be severally communicated to membranes provided with styles which make traces on a revolving drum. Owing to the damping and distortion introduced by the recording mechanism, this instrument is useless for obtaining exact traces of speech sounds, but is fully satisfactory for recording the relative time intervals involved in speech sounds, and for determining the relative extent to which different parts of the vocal apparatus contribute to the sound, as, for example, in the nasalisation of a vowel or a consonant.

(2) An Einthoven string galvanometer, which while capable of giving accurate traces of vowel sounds, is too heavily damped with regard to frequencies above 6,000 cycles/sec. to record correctly the fricative high-pitched sounds associated with many of the continuant consonants. This is, in fact, the principle of the apparatus by which most talking-films are made.

(3) A cathode ray tube. This is the most effective instrument of all, and is capable of delineating the wave-form at all frequencies to which the microphones are able to respond. For visual examination of vowel sounds a 'sweep circuit' is used, which allows of a single wave-pattern being 'held' on the screen; otherwise a moving film camera is used, capable of taking photographic records of the to-and-fro motion of the spot on the fluorescent screen at 6 ft./sec., a rate which permits of the recording of the high frequency stopping and starting noises that are characteristic of the consonants.

(4) There is also an electric gramophone recorder for making dialect gramophone records, and a jet-tone apparatus for studying the action of the vocal organs in speech.

The first work of the laboratory, which is under the joint supervision of Mr. H. Orton, of the English Department, and Dr. E. G. Richardson, of the Physics Department, will be to obtain definitive pictures of the standard English speech sounds. This work is, in fact, almost completed. Records of dialect speakers will then be taken for the purpose of the main object of the laboratory, which is the comparative philology of the region in which the University of Durham lies. In this connexion, room is provided elsewhere in the College for card indexes of local variants in pronunciation.

For the benefit of others who may be intending to take up similar work, it may be mentioned that the cost of the equipment of a laboratory such as this is quite moderate. Excluding the string galvanometer (which is not essential), the whole of the equipment has cost less than fifty pounds, although it is true that this does not include the cost of the labour of assembling the apparatus.

Chemical Society's Mendeléeff Commemoration

THE centenary of the birth of Mendeléeff was commemorated by the Chemical Society on April 19, when Lord Rutherford delivered an address at the Royal Institution on "The Periodic Law and its Interpretation".

About the period 1860–70, accurate atomic weights and chemical data were available for the known elements, and the time was ripe for some connecting generalisation. The conception of a periodicity in properties when the elements are arranged in the order of their atomic weights was advanced tentatively by Newlands in 1864. Mendeléeff was the first, in 1869, to enunciate the law clearly, to perceive its utility in correlating and even correcting the recorded chemical properties of the elements, and to make from it predictions which might be verified by later investigation.

Mendeléeff's first table, published in 1871, bears a remarkable resemblance to that of the present day. He perceived the true place of the transition elements in the scheme, and did not hesitate to reverse the apparently discordant order of iodine and tellurium. Where his table demanded the presence of then unknown elements, he ventured to predict their properties, his prophecies being strikingly fulfilled by the subsequent discovery of scandium, gallium and germanium.

The discovery of argon and its congeners by Ramsay, at the close of the century, led not to an alteration, but to a widening of Mendeléeff's scheme, the inert gases falling naturally into a group of zero valency and forming a transition between the halogens and the alkali metals. During this period, the Periodic Law lacked any theoretical background which might lead to its interpretation. Sir J. J. Thomson's recognition of the electron as a constituent of all atoms of matter, in 1897, first led to the conception of the electrical structure of matter.

Lord Rutherford himself has been intimately connected with much of the subsequent development in this field. From consideration of the scattering of α-particles by heavy atoms, he was led to the nuclear theory of the atom, according to which the mass of the atom is concentrated in a minute, positively charged nucleus, the charge on which is proportional to the atomic weight of the atom. The conception that the nuclear charge and ordinal number of an element might be the same was applied by Bohr in his theory of spectra. It was brilliantly verified by Moseley's work on the X-ray spectra of the elements, which fixed the true order of the elements, and showed that only 92 exist from hydrogen to uranium. Of these, only one—No. 85—still awaits discovery.

The recognition of atomic number rather than atomic weight as defining the properties of the elements cleared away the apparent discrepancies in Mendeléeff's table. It has been found that most of the elements are actually complex, consisting of isotopes having the same nuclear charge but different masses. The chemical properties of isotopes, depending on nuclear charge, are identical: properties depending on mass may differ sufficiently to render separation possible, as is the case with hydrogen and lithium.

The explanation of the Periodic Law must lie in the arrangement of the outer electrons. Bohr's conception of quantised planetary orbits has been developed by the new wave mechanics to give a complete picture of atomic properties. The rare gases have highly symmetrical, tightly bound configurations. Addition of successive electrons leads to the occupation of the next group of orbits, and runs parallel to the observed chemical properties of the elements. A periodic pattern is thereby obtained, repeating after each inert gas, in which the transition elements and rare earths find a natural place. About the structure of atomic nuclei, little is yet known: the recognition of any periodicity with increasing nuclear charge awaits the discovery of the future.

Increase in Temperature due to Solar Radiation

PROFESSIONAL NOTE No. 63 of the Meteorological Office, the title of which is "Maximum Day Temperatures and the Tephigram", by Lieut.-Col. E. Gold, is a discussion of the problem of estimating the probable rise of temperature in the course of a single day during clear weather on account of the solar radiation, with the aid of the 'tephigram' of Sir Napier Shaw.

In the 'tephigram' the rectangular co-ordinates are temperature and entropy, and any closed area, corresponding with a cycle of changes of a portion of the atmosphere, represents a definite amount of energy. Isothermal lines and dry adiabatics are represented respectively by vertical and horizontal lines, and moist adiabatics, corresponding with saturated air that is rising and expanding, and is in consequence having its entropy increased by the energy released by condensation of water vapour, are represented by sloping lines that become more nearly horizontal at low temperatures owing to the diminished capacity of air for water vapour at such temperatures. This form of diagram is in use in the

Forecasting Department of the Meteorological Office, and the note, apart from the intrinsic interest and importance of the subject, should be helpful to forecasters when interpreting the significance of the physical state of the atmosphere revealed by observations made in aeroplanes equipped with meteorological instruments.

A discussion of the energy equivalent of 1 cm. on this diagram leads up to a consideration of the amounts of radiation received in different months and the heights up to which the dry adiabatic lapse rate can be brought into being in each case, given isothermal conditions initially.

When passing on to consider what proportion of the total incoming radiation may actually be available for warming the atmosphere, allowance having been made for the increased radiation from the earth's surface, the incoming diffuse radiation of short wave-length, the reflected radiation, and for the heat absorbed in evaporating water from the surface, the author is on difficult ground. An estimation of the last item, for example, has apparently been based entirely on figures for the evaporation from water tanks; the relationship between such figures (practically the only data available) and those representing the average evaporation by day at the season in question from unit area of the earth's surface, is very much a matter of speculation. The table on p. 8 giving the various allowances suggests, however, that in summer this may be a very important item. A suitable warning in regard to the uncertainties of *all* these allowances would not have been out of place in order to prevent the uninitiated from thinking that the difficult problems under discussion have reached anything approaching an exact quantitative solution. E. V. N.

University and Educational Intelligence

BIRMINGHAM.—The University has decided to institute a Department of Industrial Hygiene and Medicine, and arrangements are being made with the view of opening it on October 1, 1934. It is believed that this is the first department of this nature to be established in a Medical School in Great Britain. The research work contemplated includes the investigation of the deleterious action on workpeople of the materials they work with and methods of prevention; the training of medical men to advise employers as to methods by which the number of certain types of accidents may be reduced, the selection of employees for various kinds of work, and improving the hygiene of factories. It is probable that the University will grant a diploma to those who complete the course successfully.

CAMBRIDGE.—The Sheepshanks Exhibition for 1934 has been awarded to C. G. Pendse, of Downing College.

The Linacre Lecture will be delivered by Sir Henry Dale, director of the National Institute for Medical Research, on Saturday, May 5, at 5 p.m., in the New Museums. The title of the lecture will be "Chemical Transmission of the Effects of Nerve Impulses".

LONDON.—The degree of D.Sc. in chemistry has been conferred on H. E. Cox (private study) for ten independent publications and four conjoint subsidiary contributions relating to the chemical examination of furs in relation to dermatitis, and food analysis.

APPLICATIONS for the Bayliss-Starling Memorial Scholarship, tenable at University College, London, W.C.1, must be sent to the College Secretary not later than May 12. The annual value of the scholarship is £120 with exemption from tuition fees. The scholar will be required to follow a course of study approved by the Jodrell professor of physiology, involving a training in the principles and methods of research in physiology or biochemistry or both.

Science News a Century Ago

King's College, London

On April 30, 1834, the annual court of governors and proprietors of King's College was held for receiving the report of the council for the previous year. The Archbishop of Canterbury presided. The report stated that the council had previously expressed some doubts as to whether it would be possible to complete the river front, owing to the considerable sums promised by subscribers not being forthcoming. A meeting, however, had been held, at which it was agreed to make an appeal to the friends of the institution, and the consequence was, that, in advances of ten per cent on the shares and in subscriptions and donations a sum of £7,297 17*s.* had been received. During the year there had been 104 regular and 171 occasional students in the senior department, 66 regular and 175 occasional students in the medical class and 404 students in the junior department. A class of associates had been instituted. The College had never before been so prosperous. Two additional schools had been added, so that there were now seven schools in the metropolis acting in union with the College. The receipts for the year were £16,197 11*s.* 6*d.* and the expenditure £12,446 14*s.* 5*d.*, leaving a balance of £3,750 17*s.* 1*d.* besides £4,000 in exchequer bills.

Friday Evening Meetings at the Royal Institution

At the annual meeting of the members of the Royal Institution on May 1, 1834, the Visitors commented on the increased membership and improved financial position shown by their Report. This satisfactory state of affairs they attributed largely to the interest excited by the Friday evening meetings, which had been begun about 1825, and had become a regular feature of the Institution's activities. The Visitors reminded members how deeply they were "indebted for these advantages, to the unwearied exertions, important discoveries, and happy illustrations of one, who has contributed the chief attractions to the meetings in question". The reference is to Faraday. Not only had he given a considerable number of the discourses himself, but from the beginning had acted as secretary of the small committee charged with the duty of arranging the Friday evening discourses. That their success depended almost entirely on his activities may be inferred from a letter written to Faraday in 1839, in which W. T. Brande, then the senior professor at the Institution, regretted that he could not help at a time of emergency. He wrote: "You know how sad a figure I cut on those occasions; and as to the tact requisite for their general management and arrangement, I candidly confess I have it not".

Belgrave Literary and Scientific Institution

On Saturday, May 3, 1834, as reported in the *Times*, a public meeting was held to give effect to the arrangements of the provisional committee of the Belgrave Literary and Scientific Institution, and for opening the Institution for the accommodation of members. Earl Fitzwilliam presided and the report of the committee said that the foundation of the Society had been laid by voluntary subscriptions of books, and that it was intended to open No. 30, Sloane Street for the purposes of the Institution. Dr. Lardner and others had offered to give lectures gratuitously, the Duke of Sussex had consented to accept the office of patron and Earl Fitzwilliam that of president.

A New Orchid

Probably the most important account in *Curtis' Botanical Magazine* for 1834 is that of the first flowering of the new orchid *Epidendrum bicornutum* from Trinidad, which occurred in April 1834 at Wentworth Gardens, the seat of Earl Fitzwilliam, under the care of Mr. James Cooper, the celebrated orchid grower. The specimen is described (p. 3332) as having produced large and highly fragrant blossoms, which smell like the Persian Iris. This plant was introduced into England by Mr. John Sheppard, curator of the Liverpool Botanic Gardens, marked as "Cattleya n.sp." It had many points in common with that genus, especially in its general habit and the large flower, but differed remarkably in the labellum and the shortness of the column. The specimen was sent to Prof. Lindley who replied to the editor: "Your Trinidad orchideous plant is certainly a new species but I think it can not be separated from Epidendrum. The only distinction between it and that Genus consists in the labellum being distinct from the column: but you will find various degrees of separation between those parts in *E. asperum*, *venosum*, *vitellum* and *bidentatum* which nobody can doubt are genuine Epidendra. Should you, however, be of opinion that it nevertheless must form a new Genus, its character will have to depend upon the large size of the petals and the slight adhesion of the sepals to their base. The latter is however a falacious character and the former occurs in what I consider true Epidendra."

Other Flower Records

Further interesting records of the flowering of rare orchids and other plants introduced into Great Britain occurred in April 1834, mostly at Kew Gardens. In *Curtis' Botanical Magazine* (p. 3401; 1835) is described the first flowering at Kew of *Pteostylis acuminata*, the acuminated pteostylis (Orchideæ), of a singular Australian genus introduced by Mr. Cunningham from Port Jackson in 1827. *Acacia elongata* (Leguminosæ) a slender and beautiful species from the Blue Mountains of New South Wales and the interior to the west of Port Jackson, originally discovered during the first expedition of Mr. Oxley to the Lachlan River in 1817 and introduced into England in 1823, when the plants were received at Kew, was in full flower at the latter gardens in April 1834. Another flowering record of the month, in the gardens of Mr. William Christy at Clapham Road, was *Schinus molle*, the Peruvian mastick tree (Terebinthaceæ), which grew wild in Chile, Peru and Mexico. The occurrence is recorded, with a plate of the bloom, in the 1834 volume.

Societies and Academies

London

Society of Public Analysts, April 4. Guy Barr and A. L. Thorogood: Determination of small quantities of fluorides in water. The reagent consists of an aqueous solution of zirconium oxychloride and sodium alizarin monosulphate. The test is sensitive for 0·1 part of fluorine for concentrations up to 5 parts per million. A. W. Middleton: A test for ethylene glycol and its application in the presence of glycerol. The test is based upon the oxidation of glycol to oxalic acid by means of nitric acid, whilst under the same conditions glycerol yields aldehydic substances. Glycerol does not interfere unless present to the extent of more than 75 per cent of the mixed alcohols, and the test is sensitive to 0·1 gm. of glycol in 10 ml. of aqueous solution. W. Mather and W. J. Shanks. Detection of diamines in leather. Tests are described whereby extremely small quantities of para- and meta-diamines can be detected in dyed and finished leathers. These diamines can be extracted from leather in the cold by means of $N/10$ hydrochloric acid or 1 per cent acetic acid, and that precipitation of the extracted tannins with lead acetate does not interfere with the subsequent tests for diamines. The reagents used include 0·1 per cent solutions of dimethyl-*p*-phenylene diamine, dimethyl-aniline, aniline, *o*-toluidine, *p*-phenylene diamine, and *m*-toluylene diamine.

Royal Meteorological Society, April 18. D. Brunt: The possibility of condensation by descent of air. From a consideration of the variation with height of the humidity-mixing-ratio, it is shown that in the stratosphere condensation can occur in descending air-masses which take up the temperature of their environment. The fact that saturated water vapour produces condensation when expanded adiabatically while other saturated vapours produce condensation when compressed adiabatically, is discussed briefly. D. Dewar: An investigation of the statistical probability of rain in London. The paper gives an account of an investigation of the frequency of rain at Kew, based on hourly tabulations of rainfall from 1872 to 1921. Amounts of rain were classified as 'heavy', 'moderate', 'slight', or 'no rain', according as the quantity which fell in a 6-hour interval of the day was 1 mm. or more, between 0·5 and 1 mm., between 0·2 and 0·5 mm., or less than 0·2 mm. The intervals were taken as early morning, forenoon, afternoon and night, each division of the day being taken to cover an interval of 6 hours. Each month was divided into three periods of approximately 10 days. The probability of rain of a given amount in a given interval of the day during these periods was obtained by dividing the number of occasions on which rain of that amount had fallen by the number of possible occasions. A comparison between actual values and figures computed from the average probability shows that the frequency of 'heavy' rain in 6-hour intervals for individual days is distributed approximately according to a chance distribution. The average probability of rain in a 6-hour interval is: approximately 1 in 9 for heavy rain; approximately 1 in 20 for moderate rain; approximately 1 in 33 for slight rain. Caleb Mills Saville: Some rainfall variations, England and New England (U.S.A.). The maximum and minimum rainfall experienced during periods of from one to twelve consecutive months is

similar in both localities. Details are given as to the extremes of rainfall recorded at West Hartford (U.S.A.) for periods of 1–120 consecutive months. In Great Britain a run of wet years persisted before the present drought but in New England dry years predominated. This marked inverse relationship held from 1868 until 1932 in the case of residual mass curves, and from 1838 until 1932 with a somewhat different set of data expressing the rainfall as 5-year means.

PARIS

Academy of Sciences, March 5 (*C.R.*, 198, 861–996). CH. FABRY: The use of the red cadmium line as a meteorological and spectroscopic standard. A discussion of the suggestion of Pérard that the red line of cadmium is unsuitable as a standard, because, under certain conditions, it can be changed into a fine doublet. In view of the work already carried out with light of this wave-length and of the ease with which this reversal can be avoided, the author disagrees with the view of Pérard. JEAN REY: The working of a thermocompressor carrying successively two compressible fluids of different densities. Experimental results. LUC PICART: The calculation of the orbits of the visual double stars. A. VAYSSIÈRE: The internal organisation of the nymphal larvæ of *Bœtisca*. GASTON JULIA was elected a member of the Section of Geometry, in succession to the late P. Painlevé. BERTRAND GAMBIER: Tetrahedra inscribed in a biquadratic and circumscribed to a developable of class 4 genus 1 or to a quadratic. R. JACQUES: Certain congruences of spheres. GEORGES KUREPA: Directed ensembles. GEORGES GIRAUD: A new generalisation of questions relating to equations of the elliptic type. J. GERONIMUS: Some extremal properties of polynomials. SOULA: The zeros and poles of a meromorph function in a sector. P. VINCENSINI: The centres of gravity of homogeneous finite bodies. J. OTTENHEIMER: The displacement of water in the course of submarine explosions. J. DUPUY: The application of interference to the study of the distribution of the pressures and velocities round the wing of an aeroplane. EDMOND BRUN: The heating by friction of a body undergoing rapid displacement in carbon dioxide. HENRI ROURE: An inequality with very long period of the mean motion of Pluto due to the action of Uranus. A. DAUVILLIER: The nature of the photosphere and of the electronic emission of the sun. P. SALET: The measurement of the velocity of the light coming from the stars. From an analysis of the experimental data available, the author concludes that the spectroscopic method gives different values for the velocity of light according to the spectral type. P. LEJAY and LOU JOU YU: Observations of the intensity of gravity in the north-east of China. The results of measurements with the Holweck-Lejay instrument for 37 stations are tabulated. BERNARD KWAL: Spinors and quaternions. L. DUNOYER: The measurement of small expansions. Suggested modification of the Chevenard interference dilatometer. P. DONZELOT, E. PIERRET and J. DIVOUX: Indirectly heated valves in the amplification of continuous currents. V. POSEJPAL: The materialisation of the polarised ether. F. BOURION and MLLE. D. BEAU: The magnetic study of hydrated thoria. Hydrated thoria behaves from the point of view of its magnetic properties as a mixture of water and a feebly paramagnetic hypothetical oxide, ThO_2. P. LAINÉ: The magnetic properties of mixtures of liquid ozone and oxygen. The magnetic susceptibility of pure liquid ozone. The specific susceptibility of liquid ozone, at temperatures near that of liquid air, is about $1{\cdot}5 \times 10^{-7}$, with a thermal variation certainly less than one third of that which would be predicted from Curie's law. ALBERT PERRIER and MLLE. T. KOUSMINE: Longitudinal magneto-thermoelectric effects in nickel and iron: theoretical interpretations. P. DEBYE, H. SACH and F. COULON: Experiments on the diffraction of light by ultra-sonic vibrations. F. WOLFERS: The diffraction phenomena of Fresnel with a large source [of light]. PICON: Some solubilities of quinine iodobismuthate. The behaviour of the quinine salt with acetone, cyclohexanone and ethylene glycol is described. PARISELLE: Polarimetric researches on narcotine. Narcotine, lævorotatory in organic or neutral media, is dextrorotatory in acid or basic solution. MLLE. SABINE FILITTI: The oxido-reduction potential of the system xanthine $\rightleftarrows$ uric acid. VICTOR LOMBARD and CHARLES EICHNER: An attempt at the fractionation of hydrogen by diffusion through palladium. Hydrogen which has been diffused through palladium diffuses at a different rate from the non-diffused hydrogen. The authors are not inclined to ascribe this difference to the accumulation of impurities, but consider that the fractions probably contain different proportions of allotropic varieties of hydrogen. EDOUARD RENCKER: Study of the softening point of vitreous bodies by differential thermal analysis. MARCEL CHAUSSAIN and HENRI FOURNIER: The chemical methods of cleaning light and ultra-light metals after corrosion. The use of nitric acid for removing the products of corrosion of the light metals, requires a correction for the clean metal dissolved. A suitable method of obtaining this correction is indicated.

(*To be continued.*)

GENEVA

Society of Physics and Natural History, December 21. P. ROSSIER: The spectrographic photometry of the F_0 stars. On the basis of 120 spectrograms the author states and discusses the relation between the magnitude and the length of a spectrogram. This relation, which is linear, depends on the spectral type. F. BATELLI, D. ZIMMET and P. GAZEL: The epicephalic reflex in amphibians.

CRACOW

Polish Academy of Science and Letters, December 4. K. DZIEWONSKI and T. DUZYK: The action of chloracetyl chloride on β-naphthol. P. LADA: Contributions to the genetics of fragile rye. J. WLODEK, MME. M. WODZICKA and E. RALSKI: Granitic soils covered with plants requiring lime (Morskie Oko, Haut-Tatra, Poland). K. GAJL: *Branchinecta paludosa* from the Tatra massif considered as a new species. Remarks on the morphology, ecology and zoogeographical distribution of this species. Zdz. RAABE: Certain species of the genus *Conchophthirus*. M. GIEYSZTOR: The group of species *Dalyellia viridis* (Rhabdocœla). F. BIEDA: The nomenclature and classification of certain species of Nummulina (3). Z. GRODZINSKI: The development and comparative anatomy of the axial blood vessels in the anterior extremities of vertebrates. J. ZACWILICHOWSKI: The innervation and the sensorial organs of the wings of the Trichoptera. B. SKARZYNSKI: Œstrogenic substances of plant origin. W. HEINRICH: The reaction of the capillary vessels of the rabbit during the working of the cortical centres.

January 8. S. MAZURKIEWICZ: Translative means and the law of Gauss. H. GAMS: The Starunia mosses considered as an index of the character of the flora and climate, as well as the principal petrifactions of the diluvial epoch. J. STACH: The genus *Oncopodura*, and also a new species belonging to this genus, found in the caves of north-east Italy. T. VETULANI and R. SCHULZE: The hypophysis of the small Polish horse representing the type of the tarpan horse (1 and 2).

LENINGRAD

Academy of Sciences (*C.R.*, No. 3, 1934). V. FOCK: New asymptotic expression for Bessel's functions. N. KOSHLIAKOV: On a certain definite integral connected with the cylindric function $K_v(x)$. I. VERCHENKO and I. KHOLMOGOROV: Discontinuities in the functions of two variables. A. KAPUSTINSKIJ: The problem of the composition of air in the stratosphere. Samples of air brought from the stratosphere by Prokofiev proved to be almost identical with the air near the ground. This can be explained by the enrichment of the stratosphere by nitrogen owing to gravitation (Laplace's rule), and by oxygen through thermal diffusion as described by Dootson, Chapman and Endskog. G. KWATER, N. KREMENEWSKY and A. FILIPPOV: The absorption spectrum of thallium vapour in the ultra-violet. M. SAVOSTIANOVA: The problem of the excitation of an alkali-haloid crystal. A. CHICHIBABIN and M. OPARINA: The volatile base of Valerian roots. The base is a colourless oil, which does not crystallise at 0° C. and is insoluble in water. I. N. NAZAROV: On metal-ketyls of the aliphatic series (2). It is only secondary and tertiary radicals connected with a carbonyl group that make possible the existence of metal-ketyls. The stability of metal-ketyls is particularly increased by the tertiary heptyl $(C_2H_5)_3C$. K. GORBUNOVA and A. VAHRAMIAN: The mechanical activation of the surface of an electrode. The formation of the first microcrystals occurs at a lower potential when the surface of the electrode bears scratches, than when it is intact. A. CHARIT and I. FEDOROV: The oxidation and reduction processes during muscular contraction (2). The oxidation-reduction potential of blood and of urine under the influence of muscular work. The potential of arterial blood before work was 0·607 v., and after work 0·578 v.; figures for the venous blood were 0·580 v. and 0·557 v.; and for urine, 0·118 v. and −0·73 v. respectively. D. SABININ: (1) Exchange adsorption in root systems. Adsorption processes play an important part in the entrance of substances into cells, if the substances are derived from diluted solutions with varying values of *p*H and in the presence of surface active substances. (2) Influence of the technique and time of the introduction of fertilisers on the nature of plants. M. SHKOLNIK: The physiological rôle of boron. The absorption by plants of phosphate, nitrate and calcium decreases in the presence of boron, which therefore exercises an influence on the permeability of the protoplasm. V. CIVINSKIJ: Capacity of cotton to withstand cold. Those varieties in which the concentration of the cellular sap was high proved to be most resistant to frost, but some other factors may also be of importance. B. B. ROHDENDORF: Some new species of Tachinids from U.S.S.R. Two new species of *Craspedothrix* (Diptera, Larvævoridæ). O. VIALOV and R. VIALOVA: The age of the tufogenous suite of Caucasian flysh. The fossils indicate that the suite belongs to the Cenomanian.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, April 30

UNIVERSITY COLLEGE, LONDON, at 5.—Prof. C. Singer and K. J. Franklin: "The History of Physiology" (succeeding lectures on May 1, 2, 7, 8, 14, 15 and 22).*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—F. Kingdon Ward: "The Himalaya East of the Tsangho Gorge".

Wednesday, May 2

ROYAL SOCIETY OF ARTS, at 8.—J. C. Wilson: "Trichromatic Reproduction in Television".

Thursday, May 3

KING'S COLLEGE, STRAND, W.C.2, at 5.—Prof. R. J. S. McDowall: "The Integration of the Circulation" (succeeding lectures on May 10, 17 and 24).*

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. M. Schleicher: "Modern Practice in Germany and other Parts of the European Continent with regard to Supervisory Control Systems as applied to Large Interconnected Supply Areas".

CHEMICAL SOCIETY, at 8.—Discussion on "Unicellular Chemistry" to be opened by Dr. J. Vargas Eyre.

Friday, May 4

PHYSICAL SOCIETY, at 5.—Prof. C. V. Boys: "My Recent Progress in Gas Calorimetry" (Nineteenth Guthrie Lecture).

HUXLEY MEMORIAL LECTURE, at 5.30.—(in the Lecture Theatre, Huxley Building, Exhibition Road, South Kensington, S.W.7).—Prof. Johan Hjort: "The Restrictive Law of Population".

INSTITUTION OF MECHANICAL ENGINEERS, at 7.—R. C. Walker: "Photoelectric Cells and their Application". (Informal meeting.)

GEOLOGISTS' ASSOCIATION, at 7.30.—(in the Architectural Theatre, University College, Gower Street, W.C.1).—L. A. Wager: "Mount Everest and the Eastern Himalaya".

WORLD'S DAIRY CONGRESS, April 30–May 6.—To be held at Rome and Milan.

Official Publications Received

GREAT BRITAIN AND IRELAND

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1562 (I.C.E. 887; T.V.C. 59): Torsiograph Investigations on a Radial Engine with and without a Spring Hub, with some reference to Damping. By B. C. Carter, N. S. Muir and H. Constant. Pp. 14+19 plates. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

OTHER COUNTRIES

Obras completas y Correspondencia cientifica de Florentino Ameghino. Vol. 12: Primera Sinopsis Geológicopaleontológica. Dirigida por Alfredo J. Torcelli. Pp. 770. (La Plata: Gobierno de la Provincia de Buenos Aires.)

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 13, No. 2: Untersuchungen über Dunkelnebel. Von Carl Schalén. Pp. 47. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 21, No. 13: The Templeton Crocker Expedition of the California Academy of Sciences, 1932. No. 13: Diptera. By C. H. Curran. Pp. 147–172. (San Francisco.)

Smithsonian Institution. Explorations and Field-Work of the Smithsonian Institution in 1933. (Publication 3235.) Pp. iv+59. (Washington, D.C.: Smithsonian Institution.)

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