NATURE

SATURDAY, APRIL 6, 1935

No. 3414 Vol. 135

CONTENTS

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: WHITEHALL 8831
Telegraphic Address: PHUSIS, LESQUARE, LONDON

The Peoples of Britain

AT the present time, when racial questions are very much in the air, the proposal of the Royal Anthropological Institute for promoting a survey of the racial characters of the inhabitants of Great Britain is more than opportune. It meets an urgent need in scientific investigation; and, incidentally, it will fill a serious gap in the common fund of established fact which makes up the background of public opinion. Public policy recently has become involved in the discussion of a number of intricate and technical problems, with the result that clear thinking and clear definition were never a more urgent necessity than they are to-day. It is here that the assistance of the anthropologist is invoked. The importation of the racial question into international and national relations has opened a way to biased interpretation and racial prejudice which a statement of the facts and their direct implications alone can dispel.

It is disconcerting to the anthropologist, and also perhaps humiliating to the dignity of his science, to reflect that one of the earliest, if not the first, survey of racial characters on a nation-wide scale was the outcome of political animosity. The story is sufficiently well-known, but is worth recalling. After the siege of Paris in 1870, in which the Muséum National d'Histoire naturelle was damaged by shell-fire—a catastrophe which, it is to be feared, we should not now regard with a like degree of surprise—de Quatrefages, the French anthropologist, while deploring the outrage, implied that it was congruous with the behaviour to be expected of Prussians, whom he demonstrated to be akin to the Mongolian Finns and, as such, barbarian intruders into Europe. Amid the storm of controversy this statement aroused, the German Government countered with an order that the hair- and eye-colour of 6,000,000 German school children should be examined in the expectation that the facts thus elicited would be a sufficient refutation of the scandal. It is, however, not uninteresting to note that Prof. F. G. Parsons, who measured a large number of German prisoners during the War, found that their heads were considerably broader than the officially accepted figures, these latter emphasising the length and consequently Nordic character of the German head.

Any light which a survey of the physical characters of the British population might throw upon current theories of European racial distinction

would be incidental to, and implicated in, racial analysis of the material collected, rather than direct. Yet understanding of the racial composition of the inhabitants of Britain must be dependent upon and must be brought into relation with the racial constituents of the population of Europe, with which, we know, it is historically connected. In any event, the results of the survey must impart to public discussion a leaven of clear thinking, and at the same time reduce to a more correct proportion any arguments as to national cleavage on a racial basis which may be imported into political discussion. It is fairly safe to anticipate that accurate knowledge of the facts will scarcely lend support to an exaggerated view of the importance of any one strain in a given population.

Any such contributions to current thought, however, it may be repeated, must be regarded as a by-product of the proposed survey. Its aim primarily will be to obtain a record of the facts relating to the population of Great Britain. The need for this is sufficiently urgent. The outline which appears in another column (p. 530) of the attempts to promote an anthropometric survey of the British population, shows that it is now more than fifty years since any extended series of measurements of the people as a whole has been made. Individual observers have been at work up and down the country, more numerous perhaps than a summary reference would suggest, and studies have been made of special categories, such as university students; but these efforts have been unco-ordinated, and uniform methods have not been employed. There have been important studies also of skeletal material, of which Prof. F. G. Parsons's examination of Saxon skulls aimed at being complete. But of the earlier observations, it may be said generally, that they do not meet the requirements of modern methods of analysis, and often are not adequate for statistical treatment. In some instances it was admitted at the time the measurements were first submitted for examination that their value had been impaired by the lack of training of the observer.

While the physical anthropologist is, therefore, in a position to put forward a strong plea for renewed activity in this branch of his science, activity which will both bring together such scattered material as is already available and will stand the test of modern standards of measurement, as well as extend it by fresh observations to a national survey, the needs of the student of British archæology are by no means to be overlooked. The great advances in the study of British archæology during the last fifteen or twenty years have demonstrated that movements of culture and cultural changes in the prehistory of the British Isles can be demonstrated in far more refined detail and in far more complicated pattern than was ever dreamed in the theories of the broad cultural and racial movements of which our predecessors traced the ways. For the decisive answer as to how far cultural distinctions correspond to racial movements—a correspondence which is often assumed—the archæologist must turn to the student of race, the physical anthropologist. Nor will the material for the reply be drawn exclusively from the skeletal material of past ages, for, as Prof. H. J. Fleure has shown, the persistence of ancient racial characters in certain areas can be demonstrated with a certainty nearly beyond question. This problem indeed is one of the most interesting upon which investigation may be expected to throw light. Many years ago, Dr. J. Beddoe in a presidential address to the Anthropological Section of the British Association directed attention to the survival of pockets of the short dark population in areas otherwise predominantly tall and fair—he was speaking more particularly of his observations in the area of Bradford where the Association was then meeting. As a germane issue, it will further be of moment to note how far it is possible to determine the persistence of type in the face of modern conditions of movement and of the contact of the population of areas once kept apart by difficulties of communication.

While it is not possible to specify the numerous problems upon which it may be expected that light will be thrown, it may be noted that a whole group of problems is connected with the trend of racial development, upon which it is at present possible to speak with some probability, but upon which a definitive verdict is desired. Sir Arthur Keith, for example, has told us that he regards a nation as a race in process of formation, in other words, it is a unit of specialisation. Is there adequate evidence, as some would hold, that we in the British Isles are evolving out of the elements of our mixed physical heritage a special type differing from, though obviously related to, the racial strains of the European continent? Again, there is the change in the shape of the head. Prof. Parsons maintains that the skulls of Londoners in the last two hundred and fifty years have

undergone a process of broadening. Is this true of the country generally or a phenomenon confined to London only? And in the latter event, is it due to the immigration of a broader strain or to other causes?

Although not part of the function of a racial inquiry as such, on a strict interpretation, it is clear that any evidence which may bear upon changes in the physical characters of the population is of the greatest moment on national grounds, especially if it can be correlated with evidence of a standard of health and the like. The investigations of Prof. Fleure and his colleagues in Wales, which seek to link up racial characters with the incidence of disease and other factors of social significance, do more than justify an appeal for public assistance towards the cost of the survey, which will be not inconsiderable. Indeed, in the eyes of some, such inquiries, of which the survey is an essential preliminary, justify a claim for Government assistance. A knowledge of the physical characters of the population of Britain is of the greatest interest to science, but it should be beyond the need of argument to show that it is of no less moment to the State.

Reviews

Geology and Mineral Wealth of Burma

(1) *The Geology of Burma.* By Dr. H. L. Chhibber, with Contributions by R. Ramamirtham. Pp. xxviii+538+26 plates. (London: Macmillan and Co., Ltd., 1934.) 30*s.* net.

(2) *The Mineral Resources of Burma.* By Dr. H. L. Chhibber. Pp. xv+320+10 plates. (London: Macmillan and Co., Ltd., 1934.) 18*s.* net.

(1) THE need for a treatise on the geology of Burma has been felt for many years, not only by those interested particularly in that country, but also by geologists who study the earth's crust on broad structural lines, by palæobotanists and palæozoologists who trace the natural history of flora and fauna throughout geological ages on world-wide evidence, and by petrologists who correlate information from different petrographic provinces to enable them to establish generalisations of great importance with respect to the story of the rocks. The need has been greater in the case of Burma than almost any other portion of the globe, because that country is situated to the south and west of one of the most extensive parts of the earth's surface about which least is known geologically. Tibet, Mongolia and Siberia to the north, and Siam and China to the east, have never been surveyed by geologists, with the result that for many thousands of square miles in that part of the world, geological knowledge is scanty in the extreme and, unfortunately, likely to remain so for some generations. It thus becomes of the greatest importance to place on record the available geological data about the only part of this vast land-mass where geologists have for some years been at work.

An account of the geology of so extensive a country as Burma must necessarily be largely a compilation. A careful summary and critical analysis of the work of others by one who, like the author, is well-qualified for the task, is valuable in itself, but the importance of this volume is greatly enhanced by the fact that the author has himself surveyed geologically certain parts of the country, enabling him to correlate information from isolated areas and to give, for the first time, a general outline of the geology of most of the province, although there still remain important gaps, especially in some of the hill regions.

The first three of the thirty-four chapters deal with physical features, river systems and lakes; chapters iv–ix with earthquakes, hot-springs, mud-volcanoes, denudation, limestone caves and the coast-line; chapters x–xxvi describe the geological formations from the Archean to Post-Tertiary deposits; chapters xxvii–xxxii give an account of igneous activities and petrological descriptions and chemical analyses of various types of rocks; chapter xxxiii gives a series of variation diagrams based on rock-analyses, and the final chapter contains much new information relating to the geotectonics of the country.

The author, when recently in Great Britain, availed himself of the opportunity of consulting a number of eminent geologists on various branches of the subject, and was particularly fortunate in being able to incorporate two valuable appendixes, one on the correlation of the geology of Burma and Malaya specially written for this volume by J. B. Scrivenor, late director of the Geological Survey Department of the Federated Malay States, and the other on the correlation of the geology of Burma and Assam, by P. Evans of the Burmah Oil Co.

The book is illustrated by twenty-three plates, thirty-seven figures and three geological maps in folder-form. A comprehensive, almost complete, list of references is added at the end of every chapter.

(2) Burma is one of the most important provinces of the Indian Empire as a source of minerals of economic importance, and with respect to petroleum, silver-lead-zinc ores, and tungsten ore it is the chief British producing country in the Far East. Indeed, during the War, its mineral production was of extreme importance. It supplied the Empire, for example, with most of the ore from which tungsten, needed for the manufacture of high-speed tools essential for munition purposes, was extracted. Deposits carrying gold, ores of tin and other base-metals, are mined in the country, and coal of an inferior quality occurs extensively. Its famous rubies and sapphires are still being mined, but on a considerably smaller scale than formerly, because of the success of their synthetic production.

It was a wise decision on the part of the author not to include an account of these important mineralised areas in the volume dealing with the geology, but to publish it as a separate book. Although the two subjects are complementary, large tracts of the country which are of geological interest contain no minerals of economic importance, these being very restricted in their distribution in Burma, as in most other countries. Mining engineers and mining geologists will be thankful for a work which, within 320 pages, deals with most of the hitherto known areas of mineralisation in a province of growing importance in its mineral production.

The first chapter describes the geological and geographical distribution of the mineral deposits with statistics of outputs for the period 1926–30. Figures for two later years could have been included. The remaining fifteen chapters deal separately with the different mineral occurrences, that on petroleum being by Dr. L. Dudley Stamp.

Because of the gold boom, much attention is being given at present to the occurrence of this metal in Burma. The chapter on gold, however, whilst containing useful and recent information, occupies only eight pages, which is out of proportion, for example, to the sixty-four pages devoted to the relatively less important mineral jadeite. Those interested in the wide distribution of gold in this province will be well advised to consult the valuable article on this subject by Dr. Coggin Brown, published this year in the first two issues of the *Mining Magazine*.

The book is illustrated by nine plates, thirteen figures, and a folder giving a sketch map showing the important mineral occurrences. It is well indexed, and bibliographies are given at the end of each chapter.

The format of the two volumes is all that could be desired.

W. R. Jones.

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. 5: *Sept. 6, 1847–Oct. 17, 1851.* Pp. xiii+456+2 plates. (London: G. Bell and Sons, Ltd., 1934.) 7 vols., £12 12*s.* 0*d.* net.

At the opening of the period covered by this—the fifth volume of Faraday's Diary—Faraday was fifty-five years of age, and signs of that failure of memory which clouded his later years were increasing. Thus, in the summer of 1847 we find, in a letter to Lord Auckland, complaints of giddiness, loss of memory and confusion. So to his faithful correspondent, Schönbein, he writes enthusiastically concerning ozone, but takes shame to "say that I have not yet repeated the experiments, but my head has been so giddy that my doctors have absolutely forbidden me the pleasure of working and thinking for a while, and so I am constrained to go out of town, be a hermit, and take absolute rest". Two years later, we find him writing to Matteucci to the effect that "I have lately been working for full six weeks trying to procure results, and have indeed produced them, but they are all negative. But the worst of it is that I find on looking back to my notes, that I ascertained all the same results experimentally eight or nine months ago, and had entirely forgotten them".

Illness and failure of memory combined make a sad handicap; nevertheless, Faraday's output of work—the rough notes of which fill more than four hundred and fifty pages of the published diary—was remarkably large, and in the fertile year 1850, he read no fewer than five papers before the Royal Society. Over and above this he gave, during the period 1847–51, courses of lectures on the allied phenomena of chemical and electrical forces, on static electricity, the Juvenile Lectures on the chemical history of a candle, Christmas Lectures on the forces of matter, and a course of six lectures on "some points of domestic chemical philosophy—a fire, a candle, a lamp, a chimney, a kettle, ashes". These, with Friday Evening Discourses, ranging from Schönbein's ozone to De la Rue's envelope machinery, represent a volume of work which would do no discredit to Faraday's great powers, even at their heyday.

Dominating the early part of this volume of the

Diary are the experiments on magnecrystallic action, initiated by a description of Plücker's experiments on crystals (he makes an odd occasional appearance in the Diary as Plückner). In 1849–50 we have the record of the experiments on the relation of gravity to electricity, on diamagnetic action, on gases in the magnetic field, on magnetic conducting power and on atmospheric magnetism; the year 1851 provides the data for the twenty-eighth and twenty-ninth (the last) series of Experimental Researches, on lines of magnetic force and on the employment of the induced magneto-electric current as a test and measure of magnetic forces.

To this period belongs the introduction of the terms *paramagnetic* and *diamagnetic*, due to Whewell, who writes to Faraday in July 1850: "The purists would certainly object to the opposition of *ferro-magnetic* and *dia-magnetic* . . . it would appear that the two classes of magnetic bodies are those which place their length *parallel* . . . to the terrestrial magnetic lines, and those which place their length transverse to such lines. Keeping the preposition *dia* for the latter, the preposition *para* or *ana* might be used for the former. Perhaps *para* would be best, as the word *parallel* would be a technical memory for it".

It will be seen that the Diary shows little falling-away in the intrinsic interest of its contents. It is superfluous to add that this volume, in the matters of editing and of printing, preserves the high standard of its predecessors. A. F.

The Teaching of Geography

Memorandum on the Teaching of Geography. Issued by the Incorporated Association of Assistant Masters in Secondary Schools. Pp. xvi+418. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., 1935.) 7*s.* 6*d.*

THE established place which geography has taken in the educational curriculum during the last thirty years has been gained by a revolutionary change in the outlook of the subject. From a mere recital of place names and uncorrelated facts, disliked by both teacher and pupil, it has developed into a study of the interrelationships of various distributions on the earth's surface and their relation to human activity.

The time is opportune for this review of the scope and position of the subject, which has been made by a representative committee of teachers. In discussing the aim of the work, the committee stresses the value of geography as a unifying subject, correlating not only various scientific studies, but also giving a link between humanistic and scientific sides of the curriculum. While the utilitarian side of geography is not overlooked, the committee stresses rather the cultural aspect, inasmuch as geography properly taught gives a view of the world as a whole and provides a background for a true appreciation of local peculiarities and national aspirations. It deprecates the teaching of economic geography as apart from regional treatment of the world as giving a non-geographical bias. It might have added a warning against the tendency of many textbooks and some teachers to regard the world merely as a field for industrial exploitation.

After discussing a scheme of work for schools, in which the committee advocates the teaching of physical geography as incidental to human interests rather than as an end in itself, the necessity of noting historical factors in many geographical topics is pointed out, for example, the woollen industry, and thus providing the opportunity of linking history with geography. This is a more satisfactory plan than the attempt to teach historical geography by itself, which may lead to the pitfalls of over-generalisation and exaggeration of 'geographical control'.

In useful chapters on teaching methods and apparatus the value of the globe as correcting misconceptions due to flat maps is noted. Possibly more attention might have been given to the nature of wall maps and atlases, of which many produced for school use are crude and over-generalised. A list of books suitable for the school library is not intended to be exhaustive, but the inclusion of several might be criticised. In a discussion on the training of teachers, the value of travel is an important point raised. This is rightly said to be as necessary to teachers of geography as to teachers of modern languages, to whom it is generally conceded.

A long chapter on examinations contains many criticisms and suggestions that should be helpful to examiners who are conscious of the pitfalls which beset them. The committee believes in easy papers with a high standard of marking. It gives a cautious acceptance to the new style of paper which certain examination boards are now trying. These papers in their demand for factual knowledge and discouragement of critical answers destroy initiative and penalise the bright candidate at the expense of the dull one. The greater possibilities of standardising the marking of a number of examiners seems to be the chief, if not the only merit of this type of papers. Their acceptance would mark a distinct reversion to the old and non-educational aspect of geography. The volume concludes with a careful bibliography of geography teaching. R. N. R. B.

A Course of Psychology

The New Field of Psychology: the Psychological Functions and their Government. By Prof. Madison Bentley. Pp. xvi+439. (New York and London: D. Appleton-Century Co., Inc., 1934.) 12*s*. 6*d*. net.

PROF. MADISON BENTLEY has chosen an ambiguous and even a misleading title for his book. To most people the phrase "the new field of psychology" will suggest a study of one or more of the many recent movements in psychological science. In fact, as all psychologists know, Dr. Bentley published a book called "The Field of Psychology" some time ago, and this volume is simply a very thorough revision of that.

The author now ceases to discuss anything in terms of 'mental' events, processes, or forms of existence, and writes only of functions. The functions of the living organism, he holds, can be studied in two ways: as chemical and biological processes which run their course within the bodily organism itself, and as psychological processes which cannot apparently be very clearly defined, but all of which involve some direct interplay between the body and what goes on outside the body. Psychological functions he considers to be of three main varieties, those which further *apprehending*, those which carry out *action*, and those which lead to *comprehension*. All these are closely related to the physiological functions, and must be regarded as growing out of them, and as based upon them. With this general scheme he discusses all the usual questions raised in a functional psychology.

The book is a textbook, and appears to be intended to cover the requirements of an introductory but comprehensive course. It consists of printed lectures, and it has much of the discursiveness and illustrative character of the lecture form. Students and teachers are likely to get a little weary of it before they have finished, and to look for some presentation more direct and condensed. But of course it is well informed, it is generally clear, and it has the high merit, in a general psychological textbook, of complete consistency.

Dr. Bentley has printed seventy pages of footnotes to his lectures. Both the teacher, and the student who already knows something of psychological investigations, will find these far and away the most interesting part of the work. It is here that the author discusses the views of other people, and indicates the sort of reading that he would wish his students to undertake. His expositions are sometimes arresting, his criticisms usually exceedingly good and not by any means always the conventional ones, and his selected authorities excellently chosen.

Short Notices

Russian Sociology: a Contribution to the History of Sociological Thought and Theory. By Dr. Julius F. Hecker. Pp. xvi+313. (London: Chapman and Hall, Ltd., 1934.) 8*s*. 6*d*. net.

THE writings of nearly thirty social philosophers are reviewed and summarised by Dr. Hecker in this book, which is re-issued after nineteen years. Its general tendency will soon be obvious to the reader, especially if he turns towards the latter part of the volume, but it should be observed at once that the review covers the work of many other thinkers than those belonging to the later phase of dialectical materialism. So far as it does this, it both increases the value of the book and the ease of the reader.

True and interesting remarks flash out here and there, and one is always curious to see how the generally accepted facts of the modern industrial State are met by the abstract theorist, whether of the Lenin or any other school. Mikalovsky, for example (fl. 1842–1904), said quite truly that, "Atrophy of the physical or the mental characteristics of man is possible through social or economic subdivision of labour". Bogdanov, the later and more purely theoretical writer (fl. 1873–1928), suggests that this may be corrected, "for the further increase in the complexity of machinery and the growing intelligence of the workers will eventually remove the final vestige of specialization. Organizer and worker will merge into one"—a cryptic remark akin to the still more famous Marxian dogma that action and thought are identical. More definite is Bogdanov's criticism of the Marxian doctrine that the ruling class owed its position to the ownership of the means of production; Bogdanov would find it rather in the power of organisation. He is also the first exponent of 'teetology', or 'organisation-science', claiming for man the power to organise the "outer forces of nature, as well as human forces and experience itself". Here is the philosophy of a national plan in its germinal and most general form. The result of such organisation, especially in its Russian shape, we are all awaiting with interest; that it can contain much of the personal liberty which so many of these writers so ardently desire, is the most doubtful point. F. S. M.

Geologic Structures. By Bailey Willis and Robin Willis. Third edition, revised. Pp. xviii+544. (New York and London: McGraw-Hill Book Co., Inc., 1934.) 24*s*. net.

THIS book was first published in 1923 and a second edition appeared in 1929. In the third and latest edition the text has been completely rewritten and rearranged, while some fifty additional maps and

figures have been added. As a result, the value of the book has been considerably enhanced, and in its new form it is undoubtedly the most exhaustive treatise on structural geology in the English language.

The subject is treated from a descriptive and analytical point of view and there is a conspicuous absence of the confusing mass of theory and hypothesis with which the literature of tectonics is so overburdened. The descriptive portion of the book is preceded by a discussion of the fundamental mechanical principles involved in the deformation of rock masses. The description of each type of structure (folding, faulting, etc.) is followed directly by a detailed analysis of the stresses and strains involved in its production.

New chapters have been added on "The Physiographic Expression of Structure" and on "Practical Problems", while the section dealing with the wider problems of earth dynamics has been completely rewritten and affords an excellent account of modern views concerning the nature, age, constitution and physical and thermal state of the earth.

Although the book is of a detailed and systematic nature it is equally suited to the needs of the elementary student and the advanced worker, since the purely descriptive and the analytical sections respectively are treated separately, as indicated in the table of contents.

A Hundred Years of Psychology, 1833–1933. By Prof. J. C. Flugel. (100 Years Series.) Pp. 384. (London : Gerald Duckworth and Co., Ltd., 1933.) 15*s.* net.

THIS important book fills a very obvious gap in psychological literature, and will serve for many years as the most useful outline, although in no way sketchy, of psychology during its period of most energetic development.

The author begins by giving a vivid picture of the position a hundred years ago, when Herbart's works had laid the foundation of psychology as a subject in its own right. The next part surveys the period up to 1860, showing the rise of systematic, physiological and abnormal psychology. During the next period, that is, up to 1900, the influence of the theory of evolution was felt, and psychology was applied to problems of the individual, the child and the animals ; a period that experienced the activities of Spencer, Galton, Wm. James, Fechner, Helmholtz, Wundt, Charcot and Ribot, to mention only a few names, was clearly one of rapid development.

During the last thirty-three years there has been a tendency for schools to develop, each probably feeling much more in opposition to the others than will later prove to be the case. The most outstanding characteristic of this period has been the fruitful application of psychology to education, industry and medicine.

Unlike so many shorter histories, this book is interestingly written and should be read by all students of psychology, who will gain much from seeing their own speciality in perspective and treated in an unbiased way.

Geometrische Elektronenoptik : Grundlagen und Anwendungen. Von E. Brüche und O. Scherzer. Pp. xii+332. (Berlin : Julius Springer, 1934.) 28.40 gold marks.

ELECTRONS behave in many respects like light. They may travel in straight lines ; may be 'refracted' in electric or magnetic fields, may be focused as by a lens in suitably graded fields, or may be caused to produce interference patterns in properly disposed apparatus. These are the matters which the authors of this book have chosen for their topic, and which they have elaborated with most praiseworthy attention to detail and extreme completeness of reference.

Almost exactly the first half of the volume (164 pages) is devoted to the more mathematical and theoretical parts of the subject, while the second half (165 pages) is concerned with the more practical applications. Commencing with the formal analogy between light waves and electrons, the authors proceed in logical manner to develop the theory of the motion of electrons in electric and magnetic fields, including a very complete mathematical discussion of 'electron lenses'. The experimental side of the subject is always kept in view.

In the second half of the book the development of the original Braun tube to the present-day cathode ray oscillograph is first detailed, followed by a long chapter on the 'electron microscope'. A very interesting set of comparison photographs of the same objects taken through the ordinary light microscope and the new electron microscope allow the reader to form his own conclusions about the present state of the new technique in relation to the old.

Herbert Spencer's Sociology : a Study in the History of Social Theory, to which is appended a Bibliography of Spencer and his Work. By Dr. J. Rumney. (Herbert Spencer's "Descriptive Sociology", continued by his Trustees.) (Published for Herbert Spencer's Trustees.) Pp. xvi+357. (London : Williams and Norgate, Ltd., 1934.) 10*s.* 6*d.* net.

THE winding-up of the trust created under the will of Herbert Spencer for the publication of sociological material relating to the less advanced societies has been fittingly marked by the Trustees in the publication of this account of Herbert Spencer's sociological work. Dr. Rumney, to whom they entrusted the task, has wisely not confined himself to a summary of Spencer's theories, but has analysed them critically in the light of modern developments in theory and method.

Spencer has not received a very cordial welcome in academic circles, and it will perhaps come as a surprise to many who have not an extensive acquaintance at first hand with his writings to find how well they stand the test. Dr. Rumney finds the main ground of criticism in the attention given to structure rather than function and in the neglect of modern or civilised societies in favour of primitive or archaic forms. The explanation of the latter failing, as he points out, is that in the days in which Spencer was working it was erroneously believed that the 'savage' society is the simpler—a fallacy exposed by modern research.

Mathematical Biophysics

By N. Rashevsky, Department of Physiology, University of Chicago

THE application of physico-mathematical methods to biology has been advocated now and again by scientific workers; but until recently no systematic attempt to create a mathematical biology has been made, and the advocates of this 'science to come' have confined themselves to outlining the possibilities of such an approach. True, there is a wealth of literature on the application of mathematical statistics to various biological phenomena; but the whole of this field of research lacks almost completely the physical point of view. General physics is accepted as of paramount importance in the study of biological phenomena; the application of physical methods has already resulted in important biological discoveries. But most of this application is restricted to the use of physical apparatus in biological experiment; and very little attempt has been made to gain an insight into the physico-chemical basis of life, similar to the fundamental insight of the physicist into the intimate details of atomic phenomena. Such an insight is possible only by mathematical analysis; for our experiments do not and cannot reveal those hidden fundamental properties of Nature. It is through mathematical analysis that we must *infer*, from the wealth of known, relatively coarse facts, to the much finer, not directly accessible fundamentals. The greatest advances of modern physics are due to such men as Einstein, Bohr, Heisenberg, Dirac, who unravel the mysteries of the physical universe by the power of their thought, using mathematics as their tool.

The objection has been frequently raised that mathematical methods, however useful in physical science, are inapplicable to biology, because of the tremendous complexity of biological phenomena. But this argument should really be used in favour of, rather than against, the application of mathematics to biology. A simple phenomenon can be understood by mere 'inspection', but it requires mathematical analysis to see through a complex system. The main thing is to apply mathematics methodologically correctly, by first studying abstract, over-simplified cases, which may even perhaps have no counterpart in reality. Afterwards the various complexities of the case have to be taken into account gradually, as second, third and higher approximations. This use of abstract conceptions in the beginning is *the* characteristic of the physico-mathematical method. Violation of this rule, and all attempts to start with actual cases in all their complexity, result in failure and have contributed to a sceptical attitude towards mathematical methods*.

The following brief review of my own researches in mathematical biophysics may serve to illustrate the fruitfulness of a mathematical approach to this field.

The fundamental living unit is the cell; hence it is with the study of a cell that we must begin. But, faithful to our rule, we must start with a mathematical description not of any given type of actual cell, but of an abstract concept of a cell. Not only are there innumerable varieties of cells, but also no two cells are quite alike. They differ in size and structure and chemical composition. Most of them possess a nucleus; some have several, others have none. Some cells consume oxygen, some not. Some metabolise one type of substance, others a different type. If we discard all such properties of a cell as are not common to absolutely *all* cells, we arrive at the following definition of a cell, which holds for *all* cells whatsoever and which we take as defining our abstract conception of a cell.

A cell is a small liquid or semi-liquid system, in which physico-chemical reactions are taking place, so that some substances enter into it from the surrounding medium and are transformed, through those reactions, into other substances. Some of these other substances remain within the system, causing it to increase in size; some diffuse outwards.

Such a system is no longer so complex as to forbid any application of mathematical analysis, and we shall proceed to investigate mathematically various properties of such systems, or in other words, various consequences of the above definition.

At a first glance not much can be done with such a general definition, but actual analysis shows quite the opposite. As in geometry extremely simple axioms and definitions lead us to very complex propositions by reasoning, so will the same mathematical reasoning lead to important conclusions from the above definition of the cell[1].

First of all, it is easily demonstrated that whenever a system consumes or absorbs any kind of substance in solution in the surrounding medium, the concentration of this substance will not remain uniform, either in the system itself, or in the surrounding medium. The concentration outside of the system will have a gradient towards the system: in the system itself there will be a

* Cf. my article in "Philosophy of Science", 1, 176; 1934.

gradient from the periphery towards the inside. The reverse holds true whenever the system produces a substance which diffuses outwards into the *milieu externe*. The concentration will be greatest inside, and will decrease towards the periphery, and will then further decrease with increasing distance from the system. The exact variation of the concentrations from point to point will depend on a number of factors, such as the size and shape of the system, the diffusion constants inside and outside, the permeability of the boundary, the type of reaction producing the gradient, etc. But whenever a reaction producing or absorbing a substance takes place in the system, *as is always the case with a living cell*, such gradients of concentration are present.

Any dissolved substance produces an osmotic pressure, which for dilute solutions is proportional to the concentration of the solute ; hence, whenever concentration gradients are present, they result in non-uniformity of osmotic pressure. This in its turn results in forces, acting on each element of volume, and proportional to the gradients of pressure. Thus the very general and simple fact that *every cell metabolises* leads to the existence of a system of forces within and without the cell. Like the gradients of concentration, the exact distribution of these forces will vary from case to case ; but they are always there.

Having thus deduced the existence of these forces, we must now investigate their possible effects. To this end we must investigate various possible cases, which open up an unexplored field to the mathematician.

We start with the simple case of a spherical homogeneous cell, which either absorbs or produces some substance at a constant rate per unit volume : this rate being independent of the concentration of the substance. The distribution of concentrations within and without the cell has in this case a spherical symmetry and can be easily calculated : the resultant force will be *zero*. But things are different if the cell is slightly deformed from its spherical shape. Mathematical investigation of the forces produced by such a deformed cell shows that, for substances absorbed by the cell, the forces are such as tend to restore the spherical shape ; but for substances which are produced by the cell, the forces are such that they tend to increase the departure from the spherical and to *divide* the cell into smaller ones. Since in an actual cell substances are both produced and absorbed, the net result will depend on which forces prevail. This, again, is determined by various physical constants of the cell, the rates of reaction, etc.

Let us consider the more interesting case, when the *dividing* forces prevail. It can be shown that even in this case the cell will only become unstable and divide spontaneously when its size is greater than a certain critical value ; for when the cell is below that size, surface tension, which opposes division, always prevails. This critical size can be calculated in terms of the above-mentioned constants of the cell. Although we do not know these constants with any accuracy, we have a fair knowledge of their order of magnitude, and can estimate the order of magnitude of the critical size at which a cell will divide, if it divides at all. The sizes thus calculated happen to be the same as the sizes of actual living cells[2]. We thus see that, merely by virtue of its metabolism, every cell contains in itself factors which may cause its division into two, whensoever in the course of its growth it comes to exceed a definite critical size. The half-cells grow on until they in turn divide, and so on.

As our next step, we must consider more complex cases of cells consisting of two phases, nucleus and cytoplasm. The mathematical treatment here becomes much more complicated, but the general results remain the same.

A further step leads us to non-spherical cells. At a first glance the existence of free, non-supported, liquid systems with a non-spherical shape sounds like nonsense, since we know from the laws of capillarity that in such a case the only stable shape of equilibrium is a sphere. But this holds true only when forces other than a *constant* surface tension are absent. Now, the presence of concentration gradients produces non-uniformities in the surface tension of the cell ; this modifies the situation and makes non-spherical shapes of equilibria possible. But those non-spherical shapes are possible *only* so long as the cell metabolises ; as soon as the cell dies its metabolism stops, the gradients disappear and the cell assumes a spherical shape. An illustration of this is found in many unicellular organisms, which possess oblong and sometimes eccentric shapes during life, but round up after death[3].

We have seen that the forces discussed above do not always produce division of the cell. In such a case, however, a cell will not grow indefinitely. As it increases its specific surface decreases, and the relative rate of growth decreases too. A stage will be reached when anabolism just balances katabolism, and no further growth will result.

The osmotic forces are not the only ones produced by concentration gradients. Other forces, due to attraction between various molecules, enter into play whenever concentration gradients are present. These forces may be of opposite sign to the osmotic ones. Taking them into account makes the whole picture much more complex, but

the general conclusions remain as given above. We see that our apparently simple definition of a cell necessarily implies a complexity reminding one of the actual conditions in biological systems![2]

An objection has been raised to all the above considerations that, in actual cells, protoplasmic streamings are often observed, which should stir the interior of the cell and even out the concentration gradients. This objection is based on fallacy. Not only does the existence of protoplasmic streaming constitute no argument against the existence of gradients, but it is a positive proof for their existence. Where there are streamings, there are the forces which produce them; and if everything were homogeneous, no such forces could be produced. It is true that the occurrence of streamings will modify the distribution of forces, and so far this complication has not been taken into account; it is one of the next problems on our programme. It has been already suggested that such a further generalisation of the theory may throw light on the mechanism of locomotion in the Protozoa.

Thus far we have been considering the effect of the forces produced by the cell on the cell itself; but the concentration gradients outside the cell result also in forces between one cell and another. All those forces being of the same origin, there is a close relation between them. Whenever we have an aggregate of cells in which the dividing factors prevail, they will repel each other. On the other hand, when the 'restoring' factors prevail, cells attract each other. Of all cells, the neurones have most completely lost their property of dividing; we should expect forces of attraction between them. Indeed the existence of such forces has been inferred by a number of neurologists, notably Ariens Kappers and Ramon y Cajal, from various observations. The peculiar irregularity in shape of the neurones and the existence of a great number of interneuronic connexions is also to be accounted for by those forces. It has been suggested that a formation of new anatomical connexions between neurones may be the cause of conditioned reflexes and learning. Calculation shows that the above forces may account for it. Under certain conditions they will produce an actual new connexion in a very small fraction of a second.

This leads us towards a mathematical theory of nervous functions. We find that, under very general conditions, aggregates of cells such as are studied above will possess many properties characteristic of the brain. These include differential discrimination of spatial and temporal patterns by learning, and what is known in psychology as 'Gestalt-transposition'. For details we must refer to the original papers[4].

Finally, the theory of intercellular forces has been applied to the form of cellular aggregates, forming multicellular organisms. It has been shown that those forces account in a general way for the various stages of embryonic development (blastula, gastrula, neurula), and for the gross features of the forms of various classes of animals[5].

Having thus started from a study of the most general properties of a cell, we arrive in a deductive, synthetic way at a possible understanding of such problems as "why we behave as we do" and "why we are shaped as we are".

We have not mentioned at all the 'mechanism-vitalism' controversy. The problems discussed here are entirely independent of its issue, if there be an issue[6]. Whether the present-day concepts of physics will prove sufficient to provide an exhaustive explanation of life, or whether new principles will be introduced in the future, the treatment of those problems will of necessity be mathematical, if it is to be exact and scientific and not to resolve itself into mere verbal disputes.

Much remains to be done, but there can be little doubt of the fruitfulness of this approach. The further we proceed, the more difficult become the mathematics involved; but the results compensate for all difficulties. C. F. Gauss, "rex mathematicorum", derived many an inspiration for his purely mathematical discoveries from the study of physical phenomena. The time has come when mathematicians may find their problems in the ever-inspiring realm of living Nature.

[1] *Protoplasma*, **14**, 99; 1931. **15**, 427; 1932. **16**, 387; 1932. *Physics*, **1**, 143; 1931.
[2] Cold Spring Harbor Symposia on Quantitative Biology, **2**; 1934.
[3] *Physics*, l.c.
[4] Forthcoming in "Philosophy of Science" and in the *Journal of General Psychology*.
[5] Protoplasma, **20**, 180; 1933.
[6] Cf. concluding paragraphs in "Philosophy of Science", l.c.

Racial Studies in Britain

THE proposals put forward by the Royal Anthropological Institute for an organised anthropometric survey of Great Britain (see NATURE, **135**, 463; 1935) revives a project in anthropological research of which too little has been heard in recent years. It is a project which has had a curiously chequered history; and its fate up to the present has been less than is deserved both by its intrinsic merits and by the enthusiasm and strenuous efforts of those who, from time to time, have endeavoured to bring it to practical effect. The story covers more than half a century

of the comparatively short history of anthropology as a science.

The racial history of Britain begins in what is now called pre-history with the studies of prehistoric skeletal material by Barnard Davis, Thurnam and Rolleston. From this emerged the concept of a racial succession of long-heads and broad-heads of the stone and bronze ages with the long-headed Saxons and intruding Danes as an overlying element in the building up of the population. Even before the publication of Thurnam and Davis's "Crania Britannica" in 1865, Dr. John Beddoe had been at work in the 'fifties, collecting particulars of hair- and eye-colour in Scotland, Ireland and England, which he was afterwards to utilise in his "Races of Britain". But the first organised attempt at measurement of the living on an extended scale was made by the Anthropometric Committee of the British Association which reported in 1878 and succeeding years and in 1883 published a comprehensive final report, to which reference is sometimes made under the name of its secretary, C. Roberts, who was responsible with Sir Rawson W. Rawson for its compilation. Notwithstanding the lapse of time, and in some instances the uncertainty of conclusions based upon insufficient data, this is still the standard of reference for any comprehensive account of measurements of the living in the British Isles.

Various attempts, mostly somewhat spasmodic, were made to keep alive the work of the Anthropometric Committee. Francis Galton measured 10,000 individuals at the International Health Exhibition of 1884, and a laboratory which he instituted at the South Kensington Museum with an elaborate programme of observations was in existence for some years. From the Manchester meeting of the British Association in 1887 until the Nottingham meeting in 1893, measurements were taken of such of the members of the Association as visited a temporary laboratory set up at each meeting under the care of a committee which reported annually. Other British Association Committees were appointed from time to time. A committee on the measurement of children became a committee for the study of the abnormal and, acting in co-operation with a committee appointed by the International Congress of Hygiene of 1891, recorded the observation of 30,000 children in 1892–93 and helped to secure the special treatment of the defective child; while a committee to promote anthropometric measurements in schools collected a certain amount of information, aroused some enthusiasm, but failed to initiate any general or extended action. Anthropometric observation also formed part of the extensive programme of a committee for the ethnographic survey of Great Britain appointed in 1892, which published five reports between that date and 1899, when it ceased to exist in favour of a proposal for an Ethnographic Bureau for Great Britain.

Following this, the most serious effort in promoting anthropometric research was made early in the twentieth century by another Anthropometric Committee of the British Association appointed in 1902, which, although it did not carry out measurements on the living as was originally intended, nevertheless had an important influence on the further development of anthropometric observation. This it achieved in the first place by drawing up under the chairmanship of D. J. Cunningham a code of instructions for anthropometric measurement, which, whatever its defects may have appeared to be to a later generation, secured the standardisation of a technique which was in advance of that of its day; and secondly by its efforts, and more particularly the efforts of individual members of the committee, to secure the recognition of an anthropometric survey of the inhabitants of Britain as a work of national importance, which should be supported by a subvention or even undertaken as a national charge.

In the latter of these two activities of the Committee one member was indefatigable. This was John Gray, its secretary throughout the whole of its existence. A native of Aberdeenshire, he had taken up anthropometric work in the 'nineties, when he used to visit the fairs and other countryside gatherings in Buchan and record the physical measurements and characters of those who attended them. His early contributions to anthropometric research were studies of the material thus obtained, which were submitted to the Buchan Field Club. In this work he was soon joined by Mr. J. F. Tocher, then of Peterhead, who made an ethnographical study of the school children of Buchan, which was also communicated to the Field Club. This work had one important consequence. It brought the two men into touch with Sir William Turner, himself a famous craniologist and then professor of anatomy in the University of Edinburgh, through whose influence they were able to obtain financial assistance for their further work of anthropometric survey, one outcome of which was the important and authoritative study of the physical characters of the inmates of the asylums of Scotland.

It is not so much Gray's work as a persistent measurer of heads on all occasions, suitable or otherwise, or his ingenuity in devising 'fool-proof' anthropometric instruments, with which we are concerned here, as with his unobtrusive but determined and unceasing efforts to secure public recognition of the value of anthropometry, more

especially in its application to the population problem of Britain. A word, however, must be spared for his early appreciation of the significance of biometric methods in anthropology. Like C. S. Myers, whose paper on "The Future of Anthropometry" in 1903 has been regarded as a landmark, he recognised that much early work in physical anthropology was vitiated by the insufficiency of the data on which its conclusions were based, and advocated the employment, and himself consistently employed, sound statistical methods on the lines of Prof. Karl Pearson's work, in the critical treatment of the data of the observer.

It is not proposed here to attempt an examination of the contribution of the biometric school to the racial history of the British population, of which a brilliant example has recently come from the pen of Dr. G. M. Morant. For one reason it stands somewhat outside the movement now under consideration, though, it is to be judged, under the present proposals of the Royal Anthropological Institute, a more or less complete fusion of material from both sides will now take place.

At about the time of the appointment of the last-named of the Anthropometric Committees of the British Association mentioned above, the people of Great Britain were much alarmed, so far as was to be gauged from the daily Press, by the alleged fact of a serious physical deterioration in the population and a marked inferiority of development among the children of the less well-to-do in the community. In part this was an aftermath of the Boer War, not unconnected with difficulties in recruiting for the Army. Largely as a result of newspaper agitation, an Inter-Departmental Committee was set up to inquire into the matter. Among those invited to give evidence before this Committee were several anthropologists, including D. J. Cunningham, chairman of the Anthropometric Committee and by now professor of anatomy in the University of Edinburgh.

The Inter-Departmental Committee issued its report in 1904. Almost immediately afterwards the British Association met at Cambridge, where a full-dress discussion of the situation took place in Section H (Anthropology) under the presidency of Mr. Henry Balfour, at which the Right Hon. Arthur J. Balfour (afterwards Earl Balfour), then Prime Minister and president of the Association, was present. The most noteworthy features in the discussion were a doubt expressed by Arthur Balfour whether, judging from his own experience on his estate in Scotland, the conditions in rural areas were such as to conduce to the superiority in physique usually attributed to the countryman over the town population, if such superiority were a fact, and the conclusion, drawn from his observations of hair- and eye-colour, by Dr. F. C. Shrubsall, that residence in urban areas favoured the dark as against the fair element in the population, and that this might possibly bear upon the incidence of disease, especially tuberculosis and cancer.

The question raised in the discussion by the president of the Association served to emphasise the fact, already made patent in the report of the Inter-Departmental Committee, that there was a paucity of relevant measurement upon which any conclusion as to physique could be based. Broadly stated, however, the conclusion of the Inter-Departmental Committee was that there was no evidence of organic, extensive or permanent physical deterioration in the population as a whole.

It was clear that this conclusion rested, for the most part, upon expressions of opinion, well-founded, no doubt, rather than upon the evidence of extended and comparative series of measurements. These did not exist, except in so far as afforded by the British Association Committee's reports. Other figures brought forward afforded no certain basis of comparison. For children and adolescents, it is true, restricted series were available such as the measurements of the boys of Marlborough, where the annual anthropometric reports of Mr. E. Meyrick were a feature of the Field Club magazine for many years, and of Manchester Grammar School, but little was known of the working-class child-population.

Anthropologists were not slow to point out the defects of the report, and they emphasised the futility of discussion of groups of measurements from specific areas, or social groups, whether of adults or of children, unless a norm, or standard of normal development, or a series of such norms, had been established for the country as a whole and, more especially, for the various racial groups of which the population was composed. So far as the measurement of children was concerned, the anthropologists joined forces with the educationists and every effort was made by deputation and otherwise to bring their views to the notice of the Government of the day. Arrangements were made for a joint discussion between the Anthropological and Educational Sections of the British Association to take place at the Leicester meeting in 1907, in which even that distinguished authority on the school child, Prof. J. Munsterberg, was prepared to join. But when the meeting took place, its thunders had been stolen. In the course of the debate, Mr. Ramsay Macdonald, the leader of the Labour Party, who had promised to speak in support of a demand for Government action, was able to report that the previous night, or rather in the early hours of that morning, a Bill

for the medical inspection of school children had passed its third reading in the House of Commons. For the success of this measure Sir Philip Magnus, the educationist, representative in Parliament of the University of London, had been largely responsible.

The self-congratulations of the anthropologists on this measure were premature. While recognising its value, and well aware of the benefit which, as time has shown, it was to confer on the people, when the Act came into operation, they noted with regret that no provision was made for anthropometric measurement as a general operation, and no attempt was made to set up a racial standard or standards against which to measure the abnormal or under-developed. The results may be seen in some of the general conclusions put forward, especially in connexion with the effects of malnutrition, in early reports by medical officers who had not appreciated the finer points, patent to the anthropologist, in handling their material.

From this time forward, the project of a nation-wide anthropometric survey, though not sinking entirely into oblivion, became less prominent. It merged into larger proposals which the Royal Anthropological Institute contemplated promoting, while the untimely death of John Gray in 1912 and the outbreak of War helped to relegate it still further to the background in which stood the many desirable things which were to await more propitious times.

In the meantime, also, active interest in anthropometric research had shifted to the regional surveys which were being carried out by individual workers, singly or in groups, and this up to the present has continued in the post-War period. Of these surveys, it is not possible to refer in detail and mention must be confined to one or two, such as that carried out by Prof. H. J. Fleure and his colleagues and pupils in Wales, of which an early report was presented at the Sheffield meeting of the British Association in 1910, the work of Prof. F. G. Parsons and his helpers in the Chilterns, which he has linked up with wider aspects of British ethnology especially in connexion with skeletal material from London and, more recently, Miss R. M. Fleming's continuous periodical measurements of school children in Wales, and her study of hybrids.

The work carried out by Prof. Fleure, or under his inspiration, is especially important in connexion with the proposal which has been put forward by the Royal Anthropological Institute. Working with Aberystwyth as centre, Prof. Fleure and his pupils have demonstrated the relation of racial history to a number of sociological and economic problems. Of these investigations, not the least suggestive, from the point of view of practical politics, is the attempt to correlate, on scientific evidence above cavil, racial constitution and the incidence of disease.

Apart from its practical applications, to which due weight must be given when public assistance is sought, to the anthropologist the most pregnant feature in Prof. Fleure's work has been the demonstration of restricted areas in which has been found what appears to be the survival of a primitive—in some instances an extremely primitive—form among a population essentially modern in character. In this his work links up with the more subtle interpretation of the prehistoric skeletal remains which began, perhaps, in the opening years of the century with Prof. T. H. Bryce's survey of the prehistoric population of the short-cist graves of the Isle of Arran and the identification, soon afterwards, of the Beaker type, in the broad-headed skulls found in the neighbourhood of Aberdeen. As Prof. Fleure has again pointed out recently, the broad generalisations of racial history in Britain, however true at a certain level of thought, may mask rather than reveal facts of which a detailed view is needed. In linking up the prehistoric data with those relating to the modern population, the survey which the Royal Anthropological Institute contemplates will carry on methods of study which, as received from the hands of Prof. Fleure, have already had a profound effect in their application to racial problems in areas other than Wales.

Obituary

PROF. J. J. R. MACLEOD, F.R.S.

BY the death after a long illness, on Saturday, March 16, of J. J. R. Macleod, regius professor of physiology in the University of Aberdeen, medical science has lost an outstanding worker.

John James Rickard Macleod, a son of the manse, was born at Cluny, near Dunkeld, on September 6, 1876. He was educated at Aberdeen Grammar School and at the University of Aberdeen. He completed a distinguished undergraduate career by graduating M.B., Ch.B. with honours in 1898, being awarded at the same time the Anderson Travelling Scholarship. He worked for the next year in Germany, in the Institute of Physiology at Leipzig. In 1900 he was appointed demonstrator in physiology at the London Hospital Medical College and in 1902 was promoted to be lecturer in biochemistry. In 1901 he had been elected to the Mackinnon Scholarship of the Royal Society. He was appointed in 1903 to the chair of physiology at the Western Reserve University,

Cleveland, Ohio, where he remained until 1918, when he was elected to the chair of physiology at Toronto. During his later years at Cleveland, he was engaged in various duties arising directly out of the War of 1914–18. He also acted as professor of physiology at McGill University during part of the winter of 1916. After nine years at Toronto, he was appointed in 1928 to the regius professorship of physiology at Aberdeen, a post he was holding at his death.

Macleod's main interest and occupation throughout his academic life was, of course, the metabolism of carbohydrate. He published his first papers on experimental glycosuria in 1905, and between 1907 and 1917 a series of twelve papers under the general title of "Studies in Experimental Glycosuria" were published in the *American Journal of Physiology* as well as a series of eighteen papers between 1908 and 1921 dealing with other aspects of carbohydrate metabolism. Macleod had thus a full knowledge of practically all the phases of this field of metabolism and the intimate parts played in it by the main tissues and organs of the body. Thus equipped, he was both ready and willing in 1921 to put all the facilities of his laboratory and his unique knowledge of the subject at the disposal of the young investigator, F. G. Banting, who came to him with views on the isolation and preparation of the active principle of the internal secretion of the pancreas. The intensive research work which followed, in which two other collaborators deserve honourable mention, J. B. Collip and C. H. Best, culminated, as is well known, in the isolation of the active principle, insulin, from the islet tissue in such a pure form that it could be utilised as a medicament in practice. The original idea which started this particular piece of fundamental research in the Toronto laboratory was certainly Banting's, but, without the facilities and co-operation provided by Macleod and others, it is very doubtful if the investigation would have reached such early fruition. The marvel, indeed, is that such clean-cut and final results were obtained so speedily. The whole story is a testimonial to the value of team work ably directed to a single end.

Macleod's activities in the field of carbohydrate metabolism received a fresh impetus with the discovery of insulin, and most of his later experimental work was directed towards the mode of action of the active principle. His latest experiments were, in a way, a retrogression to the old ideas of Claude Bernard and his diabetic centre. Macleod had taken up the investigation of the nervous control of glycogenesis in the liver and had obtained some interesting and suggestive results.

Although Macleod's interests were centred on carbohydrate metabolism, he had from time to time carried out interesting investigations in other fields. He had published papers either alone, or in collaboration with others, on caisson sickness, the control of breathing, ventilation, the biochemistry of carbamates, phosphorus of muscle and on many other miscellaneous subjects. He published, in addition to several books dealing with insulin and carbohydrate metabolism, an original textbook, characteristic of the man's outlook, "Physiology and Biochemistry in Modern Medicine", which is now in its seventh edition.

In 1923 Macleod, jointly with Banting, was awarded the Nobel Prize in Physiology and Medicine, and in the same year was elected a fellow of the Royal Society. He was a fellow of the Royal Societies of Edinburgh and of Canada and a fellow of the Royal College of Physicians of London. In 1928 he was appointed Vanuxem Lecturer in the University of Princeton and in 1933 Herter Lecturer in Johns Hopkins University. He had been a member of the Medical Research Council (1929–33), past president of the Royal Canadian Institute (1925–26) and of the American Physiological Society (1922–23). He was a member of many learned societies, and held honorary degrees of several American universities as well as the LL.D. of his own Alma Mater.

As a man and a teacher Macleod was beloved by his friends and students alike. He was an excellent lecturer, lucid, happy and attractive. As a supervisor of research no one could have desired a more kindly and stimulating mentor. He was ever willing to listen and to help, no matter how slow the pupil, provided the worker was in earnest. As a man he was always happy, friendly and full of enthusiasm. He met every one with a cheery smile. He was an optimist who refused to be depressed by ill fortune ; and during the past four years he required all his optimism and cheeriness of spirit to stand up against his affliction. No one could have faced with greater patience and a braver spirit the handicaps placed upon him.

E. P. C.

Prof. R. O. Herzog

Prof. R. O. Herzog, who died at Zurich on February 4, made himself a name by discovering the microcrystalline structure of cellulose. He and Scherrer found it simultaneously and independently, when irradiating different kinds of cellulose fibres with X-rays. This observation gave an enormous impetus to the investigation of fibres and organic substances of high molecular weight : twenty years ago, for example, no one would have dared to write down the structural formula of cellulose or to consider the rigidity of a macromolecule containing oxygen bridges, subjects of lively discussions at many scientific meetings nowadays. Herzog himself, then the head of the newly founded Kaiser Wilhelm-Institut für Faserstoffchemie at Berlin-Dahlem, was most active in promoting this development, and his vivid imagination played from the beginning with ideas which have materialised in recent years. Michael Polanyi, Karl Weissenberg, Hermann Mark, Max Bergmann and Erich Schmid did research in his laboratory at Dahlem, and it was remarkable how successfully Herzog was able to collaborate with younger men.

The behaviour of substances of high molecular weight had always interested Herzog. He was one of the first to determine the diffusion constants of proteins and enzymes, and to become acquainted

with the anomalies of the diffusion of dyestuffs; his investigations concerning skin as an adsorbent, in correlation with the process of tanning, also deserve to be mentioned.

As to the technical work done by Herzog, his main efforts were concentrated on the literary side. He compiled a handbook of organic technology, and also edited a very comprehensive handbook series on the technology of textiles.

Herzog's intellect was keen, and his mind extremely versatile. It was striking how quickly he discerned the possible answers to a given question; owing perhaps to an artistic trend in his nature, he seemed to prefer a subtle and surprising explanation to simpler and more probable ones, and was sometimes right in doing so.

Born at Vienna on May 20, 1878, as the son of an influential journalist, Herzog took his degree at the University of Vienna in 1901. The following years he spent in Germany doing research work and commencing his academic career as *Privatdozent* at Karlsruhe in 1905. In 1912 he became professor of physiological chemistry at the German Technical Highschool in Prague, and from 1919 until 1933 he held the post at Berlin-Dahlem referred to above. He accepted in 1934 a professorship of chemical engineering at the University of Istanbul.

Many friends deeply regret to have lost so prematurely a man of his inspiring personality.

H. F.

WE regret to announce the following deaths:

Dr. Shepherd Dawson, principal lecturer in psychology, logic and ethics in Jordanhill Training College, Glasgow, known for his work on vision and statistical problems in psychology, on March 26.

Dr. Carl Duisberg, founder and chairman of the I. G. Farbenindustrie, known for his work in connexion with aniline dyes, on March 18, aged seventy-three years.

Prof. A. Hantzsch, formerly professor of chemistry in the University of Leipzig, who was an honorary fellow of the Chemical Society, on March 14.

Sir E. Sharpey-Schafer, F.R.S., emeritus professor of physiology in the University of Edinburgh, on March 29, aged eighty-five years.

News and Views

Differential Analyser for the University of Manchester

THE important new calculating machine, known as a differential analyser, presented to the University of Manchester by its deputy treasurer, Mr. Robert McDougall, and constructed by the Metropolitan-Vickers Electrical Co. Ltd., was opened on March 27. A distinguished gathering, presided over by the Earl of Crawford and Balcarres, Chancellor of the University, heard from Prof. D. R. Hartree, under whose direction the machine has been built, an account of how it is constructed and what it will do. Briefly, the object of this machine is the evaluation, by mechanical means, of solutions of ordinary differential equations; it is readily applicable to a very wide range of such equations, and in particular is not restricted to those which are linear. The original conception of such a machine was due to Lord Kelvin, and the first satisfactory working machine was designed and built by Dr. V. Bush at the Massachusetts Institute of Technology; this machine is quite distinct from one for solving simultaneous algebraical equations, also designed by Dr. Bush, of which mention has already been made in NATURE (Dec. 8, 1934, p. 877).

PROF. HARTREE mentioned the wide range of problems in pure and applied science to which the differential analyser could be applied, and said that he hoped to see it used, not only for investigations in pure science, such as the problem of atomic structure in which he was particularly interested, but also to work of technical and industrial importance as well. He paid a warm tribute to Mr. McDougall's munificence in furnishing the University with this powerful and important research tool, to Dr. Bush for his generous and friendly co-operation in its design, and to various members of the Metropolitan-Vickers Electrical Co. Ltd., who had been concerned in its design and construction. After brief speeches by Sir Kenneth Lee, who declared the machine 'open for business', Sir Henry Lyons, and Prof. Bragg, those present descended to the basement of the Physics Laboratory where the machine has been erected, and saw a demonstration of the machine in operation.

Lord Bledisloe and Maori Studies

AMONG the many public-spirited acts which have marked Lord Bledisloe's tenure of the office of Governor-General of New Zealand, few aroused more public enthusiasm than the gift to New Zealand by Lady Bledisloe and himself of the Waitangi Estate, the historic ground where the treaty between the British authorities and the Maoris was signed in 1840. To mark the ninety-fifth anniversary of the signing of the treaty, and to commemorate the gift of this land to the people of New Zealand, the New Zealand Numismatic Society, of which Lord Bledisloe is patron, has struck a medal in silver, bearing the head of Lord Bledisloe on the obverse, which was presented to him at a meeting of the Society held at Wellington on February 6. The presentation was made by the president of the Society, Prof. J. Rankine Brown. In accepting the medal, Lord Bledisloe expressed the hope that the nationalisation of Waitangi would help to promote in New Zealand the sense of nationhood, and referred to the work of the first governors, Capt. Hobson and Sir George Grey, "the great far-sighted pro-consul and racial pacificator". Lord Bledisloe went on to emphasise the

importance of Polynesian, and particularly Maori, studies. He maintained that the white people should learn the language and appreciate to a greater extent the mental and spiritual outlook of the Maori people. While he regretted that it is no longer true, as it was thirty years ago, that at least one third of the Legislature is acquainted with the Maori language and outlook, he hoped that improvement would come from the endowment left to promote knowledge of the manners, customs and language of the Polynesians by the late Prof. Macmillan Brown, whose enlightened aspirations had given him personally immense encouragement.

Recent Archæological Finds in Ireland

An authoritative article on recent Irish excavations by Mr. Sean F. O'Riordan, of the National Museum of Ireland, appears in the April number of *Discovery*. During the year 1934, the National Museum received an unusual number of accessions of exceptional interest as the result of casual discovery. Among these were the remarkable gold gorget of about 700 B.C. from Co. Clare, the bronze age wooden shield—only the second known—from Co. Mayo, the fine Middle Bronze Age rapier from Co. Tipperary and much noteworthy Viking material from Co. Dublin. The greatest advance in the study of Irish archæology, however, has been due to the participation of archæologists in carrying out the Government's scheme for unemployment. This has made possible systematic investigation on an extended scale on an unprecedented number of sites. No less than twelve excavations were carried out in various parts of the country, ranging in date of the period under investigation from post-glacial times to the fifteenth century A.D. The number of workmen engaged on individual sites in these operations varied from twelve on the smallest to fifty on the largest.

The results of the investigation of the sequence of events in post-glacial times at Ballybetagh are already well known, owing to the interest aroused by the pollen analysis, though the report is not yet complete. Another investigation of wide general interest, although purely negative in result, is that in the cave of Kilgreany, Co. Waterford. Some years ago members of the Bristol Spelæological Society claimed to have found there human remains of palæolithic age. The present investigation has not substantiated this, and evidence of palæolithic man in Ireland is still to be sought. Questions of major interest are also solved at Cush, near Kilfinane, Co. Limerick, where for the first time ring forts were found in a series of six, a souterrain was for the first time definitely dated so early as pre-Late Bronze Age, and the Irish town, previously not known before Viking times, was shown to have existed so far back as the Bronze Age.

Major-General A. W. Greely

The American explorer Major-General A. W. Greely, who has just reached the age of ninety-one years, is reported by *The Times* to have been awarded the Congressional Medal of Honour of the United States for heroism on his Arctic expedition of 1881–84. That expedition was the contribution of the United States to the International Polar Stations of 1882–83. Under Lieut. Greely's leadership, three officers and nineteen men were landed in Discovery Harbour in Grant Land (Ellesmere Island). The main objects were meteorological and magnetical observations, but Lieuts. Greely and Lockwood carried out extensive explorations in Grant and Grinnell Lands, and Lieut. Lockwood made the northern record to lat. 83° 24′ N. The relief ship was prevented by ice from reaching the camp in 1882 and again in 1883. Lieut. Greely then decided to retreat to the south with much depleted equipment and scanty stores. Near Cape Sabine in Smith Sound, they passed their third winter. Already scurvy had taken a heavy toll and the remaining men were scarcely able to hunt; fuel and food were practically exhausted when in June 1884 relief reached them in the *Thetis*. Only seven men were alive; not one could walk without assistance and at the time there seemed little likelihood of any living long enough to reach an American port. General Greely was awarded the Founder's Medal of the Royal Geographical Society in 1886 for the excellence of his Arctic work.

Henry Fuseli (1741–1825)

A renewed interest in the work of the Swiss artist Henry Fuseli (1741–1825) is being taken at present through an exhibition of some of his paintings and drawings at Ryder Street, London, S.W.1. Fuseli came to London at a time when Germany was anxious to establish channels of literary communication with England Among those whose acquaintance he cultivated was Johnson, the radical bookseller of St. Paul's churchyard, where Priestley usually stayed when he came from the provinces to the metropolis. Both Fuseli and Priestley were in holy orders, occupied occasionally with pamphleteering and possessing considerable linguistic abilities. In Thorpe's "History of Chemistry" is a portrait of Priestley delineated by Fuseli in which the discoverer of oxygen is depicted with more femininity of expression than is usually associated with such a free lance. Fuseli became one of the 'lions' of London society and an indispensable guest at many a fashionable dinner table. He was buried in St. Paul's Cathedral between the graves of Opie and Reynolds.

Professor of Astronomy at the Royal Institution

At the general monthly meeting of the members of the Royal Institution, held on April 1, it was resolved to establish a professorship of astronomy. Sir James Jeans was nominated, and in the event of his election at the ballot on May 7, will become the first professor of astronomy in the Institution. The last occasion when a new chair was created was the year 1863. This was for Dr. (afterwards Sir Edward) Frankland, who was elected to a separate professorship of chemistry while Faraday was still the Fullerian professor of chemistry. Frankland's professor-

ship lapsed, however, after Faraday's death. The other 'elected' professorship in the Institution at the time, that of natural philosophy, had been established ten years earlier, and was not so short-lived. It was created for Tyndall when he went to the Institution in 1853, and since his retirement in 1887 has continued by election and re-election down to the present day. Sir James Jeans has thus been nominated to the first new professorship to be established in the Royal Institution for some seventy years. It is also the first chair of astronomy in the history of the Institution.

Revision of Ordnance Survey Maps

DURING last autumn, the council of the Chartered Surveyors' Institution decided to press for an official inquiry into the present position of the maps and plans of the Ordnance Survey, and an article on the subject appeared in NATURE of November 3 (p. 677). In reply to a question by Sir Francis Fremantle in the House of Commons on April 1, Mr. Walter Elliot, Minister of Agriculture, said : "A substantial addition has been made to the Ordnance Survey Estimates for 1935, and this will enable a beginning to be made in the way of overtaking arrears. I propose, however, to refer to a Departmental Committee the whole question of the acceleration of the revision of Ordnance Survey maps and the preparation of plans for town and country planning. I hope shortly to be able to announce the composition of the committee and its terms of reference."

Model of the *Rocket*

A FULL-SIZE replica of the locomotive *Rocket*, as originally designed and constructed by Robert and George Stephenson, has now been acquired for the National Collections in the Science Museum, and will be unveiled by Mr. L. Hore-Belisha, Minister of Transport, at noon on April 11. The model has been made by Messrs. Robert Stephenson and Co., the firm which built the original engine, and represents it, as nearly as possible, in form, materials and workmanship, as it originally appeared. The original engine was built to compete at the Rainhill Trials in October 1829, which was perhaps the most important event in early locomotive history. The success of Stephenson and Booth's *Rocket*, which won the premium of £500 offered by the directors of the Liverpool and Manchester Railway for the most improved locomotive engine constructed in accordance with certain conditions, definitely proved the suitability of the locomotive as a means of general railway haulage, and showed that speeds hitherto unapproached could be attained. The engine was entered by George and Robert Stephenson and Henry Booth. Its success was mainly due to the adoption of the tubular boiler, which was suggested to George Stephenson by Booth. While George Stephenson is popularly credited with the design of the *Rocket*, its actual construction, at Newcastle, was carried out by his son Robert, the father's time being fully occupied with the making of the railway itself.

Co-operation between the Chemical Societies of Great Britain

THERE has recently been circulated to all members of the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry a draft agreement between the three Societies in regard to co-operation. The adoption of the agreement is unanimously recommended by the Council of the Society of Chemical Industry and the draft agreement was published in *Chemistry and Industry* on March 15. The agreement provides for the establishment of a fund to be administered by a Chemical Council consisting of three members nominated by the Council of each Society, together with three representatives of industry, co-opted in the first instance on the nomination of the Association of British Chemical Manufacturers. The objects of the fund are the allocation of grants to the constituent bodies for the co-ordination of scientific publications, promotion of research, maintenance of a library, etc. Complete freedom of action is reserved to each constituent body in respect of the matter it publishes. The management of the library of the Chemical Society is delegated to a joint library committee, and contributions to the net annual maintenance expenditure are to be borne by the constituent bodies in proportion to their membership, with due allowance for overlap. This involves, for example, an increase in the contribution of the Institute of Chemistry to £654 and from the Society of Chemical Industry to £448. The agreement is for seven years and thereafter to continue for successive periods of three years, subject to right of withdrawal on giving one year's notice at the end of any period. If the agreement succeeds, it is anticipated that means of reducing subscriptions to the three organisations will be found.

American Chemical Industry

THE American Chemical Society is holding in conjunction with its annual meeting in New York on April 22, what may prove to be the largest scientific assembly in history. The object is to expound and commemorate the development of the American chemical industry since its foundation three hundred years ago by John Winthrop Jr., son of the pilgrim Governor of the Massachusetts Colony. In 1633 he set up in Boston the first chemical laboratory and library in the United States, for which he imported apparatus, chemicals and chemical books, and two years later when he became the first colonial Governor of Connecticut, he mapped out a far-reaching programme of local industries including the production of salt, iron, potash, tar, black lead, saltpetre, medicines, copper, alum and other chemicals. Some of these chemicals were made for local use ; the chemicals of the forest were exported. It was at Winthrop's suggestion that Massachusetts passed a law in 1642 requiring every town to collect manures to make saltpetre. Chemical industry in the modern sense did not begin in the United States until 150 years later, when in 1792 the manufacture of sulphuric acid was commenced in Philadelphia by John Harrison.

SINCE that time, the American chemical industry has not ceased to expand. In 1913–14 it produced 34 per cent by value—and much more by weight—of the world's chemical output; in 1923–24 this percentage had risen to 47 per cent. At the Congress it will be shown how the infant industries have become the bulwark of national defence, the basis of modern industrial progress and the source of an ever-growing percentage of national wealth. The honorary chairman of the New York Committee is Mr. Francis P. Garvan; the presidents of the great chemical companies are co-operating with the Society. At the chief symposium the outstanding addresses will be by T. Midgley on "Chemical Developments in the next 100 years", and W. B. Bell on "National Planning and the Chemical Industries". In addition, Senator Harrison will discuss economic aspects of the chemical industries in general. Mr. Lammot du Pont will deal with chemistry's sociological results and Senator Wadsworth will consider its importance in national integrity. The Congress will be divided into eighteen divisions ranging from foods to petroleum.

Hydrogenation of Coal

A LECTURE by Dr. Pier before the Technische-literarische Gesellschaft, Berlin, on the hydrogenation of coal, possesses an unusual importance in view of present interest in this subject and also in German efforts at national self-sufficiency. In Germany the first technical success was achieved in the hydrogenation of brown coal and tars produced therefrom. For several years large quantities of petrol have been produced from brown coal at the Leuna works of the I. G. Farbenindustrie A.G. Since 1932, interest has been directed to corresponding treatment of bituminous coal in the Ludwigshafen works of the I.G. Since last year, a plant capable of a daily throughput of 20 tons of coal has been working there, and it is the successful performance of this unit which forms the subject of Dr. Pier's paper. Actually, a somewhat similar plant has been in operation at the Billingham works of Imperial Chemical Industries, Ltd. since 1930, and the large unit (500 tons daily) projected in 1933 will soon be brought into commission. The results of the German tests leave no doubts as to its success.

HYDROGENATION reactions may take several forms, for example, in liquid phase with coal or oil, and in vapour phase with more volatile liquids. At Billingham the petrol is already being made from creosote oils in vapour phase units. The patent rights in these processes are held by the International Hydrogenation Patent Co., and since 1931 experience and information in these processes have been pooled by the I.G., Imperial Chemical Industries, Standard Oil and Shell Oil Companies. Although the literature of coal hydrogenation on the experimental scale is large, information about the construction and performance of manufacturing units has not hitherto been disclosed, and this lends added importance to Dr. Pier's paper. As a result of international co-operation for scientific and industrial purposes, the work stands in marked contrast to corresponding efforts in the political fields.

Excavation of Norfolk 'Woodhenge'

ACCORDING to an announcement reported in *The Times* of March 29, preparations are being made by the Norfolk Research Committee, of which Mr. Russell J. Colman is president, to explore the site which, from its similarity to that on Salisbury Plain, has been called 'Woodhenge', at Arminghall, near Lakenham Baths, Norwich. The existence of this circle was first ascertained by observation from the air by the Royal Air Force, and certain preliminary examinations carried out soon after revealed the character of the site; but no systematic or extended excavation has as yet been attempted. The present operations will be under the supervision of Dr. Grahame Clark, of Peterhouse, Cambridge, and secretary of the Fenland Exploration Committee, and Mr. Rainbird Clark, honorary secretary of the Norfolk Research Committee. The work will begin in August next and, it is hoped, will be completed when the British Association meets at Norwich in the following month.

Jubilee of the Dublin Naturalists' Field Club

THE jubilee of the Dublin Naturalists' Field Club will be celebrated in Dublin on July 11–13 by a meeting of representative delegates from many of the natural history societies in Ireland and Great Britain, and probably from abroad. Formed fifty years ago with Prof. E. Perceval Wright as its first president, the man mostly responsible for the initiation of the Dublin Naturalists' Field Club was its vice-president, Dr. A. C. Haddon, the veteran anthropologist now at Cambridge. The formation of the Irish Field Club in 1894 brought the Society into closer touch with other natural history bodies in Ireland, while in 1892 it was largely responsible for forming the old *Irish Naturalist* as a monthly journal for the scientific recording of its and other societies' proceedings. Among the more notable workers of the Field Club in its history were G. H. Carpenter, the entomologist and mammalogist, for many years its president, as at the Galway Field Club conference of 1895; Dr. R. Lloyd Praeger, its secretary in late Victorian times, who wrote the flora section of the British Association Handbook for its Dublin meeting of 1908; and David McArdle, of Glasnevin, who wrote the section on mosses and lichens in the same handbook. Other prominent members of the Field Club in its early years were Prof. T. Johnson, its treasurer, Prof. E. J. M. M'Weeney of Dublin and Prof. G. F. Fitzgerald of Trinity College.

Twelfth International Congress of Zoology

IT is announced that the Twelfth International Congress of Zoology will be held at Lisbon on September 15–21 under the presidency of Prof. A. Ricardo Jorge, professor in the Faculty of Sciences in the University of Lisbon, and director of the Zoological and Anthropological Department of the National

Museum of Natural History (Museum Bocage). His Excellency the President of the Portuguese Republic has consented to become Patron of the Congress, and the Portuguese Government has invited foreign countries to be represented by official delegates. It has been provisionally arranged that the work of the Congress will be carried on in twelve sections, dealing respectively with (1) general zoology (including cytology and genetics), (2) embryology and the mechanics of development, (3) comparative anatomy, (4) physiology, (5) zoogeography and palæozoology (including ecology), (6) protozoology, (7) entomology, (8) invertebrates, (9) vertebrates, (10) parasitology, (11) applied zoology, (12) nomenclature. Some of these sections may be subdivided if the need arises. Among social events proposed are receptions by the President of the Republic, by other Ministers, by the Rector of the University, and by the municipality of Lisbon; and various excursions, including one to Madeira and the Azores to take place after the Congress, are contemplated. Special facilities as regards railway fares and hotel rates are being arranged for by the organising committee. Zoologists desiring to take part in the Congress are requested to communicate with the president, Prof. Arthur Ricardo Jorge, Director, Zoological and Anthropological Department, National Museum of Natural History, Lisbon, Portugal, from whom particulars can be obtained.

The Strangeways Laboratory

THE Strangeways Research Laboratory was founded by the late Dr. Strangeways in Cambridge twenty-one years ago. A recent report by the trustees and director takes the opportunity of recalling the history of its foundation and development during this period, in addition to giving the usual account of the past year's work. The building now used as the laboratory was originally equipped as a small hospital for the treatment and study of chronic arthritis, but Dr. Strangeways soon became convinced that a more complete and fundamental knowledge of the processes of normal growth was an essential condition for real progress in the investigation of this and other diseased conditions. The hospital therefore became a group of experimental laboratories devoted to the study of growth problems by the methods of artificial culture of tissues. Dr. Strangeways died in 1926: his principal collaborator, Dr. Honor Fell, has acted as director since 1928. Since 1931, the Royal Society has made itself responsible for the director's stipend, by a fellowship from its Messel Research Fund. The Medical Research Council has made grants providing for the support of certain members of the staff and for general expenses of the work. Grants have been made by the British Empire Cancer Campaign, by the Fitton Trust and by the Sir Halley Stewart Trust; and the laboratory has received voluntary subscriptions and donations, though both of these sources of income have varied widely from year to year. To enable the work of the laboratory to continue and to expand, an increase in the annual income is, however, required. During the past twenty-one years, 84 persons have worked in the laboratory and 81 papers have been published. The research work of the laboratory is devoted to fundamental problems of normal and abnormal growth and the effects of different forms of radiation upon living cells, problems of immense importance to the successful treatment of tumours in human beings by X-ray and radium.

A New Rotating Radio Beacon

A ROTATING loop type of radio beacon was developed in Great Britain several years ago, and two stations employing this arrangement are still in use in connexion with aerial and marine navigation. The advantage of the system is that wireless bearings may be obtained at any receiving station merely with the aid of a stop watch or chronometer. The use of such a chronometer is rendered unnecessary in a new type of rotating beacon, which is described in a paper by U. Okada, published in the report of Radio Research in Japan of October 1934, vol. 4, p. 185. In this new system, a vertical loop transmitting aerial is used as previously, to give the usual 'figure-of-eight' radiation characteristic. Instead of rotating this loop continuously, however, it is swung backwards and forwards about a vertical axis through an arc of 180°. During its movement the speed of rotation is uniform and equal to one revolution per minute. The movement in each direction starts from a north and south position alternately, at each of which a characteristic morse signal is emitted. This signal is then followed during the rotation of the loop by a succession of 90 dots, at the rate of 1 dot for every 2°. By counting the number of dots from the starting point to the signal minimum, the bearing of the receiver from the transmitter may be calculated. The additional observation taken with the loop moving in the reverse direction enables the midpoint of a broad minimum to be accurately determined. Tests carried out in Japan on land and at sea have shown that an accuracy of observation of $\pm 6°$ was obtained at distances up to 46 km. with an experimental beacon operating on a wave-length of 950 m. It is considered that by attention to details of the apparatus the maximum error could be reduced to 2°, which it is suggested is sufficient for most practical purposes.

The 100-in. Mirror Aluminised

ACCORDING to Science Service, of Washington, D.C., the 100-in. mirror of the great telescope at Mount Wilson Observatory, Pasadena, California, has been aluminised. It will be remembered that a new process has been developed within the past two or three years, by which coats of aluminium are placed upon glass mirrors by distillation *in vacuo* (NATURE, **134**, 522; 1934). The aluminium coat presents several advantages over the usual silver coat, chemically deposited. The aluminium coat is far more durable and resistant to tarnish, and possesses a superior reflectivity in the ultra-violet. Many small mirrors have been successfully coated with aluminium in Great Britain. It is expected that the new 200-in. mirror will also receive an aluminium coat. The

aluminium surface on the 100-in. mirror is said to be perfect except for the silhouette of a moth in one corner of the large surface.

Control of the Bed-Bug

At the request of the Ministry of Health, the Medical Research Council has undertaken to promote further investigations into the health problem caused by the infestation of houses by the bed-bug, and has appointed the following special committee to advise and assist in this work: Prof. J. C. G. Ledingham (chairman), Prof. P. A. Buxton, Mr. C. S. Elton, Mr. C. R. Kerwood, Dr. John Macmillan, Dr. G. W. Monier-Williams, Prof. J. W. Munro, Dr. P. G. Stock, Dr. R. E. Stradling, Mr. A. W. McKenny Hughes (secretary), British Museum (Natural History). On the recommendation of this Committee, grants have been made by the Council for research under the direction of Prof. Buxton into the natural history of the bed-bug with reference to the conditions of its viability, and for research under the direction of Prof. Munro into chemical methods for its destruction.

Announcements

The Rev. Canon Harold Anson, Master of the Temple, and Prof. F. R. Fraser, director of the Department of Medicine in the British Post Graduate Medical School, have been elected members of the Athenæum under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

At the annual general meeting of the Chemical Society held on March 28, the following officers were elected: *President*, Dr. N. V. Sidgwick; *Vice-Presidents, who have filled the office of President*, Prof. G. T. Morgan and Prof. J. F. Thorpe; *Ordinary Members of Council* (*Town*), Prof. J. W. Cook, Prof. G. I. Finch and Dr. J. J. Fox; (*Country*), Mr. W. A. S. Calder, Prof. T. P. Hilditch, Dr. F. G. Mann, and Prof. J. Read.

Mr. H. L. Brook arrived at Lympne on March 31, on his return flight from Australia in the Miles Falcon cabin aeroplane which he had entered for the Melbourne air race, 7 days 19 hours 50 min. after leaving Darwin. Thus he has set up a new record for a solo flight, being 1 day 2 hours 35 min. better than the record established by Mr. J. A. Mollison in 1931, and 13 hours 10 min. better than the unofficial solo 'record' set up by Mr. C. J. Melrose in 1934. The aeroplane was a low-wing monoplane with a Gipsy Major (130 horse-power) engine.

A conference to discuss current theories as to the cause of swarming of bees and the practical means of controlling it, is to be held on Saturday, April 27, at the Rothamsted Experimental Station, Harpenden, Herts. During the morning the laboratories of the Experimental Station will be open for inspection; it will also be possible to visit the apiary and to see the work which is being done by Dr. Tarr under the Foul Brood Research Scheme. Those wishing to attend should notify the Secretary of the Experimental Station not later than Wednesday, April 24.

The next congress of the International Vegetarian Union will be held in Zurich in the middle of July, when papers on eugenics and eubiotics will be read. Further information can be obtained from M. Henri Hotz, 7 Orenstrasse, Zurich.

The executive committee of the German Society of Men of Science and Physicians has decided to hold its ninety-fourth annual congress on May 24, 1936, as the meeting cannot be held this year. The president will be Prof. Sauerbruch, with Profs. Grote and Zaunich as local presidents.

A Congress of the history of Greek medicine will be held at Athens on May 8–11. It will consist of three sections dealing respectively with scientific work, hygienic organisation and professional matters. Further information can be obtained from the professor of the history of medicine, Prof. Dr. Kounis, Ecole de médecine, Athens.

During its eleventh year, the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation has made twenty-seven grants, fourteen of these being to scientific workers outside the United States. Further grants will be made during 1935–36. At present, work will be favoured which is directed towards the solution of problems in medicine and surgery. Application must be made before May 1. Further information can be obtained from Dr. Joseph C. Aub, Collis P. Huntington Memorial Hospital, 695 Huntington Avenue, Boston, Mass.

The Council of the Royal Statistical Society offers the Frances Wood Memorial Prize, value £30, for competition in 1935. The Prize is offered for the best investigation, on statistical lines, of any problem affecting the economic or social conditions of the people. Theses submitted or intended to be submitted as university exercises, and also published papers, are admissible. Essays, which must be either printed or typed, and accompanied by copies of all statistical tabulations, must be sent to the Honorary Secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2, not later than October 31, 1935.

Applications are invited for the following appointments, on or before the dates mentioned:—A civilian educational officer in the Royal Air Force Educational Service—The Secretary (A. E.), Air Ministry, Adastral House, Kingsway, London, W.C.2 (April 17). A principal lecturer and master of method in science at the Glasgow Training Centre—The Executive Officer, 140 Princes Street, Edinburgh, 2 (April 18). A principal of the Midland Agricultural College, Sutton Bonington, Loughborough—The chairman of the Governors, County Education Office, St. Mary's Gate, Derby (April 29). An engineer and surveyor of the City of Westminster—The Town Clerk, City Hall, Westminster (May 18).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 549.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Masses of some Light Atoms determined by a New Method

IT has long been realised that the only really certain method of comparing masses by observations on mass spectra is by resolving and measuring naturally occurring doublets which represent small residual differences between the atoms and molecules concerned. The recent discovery of deuterium has enabled this method to be applied generally to the lighter elements, and for some time past I have been constructing parts of a new mass-spectrograph designed for this work. One of these, a new collimator with variable slits, has been tested on the instrument now in use, with results of great interest.

The first test object used in the experiments was the easily formed doublet O,CH_4. Under the improved conditions, this was widely and perfectly resolved, and when measured corresponded to a difference of mass as stated below. This result was very disturbing, as the much lower original estimate 0·0350 had been confidently used as a check on the value for H. On examination, it seems now fairly clear that the underestimate was due to imperfect resolution.

The fineness of the lines warranted an attempt on the doublet D,H_2, expected to be about half the width. Pure deuterium was introduced and the discharge manipulated in the hope of getting that equal intensity of the lines so necessary in this work. In a number of cases this object was attained and Fig. 1 shows a photometer graph of one of the exceedingly fine doublets photographed.

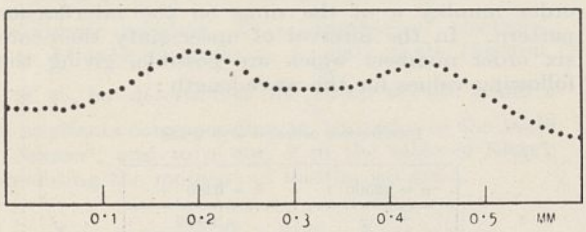

FIG. 1.

The apparent separation was estimated as below. The real separation will be probably higher, for the resolution is not yet perfect, but it seems impossible for it to be high enough to correspond to the difference 0·00187 expected from Bainbridge's determinations[1] of H and D each against the same atom He. It seems probable that the bulk of this discrepancy is to be ascribed to the ratio H,He, in which the lines were very unequal in intensity, rather than to that of D,He, in which the conditions were exceptionally favourable. To test that conclusion, I have made a provisional estimate of the wide doublet He,D_2, which within my experimental error agrees with that found by Bainbridge. That his and my estimates of the He,H ratio should have agreed so exactly seems to have been fortuitous.

The remaining link in the chain from H to O is the doublet $C{+}{+},D_3$. I have succeeded in photographing this, but only with lines of very different intensity and, like the He,D_2 doublet, it is too wide for really satisfactory treatment on my present apparatus. The results appear in the following table of doublets, giving the proportional differences in parts per 10,000 and the differences of mass on the atomic scale between the lighter and heavier components.

Doublet	Difference of Packing Fraction	Difference of Mass
D,H_2	7·1	0·00142
He,D_2	63·5	0·02550
$C{+}{+},D_3$	69·7	0·04195
O,CH_4	23·3	0·0374

I propose to measure all these doublets again with the proper refinements when my apparatus of higher dispersion is completed. In the meantime, the following values may be deduced for the masses relative to O^{16}.

$$\begin{aligned} H &= 1{\cdot}0081 \\ D &= 2{\cdot}0148 \\ He &= 4{\cdot}0041 \\ C &= 12{\cdot}0048 \end{aligned}$$

These must be regarded as provisional, and in no case is an accuracy greater than 1 in 10,000 claimed. They are considerably higher than my earlier ones and in better accord with the much more delicate but less direct calculations made from the energy relations in the equations of artificial disintegrations. At the meeting of the Royal Society on March 14 attention was directed by Dr. M. L. Oliphant to the discrepancies on the mass scale revealed by experiments of this kind and a provisional scale of values suggested.

I should like to give a word of warning to those using atomic masses determined by mass spectra. These figures may depend on a chain of relationships, and it is often found that the errors here have markedly cumulative effects. It will be well always to examine the complete data from which a single result has been derived. The results described in this letter are a good example of the dangers in this work. In conclusion, I may say that I am never likely to regret my underestimate of the mass of H made nine years ago, however serious it may ultimately turn out to be, since it played so fundamental a part in encouraging the search for deuterium.

F. W. ASTON.

Cavendish Laboratory,
Cambridge.
March 26.

[1] *Phys. Rev.*, **43**, 103; 1933. **44**, 57; 1933.

New Ion Sources for Mass Spectroscopy

FOR use in connexion with a new mass-spectrograph, I have recently developed a new type of ion source in which positively charged atoms are formed by sparks between solid electrodes in a high vacuum. Spectroscopic studies in recent years have shown that these vacuum sparks are efficient sources of multiply charged ions. Several forms of sparks were tried; the '*trembleur à vide*', the 'hot-sparks' from a large condenser discharge, and finally a spark coupled inductively to a high-frequency oscillating spark circuit. This latter has proved very successful, and an abundance of ions has been obtained, thus far from the following elements: platinum, gold, tungsten, tin, copper, nickel, iron, aluminium, carbon, beryllium and lithium.

The ions were analysed provisionally by the Thomson parabola method after being accelerated by about 20,000 volts. The presence of multiply charged ions is in most cases very striking; spots occur with fractional electrostatic deflections, indicating ions that changed their charge before reaching the electric and magnetic fields. With platinum, for example, ions with all charges up to five occur, and with gold all charges up to four. It is of interest that ions of gold and platinum, which have not been found with other methods, are very easily obtained with these sparks.

A. J. DEMPSTER.

Ryerson Laboratory,
University of Chicago.
March 4.

Interferometer Measurements of the Red Auroral Line 6300

WE know that considerable interest is attached to certain auroral lines in the region 6300–6400 A. Thus the enhancement of one or more of these lines is responsible for a particular type of red-coloured auroræ[1,3] and, according to the interpretation of the strong green line by McLennan and his collaborators, the OI-triplet ($^1D_2 - {}^3P_{0,1,2}$) should appear in this region.

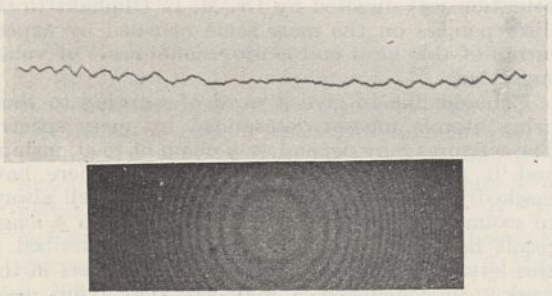

FIG. 1. Interferometer photograph of the red line 6300 and corresponding photometer curve above.

Previous auroral spectrograms taken with instruments of fairly high dispersion have shown two lines, which within the limit of error coincide with the two strongest components of the OI-triplet[3,5]; and a faint line has been observed which might be identified with the weakest line of the OI-triplet.

The mean of our present measurements gives $\lambda = 6300{\cdot}9$ ($\pm$ 1) for the strongest line ($^1D_2 - {}^3P_2$) and $\lambda = 6365{\cdot}3$ ($\pm$ 2) for the weaker one, which might correspond to ($^1D_2 - {}^3P_1$)[3,5]. Spectrograms in the red[4,5] indicate that bands belonging to the first positive group appear in the region of the OI-triplet.

Some years ago investigations were commenced at the Tromsö Observatory with the object of using interferometer methods for accurate wave-length determinations within the auroral spectrum. Our results relating to the strong green line were dealt with in a recent publication[6], and we are here going to give a preliminary, brief account of some results which refer to the strongest red line 6300.

Just as in the case of the green line we take advantage of the predominance of this red line, so we can use an interferometer without spectrograph, simply consisting of a Fabry-Pérot quartz plate in front of a camera lens combined with suitable filters and photographic plates. Under these conditions only atomic lines and not the fairly strong bands of the first positive group of N_2 can give interference fringes.

During an auroral display (January 15, 1934) an interferometer picture of the strong red line was obtained at the Tromsö Observatory with a 2·5 mm. étalon. The microphotometer curve reproduced in Fig. 1 corresponding to a line through the centre shows that the fringe-system is weak, but sufficiently distinct to be measured.

On the same plate were taken two interference pictures of the neon line (λ_{vac} = 5854·110 A.) in the way and for the purpose described in our previous paper[6]. Comparing the diameters of the rings of the interference picture produced by the aurora with those produced by the Ne-line 5854·110, we may decide that the interference pattern produced by the auroræ must be due to a fairly sharp atomic line situated near 6300 A., and only the strongest red line 6300·9 A. measured on our spectrograms can come into consideration.

The possible error of our spectrographic measurements of the red line, being about $\pm$ 1 A., interference pictures with one (2·5 mm.) étalon does not permit us to make an unambiguous determination of the order number n of the rings on the interference pattern. In the interval of uncertainty there are six order numbers which are possible, giving the following values for the wave-length:

Interference order = n + 0·536

n = 12500 +	λ = 6300· +
− 2	+ 1·859
− 1	+ 1·347
0	+ 0·835
1	+ 0·322
+ 2	− 0·190
+ 3	− 0·702

One of our values, $\lambda = 6300{\cdot}322$, is nearly equal to that (6300·328) derived from the electronic OI states given by Hopfield[7]. From direct measurements of the red line with a glass spectrograph (dispersion 29 A./mm.) Hopfield finds the wave-length 6300·23. As the determination of the electronic levels is based on spectra taken with a dispersion of 1·7 A./mm., the wave-length derived from these levels should be most accurate, and this wave-length is, within the limit of error, equal to one of our values for the wave-length of the red auroral line.

In order to fix exactly the true wave-length, we intend to take more interference pictures with étalons of different thickness. Further, by continued observations, we hope to diminish the possible error of our spectrographic measurements.

L. HARANG.

Auroral Observatory, Tromsö.

L. VEGARD.

Physical Institute, Oslo.

[1] L. Vegard, NATURE, **117**, 356; 1926.
[2] L. Vegard, *Geophys. Publ.*, **9**, No. 11; 1932.
[3] L. Vegard, *Z. Phys.*, **75**, 30; 1932.
[4] L. Vegard, *Geophys. Publ.*, **10**, No. 4; 1933.
[5] L. Vegard and L. Harang, *Geophys. Publ.*, **10**, No. 5; 1933.
[6] L. Vegard and L. Harang, *Geophys. Publ.*, **11**, No. 1; 1934.
[7] J. J. Hopfield, *Phys. Rev.*, **37**, 160; 1931.

Isotope Effect in Band Spectra of Hydrides and Deutrides

THE comparison between the band spectra of hydrides and deutrides has shown, as is well known, that the ratio ρ^2 of the reduced masses, for example

$$\rho^2 = \frac{\mu_{AgH}}{\mu_{AgD}}$$

(where $\mu_{AgH} = Mm_H/(M + m_H)$, $\mu_{AgD} = Mm_D/(M + m_D)$, m_H = mass of the proton, m_D = that of the deuton), calculated in this way, does not agree with the ratio ρ^2 as deduced from the atomic weights. As a possible explanation, E. Hulthén and W. Holst[1] have suggested that the electronic system takes part in the rotation and vibration of the molecule and gives a contribution to the effective moment of inertia.

A theoretical discussion may perhaps be interesting. If the hydride (deutride) contains an atom with high atomic number, we can assume the distribution of electrons to be spherically symmetrical and start from the distribution of the corresponding negative ion. A suitable expression for the electronic density is that given by H. Jensen[2]:

$$D = \frac{N}{4\pi P_0 . r_0^3} \cdot \frac{c - X}{X^3}(1 + cX)^3; \quad X = \sqrt{\frac{r}{r_0}}, \quad r_0 = \frac{a_H}{Z^{\frac{1}{3}} . \lambda},$$

Z = atomic number, N = number of electrons, $a_H = h^2/4\pi^2 m_e e^2$, where m_e = mass of the electron. P_0 is to be determined by $\int_0^\infty D 4\pi r^2 dr = N$, λ and c are constants corresponding to $1/\lambda$ and c in the table of Jensen[2], and to μ and k in the table of Nagy[3]. Calculating the moment of inertia, we get:

$$I_e = m_e a_H^2 \times Z^{\frac{1}{3}} \times 7{\cdot}96 \times f\left(\frac{N-Z}{Z}\right)$$

where $f\left(\frac{N-Z}{Z}\right)$, depending on λ and c, is a function of $\left(\frac{N-Z}{Z}\right)$ only. If $\left|\frac{N-Z}{Z}\right| < \frac{1}{10}$, which is certain in our case, we can write:

$$f\left(\frac{N-Z}{Z}\right) = 1 + 3{\cdot}84\left(\frac{N-Z}{Z}\right) + 9{\cdot}4\left(\frac{N-Z}{Z}\right)^2.$$

An opportunity for comparison with experimental results is given by the careful investigations[4] of E. Hulthén and E. Knave on silver hydride and silver deutride. In this case the total angular momentum of the electrons is 0, and the corrections of Kronig and Van Vleck, being proportional to its square, also equal 0. So we obtain a lower and an upper limit for the ratio ρ^2, taken from the rotational structure of the band spectra AgH and AgD, ρ^2 min. $= \frac{\mu_{AgH}}{\mu_{AgD}} = 0{\cdot}50497$, and ρ^2 max. $= \frac{\mu_{AgH} + I_e/a^2}{\mu_{AgD} + I_e/a^2} = 0{\cdot}50545$ (a = nuclear distance). ρ^2 max. is obtained if all the electrons take part in the rotation.

E. Hulthén and Knave have found $\rho^2 = 0{\cdot}50527$ from the B-values. Thus the correction is 60 per cent of the theoretical maximum. Using the electronic density D mentioned above, the calculation shows that this correction will be obtained, provided the four outermost electrons take part in the rotation. This is the same as saying that the electrons outside a sphere with radius $1{\cdot}7\ a_H$ are constrained by the hydrogen nucleus to take part in the rotation.

We may verify the reliability of the expression D for the electronic density by calculating the nuclear distance of AgH to the first approximation. Starting from the charge distribution D of the negative silver ion, we determine the distance from the Ag nucleus at which a positive particle can be in equilibrium. The result, $2{\cdot}78\ a_H$, is in good agreement with the experimental value[5] $3{\cdot}05\ a_H$ and indicates that the moment of inertia will be somewhat greater than our I_e, if the effect of the hydrogen nucleus on the electronic distribution is taken into account.

I am obliged to Prof. E. Hulthén, who directed my attention to this question, and to Prof. O. Klein, for interesting discussions on the subject.

LAMEK HULTHÉN.

Institutet för mekanik
och matematisk fysik,
Stockholms Högskola.
Feb. 12.

[1] Holst and Hulthén, NATURE, **133**, 496, 796; 1934. *Z. Phys.*, **90**, 712; 1934.
[2] Jensen, *Z. Phys.*, **77**, 722; 1932.
[3] Nagy, *ibid.*, **91**, 105; 1934.
[4] E. Hulthén and E. Knave, *Physica*, in press. I am indebted to the authors for being informed of the results before publication.
[5] E. Knave, "Dissertation", Stockholm, 1932.

Internal Recombination during Photo-dissociation of Polyatomic Molecules

IT has been generally admitted that, in the primary decomposition of a molecule by absorption of light, free atoms or unsaturated radicals are produced. In an extensive investigation upon the photo-decomposition of carbonyl compounds, Dr. R. G. W. Norrish and his co-workers[1] have advanced the view that an aldehyde molecule can be disrupted into a saturated hydrocarbon and a carbon monoxide molecule in one process. This is equivalent to a recombination of the liberated hydrogen atom and alkyl radical at the moment they leave the remainder of the molecule.

The possibility of such a process can be tested directly if the magnitude of the absorbed quantum is large enough to produce excited atoms, or radicals which will recombine to form an *excited* molecule emitting its characteristic spectrum. By observing this emission under conditions which prevent the possibility of secondary processes, that is, at very low gas pressures, we should get definite proof of the existence of such an internal recombination.

An investigation in this direction has been undertaken in this laboratory. Polyatomic molecules containing halogen atoms instead of alkyl radicals,

or hydrogen atoms, are better suited for the purpose because the excited halogen molecule liberated during the photo-dissociation process can be easily detected by its emission spectrum, which lies in the visible region. We tried several molecules of the composition $XHal_4$, and $XHal_3$, where X is C or Sn and Hal is a halogen. After some unsuccessful attempts, we obtained in SnI_4 vapour under the action of wave-lengths in the range 2500–2150 A. a bright visible emission of the spectrum of I_2 with an abnormal distribution of intensity in the bands. A detailed investigation confirmed the conclusion which immediately followed from this fact, namely, that the iodine molecule was detached from the SnI_4 molecule in one primary process. As the iodine atoms were originally bound to the central Sn atom by valency forces and did not markedly interact one with another, the whole process is equivalent to a recombination of atoms in the very act of photo-dissociation, or to a redistribution of valency bonds. The energy balance, the influence of collisions with other molecules and other features of the emission so far studied lead to interesting conclusions about the mechanism of the disruption. The most important peculiarity is a marked temperature coefficient which indicates the necessity for an energy of activation for this type of photo-dissociation.

In this connexion we have re-investigated the yellow fluorescence in BiI_3 vapour, observed in this laboratory some years ago[2]. Although the spectrum of this fluorescence on closer examination did not reveal any band structure, nevertheless the exact coincidence of its position with that of the iodine spectrum cannot be fortuitous. We assume therefore that the mechanism of this emission is the same as that given above; namely, that under the action of suitable quanta and with some thermal activation, an iodine molecule is detached from BiI_3. The continuous or blurred aspect presented by the spectrum emitted in this case may be due to the disturbing influence of the polar BiI radical remaining in close proximity to the iodine molecule which is emitting radiation.

A. TERENIN.

Photochemical Laboratory,
Optical Institute,
Leningrad 53.
Jan. 26.

[1] *Trans. Faraday Soc.*, **30**, 108; 1934.
[2] Neujiin, *Phys. Z. Sov. Un.*, **2**, 422; 1932.

Spectroscopic Constants of the Di-Atom PN

IN a recent paper[1], I ventured to predict that (*a*) "the internuclear distance of PN may be taken as closely approximating to the mean of the experimental values for NN and PP" (p. 28), and that (*b*) "it may be expected that experiment may show that PN has the highest bond constant and mean restoring force in the LK and KL periods" (p. 36).

At the time the paper was written, I was unaware of the experimental work on PN of Curry, Herzberg and Herzberg[2], but the results appear to justify both the above statements.

(*a*) r_e (calc.)[3] $= 1{\cdot}48_7$; r_e (obs.) $= 1{\cdot}4869$ A.

(*b*) ω_e (expt.) $= 1337{\cdot}24$ cm.$^{-1}$, whence the bond constant $k_0 = 101{\cdot}0 \times 10^4$ dyne cm.$^{-1}$ and mean restoring force $K = 3{\cdot}642 \times 10^{-4}$ dyne are derived. These are without doubt maximum values for the LK and KL periods.

The experimental data are consistent with the observed flattening of the periodicity curves with increasing period numbers. The presence of maxima and minima of spectroscopic constants in the symmetrical sub-group of the tenth molecular group is not without interest in connexion with problems of polarity and bonding strength of di-atoms.

C. H. DOUGLAS CLARK.

Department of Inorganic Chemistry,
University, Leeds.
Feb. 11.

[1] C. H. Douglas Clark, *Proc. Leeds Phil. Soc.*, **3**, 26; 1935.
[2] J. Curry, L. Herzberg and G. Herzberg, *Z. Phys.*, **86**, 348; 1933.
[3] W. Jevons, "Report on Band Spectra of Diatomic Molecules" (Camb. Univ. Press, 1932).

A Mycetozoan Parasite of *Zostera marina**

IN a previous note in NATURE[1] we pointed out the association of a *Labyrinthula*-like organism with the wasting disease of the eelgrass along the American Atlantic coast. Since the publication of this announcement, we have performed a number of experiments in the laboratory and in the natural beds themselves, which indicate that this organism is a true parasite of *Zostera marina*. Communications from other investigators and examinations of specimens submitted from various points show also that this parasite is uniformly present in the infected beds on the Atlantic coasts of both Europe and America.

The parasitic habit was first demonstrated in modifications of Cienkowski's moist chambers[2]. In these the actual migration of the spindle-shaped cells from fragments of diseased leaf and the invasion of healthy leaf tissue could be clearly followed. Consistent infection occurred in thirty slides, usually within eight to forty-eight hours. In only one case did a filamentous fungus make its appearance—a contaminated check preparation.

Field experiments were conducted in several beds near Woods Hole, Massachusetts. Slips of diseased and normal leaf were fastened in alternate order to healthy green leaves. Local darkening and characteristic streaking of the 'inoculated' leaves to form the pattern anticipated by this arrangement followed within one or two days. The experiment was repeated four times during the later part of the summer and corresponding tests were made in aquaria with the same results. Sections prepared from the newly infected areas showed heavy infestations of viable *Labyrinthulæ*. Such sections attached to clean plants brought about infection of the new host.

We were unable to grow the organism on artificial media or to maintain it long without its host in filtered sea water; but from microscopic observations and from field experiments it is evident that the *Labyrinthula* is capable of attacking and destroying healthy leaf tissue independently of other organisms. The rapidity with which it produces infection indicates its extremely aggressive habit. Thus far it has not been identified with any of the described *Labyrinthulæ*.

It seems well established that the *Ophiobolus* isolated from diseased eel-grass by Dr. Petersen[3], Miss Mounce[4] and by Dr. Tutin[5] varies in abundance and activity over the affected areas. The mycelium of the fungus occurs in the Woods Hole region, but in extremely minor quantities—it is far from universally associated with the disease. We have not

* Contribution No. 67, Woods Hole Oceanographic Institution and Journal Series Paper of the N.J. Agr. Exp. Station.

been able to find the pycnidia of this form upon any of the specimens from the coast of Maine, south, though they are very abundant upon the fruiting stems of plants sent us by Miss Mounce from St. Andrews, and have been described by Dr. Petersen as very profuse in the Danish beds.

We could not discover the *Labyrinthula* in the longer, wider-leaf *Zostera marina, L.*, from Nanaimo, Departure Bay, B.C., on the Pacific coast, though this grass was spotted and infested with a variety of other parasites. Despite their activities, the grass at Nanaimo was unusually abundant last year.

CHARLES E. RENN.

Woods Hole Oceanographic Institution,
Woods Hole, Massachusetts,
and
Department of Soil Microbiology,
N.J. Agricultural Experiment Station,
New Brunswick, N.J.

[1] Renn, C. E., NATURE, **134**, 416; 1934.
[2] Cienkowski, L., *Arch. Microscop. Anat.*, **3**, 274; 1867.
[3] Petersen, H. E., NATURE, **134**, 143; 1934.
[4] Mounce, Report of Biological Board of Canada, 1933; Ottawa, 1934.
[5] Tutin, T. G., NATURE, **134**, 573; 1934.

Wasting Disease of *Zostera marina*

THE variation in the width of the leaf of *Zostera marina* cannot be put down to any one particular cause. In common with all water plants, the size of the leaf is probably a reflexion of the nutritional balance in the plant itself, as is shown to be the case by Pearsall and Hanby[1] for certain *Potamogeton* species.

Many of the circumstances enumerated by Dr. Cottam[2], such as reduced salinity, abnormal temperatures, short period of submergence, low light intensity, etc., by altering the nutritional balance, doubtless react to produce narrow-leaved plants.

That the production of the narrow-leaved plant is not a simple reaction is suggested by the fact that, in some places on the English coast, plants with leaves of all sizes grow mixed up together, while at other places, only *Zostera marina* var. *angustifolia* can be found, though the large-leaved type was abundant in 1921. Nor is the size of leaf a matter of age alone, for these narrow-leaved forms flower just as profusely as the broad-leaved plants.

All this goes to suggest that, in the disappearance of *Zostera*, one has to deal with a large number of circumstances and not with a single catastrophic event.

R. W. BUTCHER.

Fisheries Research Station,
Alresford, Hants.
March 6.

[1] Pearsall and Hanby, *New Phytologist*, **24**; 1925.
[2] NATURE, **135**, 306; 1935.

Fibre Saturation Point of Wood

THE fibre saturation point of wood (f.s.p.), which is the minimum moisture content in equilibrium with a saturated atmosphere, is commonly estimated indirectly from the point at which (*a*) shrinkage begins, or (*b*) a sudden increase occurs in the compressive strength[1,2], on lowering the moisture content from the green state. Though these methods agree fairly well in defining the f.s.p. of Sitka spruce as about 25 per cent moisture content[3] (based on the dry weight of the wood), it is found that many timbers show measurable shrinkage at much higher moisture contents than those indicated by method (*b*).

Other research[4] at this Laboratory, which required the vapour pressure isothermal of Sitka spruce flour above 95 per cent relative humidity, showed that, on adsorption, moisture contents of about 35–40 per cent were attained before saturation was reached, which considerably exceeds the figure quoted above.

Desorption, on the other hand, showed a measurable drop of about 0·4 per cent in relative humidity on a slight drying from moisture contents as high as 90 per cent, the effect probably persisting up to even higher values. Others[5] have noticed that the loop does not close at the adsorption saturation value, but have not investigated higher moisture contents. Thus there is no well-defined f.s.p., and there may well be a large moisture content hysteresis at the saturation value itself, which suggests that the shrinkages observed at high moisture contents are associated with the drop in vapour pressure found on the desorption curve.

The discrepancy between the f.s.p. obtained from method (*b*) and that from the adsorption isothermal may be accounted for by the compression which, opposing the swelling presure of the wood, raises its vapour pressure[6], thus bringing to saturation a sample of 25 per cent moisture content that was initially unsaturated. In support of this view, samples of Sitka spruce of higher strength in compression are found to show a lower apparent fibre saturation point[2].

Plotting the observed shrinkage against swelling pressure calculated from the desorption curve shows a decreasing strain stress ratio on drying, corresponding to the decrease of compressibility of wood which is already well known below 25 per cent moisture content.

WILFRED W. BARKAS.

Forest Products Research Laboratory,
Princes Risborough.

[1] Chaplin, New Intl. Assn. of Testing Materials, 1931, Zurich.
[2] Wilson, U.S. Dept. of Agr. *Bulletin* No. 282, March 1932.
[3] Unpublished data by F.P.R.L. on Sitka Spruce.
[4] Barkas, NATURE, **130**, 699; 1932.
[5] Urquhart and Williams, *Shirley Inst. Mem.*, **3**, 197; 1924.
[6] Katz, *Koll. Chem. Beih*, **9**, 1; 1917.

The Smell Emitted by Seaweeds

THE offensive odour given off from masses of rotting seaweed which occasionally accumulate on the shore is a not unfamiliar phenomenon of the seaside. There can be little doubt that an important constituent of the smell is sulphuretted hydrogen produced perhaps in part by the putrefactive reduction of the ethereal sulphates which form so marked a feature of many marine algæ.

Belonging to a somewhat different category is the particularly unpleasant smell reminiscent of phosphorus given off on drying certain members of the genus *Polysiphonia*. I have recently been able to identify methyl sulphide as the odoriferous principle in this case. The origin of this substance is less easy to account for and investigations directed towards the elucidation of this question are in progress. Preliminary experiments would suggest that methyl sulphide is a product of modified vital activity rather

than a post-mortem decomposition product, in as much as it begins to be evolved very shortly after the seaweed has been gathered and is not apparently given off by material which has been dipped in boiling water.

The natural occurrences of methyl sulphide are not numerous, and it is worthy of note that one of these is petroleum from Ohio ; the finding here recorded is therefore at least not inconsistent with the theory of the algal origin which has been suggested for some oil-fields.

PAUL HAAS.

Botanical Department,
University College,
London.
March 18.

Germination of Resting Fungal Spores

I HAVE read with interest Mr. Robert McKay's letter[1] on the germination of oospores of *Peronospora Schleideni*. He notes the remarkably persistent oogonial wall, which "forms an additional protective layer" around the oospore, and the still more persistent oospore wall. In germinating these highly resistant spores he lays claim to no special method : in course of time, in this case of years, the spores germinate when placed in water.

During the last ten years, I have spent a considerable amount of time in an attempt to devise a reliable method of obtaining the germination of the similar, though not quite so resistant, oospores of *Phytophthora Cactorum*, in sufficient numbers for cytological study. After trying many and varied 'agents', I finally obtained germination in quantity by exposing three-months old oospores to a temperature of 1°–3° C. for a month and then soaking them for one or two weeks in water, kept constantly renewed. It appeared later that the spores could be older, and the refrigeration period longer, and still give an equally good result[2].

When comparing my experiments with those of other workers upon the germination of resistant spores, I felt that we had no logical method of approach to the problem. It was by trial and error that results were finally obtained : in some cases one method, in others another, chanced to be effective. At the risk of appearing to state the obvious, I would direct attention to the following facts that suggest a line of attack in such experiments.

(1) That the wall of these resistant spores is, as a rule, at least two-layered : the inner thick and of a reserve substance such as a hemicellulose ; the outer thin and of 'fungus cellulose', and practically impermeable.

(2) That the substances composing both wall layers are in a colloidal state.

(3) That germination cannot take place until (*a*) the spore has fully matured—a process, not at all understood, which involves a time factor ; (*b*) the wall is rendered sufficiently permeable to admit water and oxygen.

(4) That the various devices tried and claimed as agents initiating germination (namely heat, cold, acids, carbon dioxide, bacteria, etc.) appear to do one of two things, provided they are of a suitable intensity or concentration : (*a*) form small cracks in the wall, (*b*) bring about a change of colloidal state. (Agents such as bacteria may be effective through carbonic acid produced.)

(5) That since the spore, though dormant, is a living thing with carbon dioxide accumulating within it, the change in the nature of the wall will in course of time come from inside, that is, time is a factor in germination as well as in maturation.

ELIZABETH BLACKWELL.

Royal Holloway College,
(University of London),
Englefield Green,
Surrey.

[1] NATURE, **135**, 306, Feb. 23, 1935.
[2] *Trans. Brit. Myc. Soc.*, **15**, 294–310 ; 1931 ; and **19**, 157 ; 1935.

Extrusion of Cells in the Tubules of the Epididymis

MR. P. G. 'ESPINASSE has remarked[1] that the extrusion of nuclei which has been observed to occur from the epithelium of the oviduct in the mouse could not be closely related, as had been suggested, to the œstrous cycle. His conclusion on this point seems to derive indirect support from a comparable phenomenon which takes place in the epididymis of the mouse and rat. In those tubules of the epididymis which are lined with a single layer of columnar cells the nuclei of which are close to the basement membrane, a process of cellular extrusion is particularly well seen, though it occurs also in other tubules where the epithelium is cuboidal.

Microscopic sections suggest that the actual process could be reconstructed as follows : Here and there a nucleus becomes separated from the uniform row of its fellows and advances towards the lumen of the tubule. As it approaches the free surface, it may be preceded by a bulging of the cytoplasm into the lumen. Eventually the nucleus, sometimes surrounded by cytoplasm, becomes detached and lies free in the cavity of the tubule. This extruded body often appears to be a living cell, showing no pyknosis or other obvious signs of degeneration.

Whatever significance may be attached to the phenomenon, it appears to be of frequent occurrence in the healthy epididymis of the adult mouse and rat, and cannot readily be attributed to any periodical cycle connected with the sexual function.

HAROLD BURROWS.

Research Institute,
The Cancer Hospital (Free),
London.
Feb. 28.

[1] NATURE, **134**, 738 ; 1934.

Hydrogen Ion Concentration of the Alimentary Canal in Psychodidæ (Diptera)

INSECT physiology, and particularly the physiology of digestion, is more or less intimately correlated with the life-history and other environmental factors. An attempt has therefore been made to find out the correlation, if any, between the hydrogen ion concentration of the alimentary canal and the different feeding habits in the family Psychodidæ, which contains two sub-families, namely, Phlebotominæ and Psychodinæ. The former is easily separable from the latter by its blood-sucking habit.

The entire alimentary canal of four common species belonging to two different genera was dissected in a minimum quantity of bromthymol blue and carefully laid out on a slide. The subsequent reaction

was enhanced by puncturing a few holes in the thicker region of the alimentary canal. The changes in colour of the gut in all the four species were carefully noted and their approximate *p*H value determined by comparison with a Hellige standard colour disc for bromthymol blue. The ranges of variation of *p*H in each species are those of different regions of the gut and to some extent include the individual variations.

The accompanying table shows that the degree of variation in the *p*H of the alimentary canal is small, yet it is suggestive enough to indicate that the alimentary canal of the blood suckers is slightly more acidic than that of those which do not suck blood. The relation of the acidity of the gut with the development of flagellates inside it is being investigated and will be published elsewhere.

	*p*H value
Phlebotomus papatasii, Scop., (Mammalian blood sucker and *Leishmania tropica* carrier)	6·2–6·4 Stomach—Little or no reaction
Phlebotomus argentipes, Ann. and Brun., (Mammalian blood sucker and *Leishmania donovani* carrier)	6·2–6·4
Phlebotomus minutus (sensu lato), Rond.	6·4–6·6
Psychoda alternata, Say *sexpunctata*, Curt. (Non blood sucker)	6·6–6·8

Kala-azar Enquiry,
All India Institute of Hygiene
and Public Health,
Calcutta.
Jan. 24.

S. MUKERJI.

Simultaneous Travel of a Surge of Stress and a Group of High-Frequency Waves of Stress in a Steel Wire

THAT a high frequency longitudinal vibration will travel more slowly than a low frequency one may be qualitatively foretold from Rayleigh's[1] treatment of the effect of lateral inertia on the natural period of longitudinal vibration of cylindrical rods. However, when Rayleigh's formula is applied to the case given by Dr. Wall[2], where the wave-length is stated to be 18 inches and the diameter 0·123 in., the effect of lateral inertia is found to be negligible.

Rayleigh's formula has been experimentally investigated by R. W. Boyle and myself[3] and by Muzzey[4], and found to be applicable over a range of the ratio of wave-length to diameter including this case. It is suggested that the necessity of postulating a hitherto unknown effect may be avoided by assuming that the group of waves has a higher frequency than that given by Dr. Wall, determined possibly by the natural period of a clamp, this high frequency being 'modulated' at the inter-clamp frequency by successive reflections, and 'demodulated' in the amplifier, which the oscillograms show to have the necessary characteristics.

Dr. Wall's oscillograms show that the ratio of the two velocities is about 1 : 1·3 and Poisson's ratio for iron may be taken as 0·3 (Kaye and Laby). These values inserted in Rayleigh's formula give a ratio of diameter to wave-length of 1·2. The results of Boyle and myself show that Rayleigh's formula is *not* applicable when this ratio exceeds 0·55, probably due to the neglect of shear stresses, the approach to resonance of radial vibration, and viscosity. Field[5] has given an analysis which includes these factors, and whether or not this analysis can be applied to explain the interesting results given by Dr. Wall, it is clear that Dr. Wall's method of measuring the velocity of longitudinal vibrations may be adapted to an experimental investigation of the factors included in Field's analysis.

D. O. SPROULE.

3 Gower Street,
London, W.C.1.

[1] "Theory of Sound", vol. 1, p. 251.
[2] NATURE, **135**, 151; 1935.
[3] *Canad. J. Research*, **5**, 601; 1931.
[4] *Phys. Rev.*, **33**, 935; 1930.
[5] *Canad. J. Research*, **11**, 254; 1934.

Science and Social Progress

MAY I suggest that the decline of the adventurous spirit is due not so much to standardisation and mechanisation, as might be gathered from the leading article in NATURE of February 16, p. 245, as to specialisation ? A specialist, as I have said elsewhere, is "a human being who has narrowed the sphere of his activity at the expense of his social instincts, thereby becoming but a fraction of a man. He sees a field of activity as brightly lit, perhaps, but as limited as the field of a microscope ; and not infrequently it is as though the microscope was a little out of focus. There is a blurring as of things too close to the eyes to be distinctly seen."

I am under no illusion that specialisation can be dispensed with altogether, but I am heterodox enough to believe that we should be more truly civilised if there were more jacks of all trades and fewer masters of one. How can any man who has only read, let us say, Chapter xx of the 'book of life' hope to acquire that comprehensive vision of the human adventure in time and space, so essential to ensure sane social development ?

Since mechanisation has been mentioned, I should like to take this opportunity to combat the belief, now being revived in various quarters, that machinery, after all, does not cause unemployment. It will be seen that the subject is not irrelevant. This particular fallacy was exposed 116 years ago by Jean Sismondi as follows : "Every new product must in the long run give rise to some fresh consumption. But let us desist from our habit of making abstraction of time and place. Let us take some account of the obstacles and the friction of the social mechanism. And what do we see ? The immediate effect of machinery is to throw some of the workers out of employment. . . . A certain kind of equilibrium, it is true, is re-established in the long run, but it is only after a frightful amount of suffering."

In short, it is little consolation to a man thrown out of employment now, to know that 'in the long run' and 'on the average' scientific and technological development creates new opportunities. In the long run (as I think Mr. Keynes once remarked) we are all dead. Adjustment of the individual to mechanical progress, with less of both short run and long run unemployment, would be easier if men were less specialised, better equipped for turning readily from one type of employment to another.

HUGH P. VOWLES.

20 Ridgeway Place,
S.W.19.

The Oblong or Truncate-tailed Ocean Sunfish, *Ranzania truncata*, at Mauritius

In studying the history and distribution in the three great oceans of the very rare pointed-tailed sunfish *Masturus*, I have had to disentangle it in the literature from the other two genera of the family Molidæ—*Mola*, the round-tailed genus, and *Ranzania*, the truncate form. The former, known since Roman times, is found in the three central oceans, but to my surprise, *Ranzania*, while recorded from the Atlantic and Pacific, has seemingly never been described from the Indian Ocean. However, there is known to me an unpublished figure and description of it in this ocean and it seems well to put these on record.

Nicolas Pike was U.S. Consul at Port Louis, Mauritius, from 1867 until 1874. During these years, he made extensive natural history collections, drawings and studies and brought back to New York in 1874 eight volumes of drawings of fishes, most of them in colour. In 1905, these were purchased by J. Pierpont Morgan and presented to the library of the American Museum of Natural History. Finding these among our treasures, I published in 1929 a sketch of Pike's life and an analysis and description of his 486 paintings[1] of fishes. These I listed alphabetically under the name of the fish. Number 324 is his "*Orthagoriscus truncatus* Retz ; molle, poisson lune". The figure is noted as made from a stuffed specimen in the little museum at Port Louis, June 25, 1873, and is found on pl. 8 of vol. 6.

This figure is somewhat crude but plainly that of *Ranzania truncata* in its oblong form, truncate tail, in the relative positions and conjunction of dorsal, caudal and anal fins ; in the presence of bars on the lower side of the head as far back as the pectoral fin ; and in the imperfect markings on the hinder part of the side with some few on the dorsum. Here is Pike's brief and untechnical description.

Sunfish—Creole Molle

Height of body less the half total length. Skin very smooth, divided on back into small hexagonal scutella [drawing of one with dots]—only the raised dots visible elsewhere. It appears to have been marked nearly all over with lines, blots and dots but so effaced I can only trace what are shown in sketch. I think the broad stripe on bare part in front of D was yellow, also stripes between lines ; but where I have put large round spots, they were either white or yellow with a dark center. The entire color is a grey brown now. Snout round—a dark boss of some kind above snout, a deep hollow for P behind them —2 have scutes in front.

Numbers [of fin rays] about D 15 or 16—A 15 or 16—C 23 or 4, P 12. Above boss on head is a rise and beyond a depression (rough sketch) along back at top.

This figure and description made sixty-two years ago constitute the first and only record known to me of the presence of the oblong sunfish in the Indian Ocean. Thinking that Barnard might have a record of it for South Africa, I consulted his "Monograph"[2]. In this he lists three specimens in the South African Museum, from False Bay, Table Bay and Dassen Island—all to the west of Cape Agulhas, through which runs the meridian dividing the Indian and Atlantic Oceans.

Ranzania is an inhabitant of warm seas, and this is very far south for it. The average latitude for the three localities is about 34° S. and the mean annual temperature is about 60° F. This is cold water for this sunfish and hence one may judge that *Ranzania* is not endemic in Cape waters. Add to this the fact that it is an exceedingly poor swimmer and hence could scarcely have reached South Africa by its own locomotive powers, then how did it come to these parts ?

The answer is to be found in the currents in the western Indian Ocean. *Ranzania* is found at Mauritius, in the path of the Southwest Drift of the Equatorial Current of this ocean. In about lat. 30° S., this drift unites with the Mozambique Current to form the Agulhas Current, which sweeps around the Cape of that name, and turns north-westward around the Cape of Good Hope.

In my judgment, *Ranzania* was brought from Mauritius or elsewhere in the western Indian Ocean by these currents to South Africa, and, since False and Table Bays act as natural traps for the back-wash of the current as it sweeps west and north-west, these specimens were thus stranded. These three captures of *Ranzania* in South Africa are to me so many additional proofs of its occurrence in the western Indian Ocean.

E. W. Gudger.

American Museum of Natural History,
New York City.
Feb. 11.

[1] Gudger, E. W., "Nicolas Pike and his unpublished Paintings of the Fishes of Mauritius, Western Indian Ocean, with an Index to the Fishes." *Bull. Amer. Mus. Nat. Hist.*, **58**, 489–530, 8 text-figs ; 1929.
[2] Barnard, K. H., A Monograph of the Marine Fishes of South Africa (*Ranzania truncata*, pp. 989–990, text-fig. 32), *Ann. S. African Mus.*, **21** ; 1927.

Diffusion of Hydrogen through Aluminium

The solubility of hydrogen in aluminium has been determined by Sieverts[1], Röntgen and Braun[2], and Röntgen and Moller[3]. These authors agree that the gas is completely insoluble in the solid metal at all temperatures below the freezing point. There are certain difficulties in the direct determination in this case, and we have therefore attempted to detect the diffusion of hydrogen through the solid metal. The method used is that described in a recent paper[4].

We find that hydrogen diffuses through aluminium at a rate which is easily measurable above 400° C. Preliminary measurements show that it follows the usual diffusion law with regard to the effects of temperature and pressure, namely,

$$D = k\sqrt{P}.e^{-b/T},$$

b having a value of about 14,000. The rate of diffusion at 400°–600° C. is of the same order as that of hydrogen through copper, but the temperature coefficient is much larger. We hope later to publish exact data.

The fact that hydrogen can diffuse through solid aluminium shows that it must be soluble, but does not indicate the degree of solubility.

C. J. Smithells.
C. E. Ransley.

Research Laboratories of the
General Electric Company Ltd.,
Wembley.
March 8.

[1] *Z. Electrochem.*, **16**, 707 ; 1910.
[2] *Metallwirtschaft.*, **11**, 459 ; 1932.
[3] *ibid.*, **13**, 81 and 97 ; 1934.
[4] *Proc. Roy. Soc.*, in the press.

Atmosphere of the Planet Mercury

I NOTICE, in the Supplement to NATURE of February 9, that the existence of an atmosphere on the planet Mercury has again been pronounced impossible on account of the small mass of the planet.

As a systematic observer of Mercury, with a powerful telescope, in 1927, 1928 and 1929, I wish to state, in full accordance with Schiaparelli, that the dusky spots of the planet are frequently faded, while some of them are sometimes even totally extinguished, by local clouds. These may be due to dust, and appear white, or even brilliant, on the limb, stretching there occasionally over three thousand miles in length; and it is thus obvious that such phenomena establish beyond doubt the existence of the highly rarefied atmosphere of Mercury, which is invisible, like that of Mars.

E. M. ANTONIADI.

Paris.
Feb. 27.

Points from Foregoing Letters

FOLLOWING upon an improvement in his apparatus, Dr. F. W. Aston finds higher values for the masses of hydrogen, deuterium, helium and carbon atoms; the new values are in better accord with those deduced from energy changes during the artificial disintegration of those elements. The new determinations were made by comparing with the mass-spectrograph, to which a new collimator with variable slits was added, the masses of doublets (that is, atoms and groups of atoms having nearly the same mass/charge ratio).

Prof. A. J. Dempster describes a new way of obtaining positively charged ions of the metallic elements, including gold and platinum, for use with the mass-spectrograph. He employs a spark coupled inductively to a high-frequency oscillating spark circuit, and obtains many ions with multiple charges.

The red colour of certain auroræ may be due to electrically excited oxygen, which emits a 'triplet' of wave-lengths in the red region of the spectrum. Mr. L. Harang and Prof. L. Vegard have determined more accurately the wave-length of the strongest component of the triplet by means of an interferometer, and find that it agrees with the wave-length observed by Hopfield in the case of oxygen in the O_I state.

From spectroscopic analysis of light obtained with silver compounds of hydrogen (H) and heavy hydrogen (D), the ratio of the (reduced) masses of H and D atoms has been deduced; it does not agree with the ratio deduced from their atomic weights. Mr. L. Hulthén calculates that this discrepancy would be accounted for if the four outermost electrons of the silver atom took part in the rotation of the nucleus, which rotation is assumed to be responsible for the band spectrum.

Prof. A. Terenin states that when SnI_4 vapour is decomposed by ultra-violet light, visible light is emitted corresponding to that characteristic of iodine molecules. This he considers shows that, under the influence of light quanta, not only are the bonds of the original molecule broken, but also an instant recombination between the liberated radicles or atoms can take place. Prof. Terenin accounts in this way for the yellow fluorescence of bismuth tri-iodide which falls in the same region as the iodine spectrum.

Mr. C. H. Douglas Clark directs attention to the fact that the value for the inter-nuclear distance between phosphorous and nitrogen, and also other molecular constants, as calculated by Curry, Herzberg and Herzberg from observations on the spectrum on the PN molecule (phosphorus vapour electrically excited in nitrogen gas) agrees with certain qualitative predictions which he recently made, unaware of their experimental work.

Evidence that a slime-mould (similar to *Labyrinthula*) is responsible for the wasting disease of the eel-grass, *Zostera marina*, along the Mediterranean Atlantic coast, is adduced by Mr. C. E. Wren. A fungus, *Ophiobolus*, has also been suggested as the causative agent, but Mr. Wren finds that it is not always associated with the disease.

Dr. R. W. Butcher believes that the narrow-leaved variety of *Zostera*, which is more resistant to the wasting disease, is produced by a change in 'nutritional balance', and that the disappearance of the wide-leaved variety is due to a variety of circumstances.

Mr. W. W. Barkas finds that the moisture content of spruce wood flour (Sitka or tide-land variety) in equilibrium with saturated air, that is, its fibre saturation point (f.s.p.), is greater when the wood is being dried from a moist state (desorption) than when it is absorbing moisture from the air (adsorption). The f.s.p. is also frequently deduced indirectly from the percentage moisture when (1) shrinkage occurs, or (2) sudden increase in compression strength occurs, but in the case of many woods the values obtained by these two methods do not agree. Mr. Barkas suggests that the compression which, opposing the swelling pressure of the wood, raises its vapour pressure, also causes a decrease in the water content needed for saturation and accounts for the divergence in the f.s.p. deduced by methods 1 and 2.

The unpleasant smell given off on drying by certain red sea-weeds (genus *Polysiphonia*) is due to methyl sulphide, according to Dr. P. Haas. He points out that methyl sulphide is also found in petroleum from Ohio, a fact which supports to some extent the sea-weed theory of the origin of petroleum.

Mr. S. Mukerji finds that the blood-sucking minute moth flies (*Phlebotomus*) have their alimentary canal somewhat more acid (lower *p*H) than the non-blood-sucking species. The blood-sucking *Phlebotomus papatasii* is a carrier of *Leishmania tropica*, a protozoon which causes the malaria-like fever kala-azar in India.

Mr. D. O. Sproule points out that, according to Rayleigh's formula, high-frequency vibrations travel more slowly than low-frequency ones, but the difference in their speed in a steel wire, recently reported by Dr. Wall, is too great to be explained in that way, unless the frequency of the group of waves was rendered greater by the natural period of one of the clamps used. Mr. Sproule points out that Dr. Wall's method of measuring the velocity of longitudinal vibrations would be useful in investigating shear stresses, viscosity and radial vibration.

Research Items

Pollen Analysis from the Norfolk Fens. An attempt to reconstruct the conditions of discovery of a bronze spear-head with loops at the junction of socket and wings of the Middle Bronze Age has recently been described by H. and M. E. Godwin, J. G. D. Clark and M. H. Clifford (*Proc. Prehist. Soc. East Anglia*, **7**, pt. 3). The discovery was made some years ago at Queen's Ground, Methwold Fen, by Mr. John Harrod, of Methwold, from whom it was obtained for the University Museum of Archæology and Ethnology, Cambridge. The site was visited by members of the Fenland Research Committee, to whom Mr. Harrod was able to indicate the horizon of discovery very closely. The spear-head was found at the base of the lowest draw of peat. The level indicated by attendant circumstances was confirmed by recognition of a well-marked horizon of the surface of the undisturbed peat in the disused trench. Uncontaminated samples of peat were taken, the peat in each instance overlying chalky boulder clay. As the result of the pollen analysis, bore *A* appears to have included three major phases: (*a*) an early phase with high birch and pine pollen values; (*b*) the middle phase with overwhelming dominance of alder pollen; and (*c*) the latest, with co-dominance of ash and alder pollen and showing in its last stages small amounts of beech pollen and high values for hazel pollen. The earliest phase certainly represents the end of the Boreal climatic period and the base of (*b*) the early Atlantic. This is supported not only by the change-over from pine and birch to alder, but also by the presence in small amounts of oak, elm and lime, with the two latter genera at first dominant over the oak. Probably the change from (*b*) to (*c*) indicates a change to generally drier soil conditions with an extension of the fen area locally covered by fen carr (scrub) or fen woods. The record of beech pollen below a late Middle Bronze Age horizon is of interest to botanists since precise evidence is lacking of the history of appearance and spread of this tree in Britain.

'Fossil Tradition' in Stone Implements. Under this title, M. A. Vayson de Pradenne contributes to *Antiquity* for March a study of certain anomalies encountered in stone age industries—more particularly in certain industries of North Africa which have frequently been the subject of comment and conjecture. Excavators have long noticed the occurrence in prehistoric deposits of objects with two distinct patinas. Thus in the Mousterian deposits of La Quina, flints shown to belong to the lower deposits by their deep yellow patina have been found in the upper deposits. They had been rechipped and used again by the later inhabitants of this site, as is shown by the white patina characteristic of the upper deposits. Certain very peculiar specimens are found in North Africa with rough chipping on one side only accompanied by a tang handle of neolithic type. Since 1919, Reygasse has described numerous artefacts at Bir-el-Ater of which the Mousterian character is supplemented by tanged specimens. Further, there is a whole group of various implements which is supplied with handles. This Aterian industry is widely distributed throughout North Africa and is generally found on the surface or at a slight depth in brick-earths the upper portion of which has been re-arranged. In the Abri Alain culture, recently described by M. Pallary (see Nature, **134**, 975; 1934), are found in a group of contrasted association certain tanged objects exactly like those of the neighbouring Champ de Tir of Eckmuhl, and it cannot be doubted that the type was borrowed by the inhabitants of the Abri Alain from the old industry nearby, which was as 'fossil' to them as it is to us. Other caves near the Abri Alain, as recorded by M. F. Doumergue, include in their culture patinated flints of a palæolithic facies, also from the Champ de Tir. These implements introduced a new type into the industry which took them over, and serve to show that identity of type need not indicate either direct connexion or contemporary influence.

South African Fisheries. In Dr. Cecil Von Bonde's Report, No. 11, of the Fisheries and Marine Biological Survey, Union of South Africa, for the year ending December 1933 (1934), a résumé of operations of the R.S. *Africana*, and a list of the stations and salinity results occupy the first part, the second part containing investigational reports. Of these, the report on savings-trawl investigations in relation to the conservation and regulation of the Agulhas Bank sole-fishery by J. M. Marchand is of much importance. The Agulhas Bank mud-sole or east coast sole, *Austroglossus pectoralis*, becomes sexually mature and spawns for the first time at an average minimum length-size of 12 in. With a size-limit of 12 in. the percentage of undersized and immature soles in the commercial catches procured with the trawl-gear at present in use is too high. Investigations were carried out in order to find trawl-gear of such form, construction and mesh-dimension as would allow the escape of as high a percentage as possible of soles of less than 12 in. in length, at the same time guarding against the escape of too many mature and marketable fish. The main result is to show that the use of a larger-meshed saving-panel in the back or upper side of the cod-end of the trawl demonstrates an enormous saving of small, immature and non-marketable fish, especially soles, but also other species; the percentage escapes of marketable soles is very low. It is recommended that a certain defined breeding area be closed to trawling for five years, and that a general and special mesh and dimensional regulations be enforced with respect to trawl-nets, a savings-panel to be inserted in the cod-end.

Feeding Mechanism in *Diastylis*. Mr. Ralph Dennell, in describing the feeding mechanism of the cumacean crustacean *Diastylis Bradyi* (*Trans. Roy. Soc. Edinburgh*, **58**, Part 1, No. 6; 1934), has carried out his researches both on the living animal and on careful preparations of the mouth parts, which show the features of a typical filtratory malacostracan. There is, however, a peculiar median process projecting into the filter chamber which is of great importance in the working of the feeding mechanism and apparently has not been noticed before in the Cumacea. The filter current is due to the pumping action of the maxillæ and maxillipeds, made possible by the maxillary valve and median process, and to the action of the epipodites in sucking a subsidiary

current through the filter chamber. It is helped to a large extent by the respiratory current. The author suggests that the ancestral cumacean probably possessed certain features shown by the primitive *Gnathophausia* and *Lophogaster*. He intends to follow up the present investigation with one on the feeding mechanism of *Apseudes*, in the hope that it will be possible to describe the evolution of the *Cumacea* and *Tanaidacea* as functionally derivable from a group of primitive mysids which took to burrowing in mud, as a change of habitat is shown in other cases to have a profound effect on the crustacean feeding mechanism.

Hemipterous Insects from Ireland. Mr. J. N. Halbert has recently published a lengthy annotated list of the Irish Hemiptera, especially of the Heteroptera and the Cicadina group of the Homoptera (*Proc. Roy. Irish Acad.*, 42, (B), No. 8, 1935). For the first time, information on the insects in question is brought together with the object of providing a comprehensive survey of the distribution of the species occurring in Ireland. As might be expected, the Heteroptera, or plant bugs, have been more extensively collected than the Cicadina. Out of 455 British species of this suborder, 253 are shown to be found in Ireland. This relative paucity of the Irish fauna is regarded as being due more to past geological changes, resulting in isolation, than to such ecological factors as climate and soil. Of the Cicadina, and the allied Psyllina, the Irish species number 153, or less than half of those recorded for the British Isles as a whole. These two groups, however, have been less intensively collected, their identification is often beset with difficulties and much work remains to be done. Their species are merely enumerated without annotations, the list being tentative in character. The paper as a whole extends to more than 100 pages and is provided with a useful bibliography dealing with Irish faunistic records.

Epidemiology of Winter Outbreaks of Parasitic Gastritis in Sheep. In the course of an epidemiological inquiry into the severe outbreaks of parasitic gastritis which occurred during the winter months of 1933–34 in the British Isles, Mr. E. L. Taylor (*J. Comparative Path. and Therapeutics*, 47, pt. 4, Dec. 1934) found that the epidemic was chiefly associated with heavy infections of species of *Trichostrongylus*. *Haemonchus* and *Nematodirus* did not appear to have been involved. Inquiries on the Romney Marsh showed that 43 farmers lost £10,341 during the outbreak. Most of these losses, however, took place while the sheep were away from the Marsh for winter grazing. The outbreak was associated with a prolonged period of drought. A gradual storage of potential infective material probably took place on the ground during the drought, which may or may not have terminated in a mass development of infective larvæ, depending upon the advent of a period of damp weather of sufficient duration for the infective larvæ to develop. Experiments on the effect of diet on the susceptibility of lambs to worms showed that more worms develop in sheep fed on a deficient diet than in those receiving a full ration; and that those on an adequate diet eliminated their worms more readily than those on an inadequate diet. After a period of drought the herbage is short, scarce and of very poor quality, leading to maximum intake of infective larvæ, and actual under-nourishment of the sheep. It is advised that, where a shortage of pasture is threatened, the sheep should receive an ample allowance of concentrated food and that use might be made of the application of nitrates to some of the pastures towards the end of the summer, to stimulate the growth of grass of a more nutritious quality.

Improved Methods of Vegetative Propagation. An article entitled "Working up Stock" appears in the *Fruit, Flower and Vegetable Trades' Journal* of February 2, 1935. The identity of the author is hidden behind the pseudonym "Crusoe", but the subject-matter reveals a vigorous awakening of the nursery trade to present-day conditions, as relieved by the provision of import duties on foreign produce. It is shown that seed propagation of several plants is slow in comparison with the newer methods of vegetative propagation suggested by the article. Lupins may be raised as cuttings from the abundant shoots at the base of old stems. *Anchusa* may be multiplied by root cuttings, but attention must be paid to polarity—the piece of root must be planted in the same position in which it naturally grows. Gaillardias and *Gypsophila* may be propagated from pieces of the fine root. An interesting improvement relates to the propagation of hyacinth bulbs. The central conical stem is scooped away until the bases of the scales are exposed. Planting in ordinary soil induces the formation of innumerable small bulbils from the scales; these can then be grown to suitable size. It is interesting to note that these methods of vegetative propagation are as prolific as seed propagation, but have the additional advantage that all the vegetative produce from one plant (that is, a clone) is uniform in colour, shape and size—a very important factor in commercial work.

Rust Fungi in Scotland. The study of fungi rests, perhaps more than that of any other group of plants, upon traditions of observation and nomenclature established by highly scientific amateurs. Scotland had her share of such men. Greville really initiated the study in 1823–28 by the publication of the "Scottish Cryptogamic Flora". He was followed by the Rev. M. J. Berkeley, and in 1879, the Rev. John Stevenson published "Mycologia Scotica". Many rust fungi were described by these authors, but Trail's "Revision" of 1890 was the latest authoritative account until 1934. The Edinburgh Botanical Society has recently published a paper on "The Distribution of the Uredineæ in Scotland" by Dr. Malcolm Wilson (*Trans. Edin. Bot. Soc.*, 31, pt. 3, 345–449; 1934). Records are classified into eleven districts, each being a natural division bounded by watersheds. Trail's records have been more than doubled in number in the present publication. The account is not merely a list of new records, but also attempts to trace the influence of several factors on distribution. Some difficult problems are disclosed. *Puccinia vincæ*, for example, occurs in only one station, though *Vinca minor* and *V. major*, its hosts, are widely distributed. *P. agrimoniæ* and *P. perplexans* have similar local distribution, and attack plants common in all parts. *Phragmidium rubi* and *Puccinia sonchi* occur only near the sea, though their hosts are found abundantly inland. Several species occur in Scotland, but not in England, whilst *Puccinia Porteri* and *Uredinopsis filicina* are new British records.

Clay Minerals. In Prof. Paper 185G. of the United States Geological Survey, C. S. Ross and P. F. Kerr continue the record of their investigation of the clay minerals by chemical, optical, X-ray and dehydration methods. In 1931 they described kaolinite, dickite and nacrite, and their present study shows that *halloysite* is a fourth member of the group, related to, but distinct from, kaolinite. Previously described as amorphous, halloysite is now known to have a crystal structure. The X-ray diffraction pattern has a number of lines in common with that of kaolinite, but in each case there are independent sets of lines. Like kaolinite, halloysite appears to be always the result of weathering, whereas dickite and nacrite are characteristically hydrothermal products. *Allophane* is a genuinely amorphous material that is commonly associated with halloysite. It has no crystal structure and no definite chemical composition. The name includes all materials that can be regarded as mutual solutions of silica, alumina and water with only minor amounts of bases.

Recent Developments in Molecular Rays. I. V. Guillemin has discussed recent work—since 1931—on molecular rays (*J. Franklin Inst.*, Jan. 1935). The scattering of molecular beams by gases has been calculated on quantum theory and also measured experimentally, with satisfactory agreement. The diffraction of molecular beams on crystal surfaces has been observed—this phenomenon is often obscured by adsorption and re-evaporation after a finite time. Magnetic and electric dipole moments have been measured for a number of atoms and molecules, including the hydrogen atom measured by Rabi under conditions such that the proton moment may be determined. Experiments have been devised to examine the re-orientation of atoms oriented by magnetic field when passed through a second field at an angle to the first. A number of other applications of the method are described, and a number of references are given.

Crystal Oscillators for Radio Transmitters. At a meeting of the Wireless Section of the Institution of Electrical Engineers on March 6, a paper was read by Messrs. C. F. Booth and E. J. C. Dixon on the application of the piezo-electric crystal oscillator to radio transmitter problems. This paper comprised an account of the work carried out by the Radio Section of the Post Office between 1925 and 1934 in the development of the use of quartz crystal oscillators in a number of different applications, of which the most important was the control of the carrier frequency of short-wave transmitters employed for overseas radio services. A description was given of the results of a comprehensive investigation of the chief characteristics of different types of quartz crystals, and the manner in which they must be used in order to secure the highest constancy of frequency. Particular attention has been paid to the effect of temperature on the frequency of the crystal oscillator, and special constant-temperature ovens have been designed for the oscillators used for the control of transmitters operating commercial radio-telephone services. The concluding section of the paper gave the results of a study of the performance of frequency-controlled transmitters in actual service. The graphical records show that it is possible to keep the frequency of a transmitter under strict control for periods up to two years, during which it is only on rare occasions that the variations exceed the limits of tolerance set by international agreement.

Chemistry of Fats. Prof. T. P. Hilditch (*Chemistry and Industry*, **54**, 139, 163, 184; 1935), in his Jubilee Memorial Lecture to the Society of Chemical Industry, directed attention to recent investigations of the chemical composition of fats. It had been assumed that the normal constituents of fats and oils were tristearin, tripalmitin and triolein, other substances being regarded as abnormal. It is now known that some of the supposed fatty acids are mixtures of two other acids in equimolecular proportions, margaric acid, for example, consisting of palmitic and stearic acids. Again, the assumption that simple triglycerides (containing three identical fatty acid radicals) are predominant is incorrect: in the natural fats the triglycerides are usually mixed. The major component acids of a fat often exceed three and may be as many as ten or twelve in number, and their relative proportions vary widely in different cases. In the case of fruit-coat fats, the major component acids are practically only palmitic, oleic and linoleic acids, but in many other seed fats, other quite specific acids are found. Cruciferous seed-fats, for example, contain large quantities of the unsaturated erucic acid, Umbelliferæ contain petroselinic acid (an isomer of oleic acid), etc. What Prof. Hilditch calls an 'even distribution' rule appears to operate in regulating the composition of the glycerides. A number of general questions, such as the conversion of carbohydrates into fat in living organisms, and the catalytic hydrogenation of fats, were also considered.

Effect of Ozone on Rubber Insulated Cables. It has been well known for many years that ozone attacks rubber, producing cracks and so destroying its insulating properties. The father of the present Lord Rayleigh used to show an experiment at the Royal Institution illustrating this effect. A sheet of stretched rubber was put several feet away from the spark gap of an induction coil which was then started working. After a few seconds, a hole appeared in the stretched rubber which rapidly increased in size. It will be seen that it is necessary when working with the coronal and brush discharges which appear at high voltages to shield rubber cables. In the *Electrician* of February 22, the method of testing cables used by the German Aircraft Research Establishment to see the effects of the action of ozone is described. It appears that the ignition cables of aeroplane engines have to be renewed every 400 hours due to deterioration produced by ozone. In 1932 a German cable manufacturer succeeded in producing a rubber compound which was practically unaffected by ozone under normal working conditions. A cable insulated with this new compound was subjected to the action of ozone for 1,000 hours and then passed satisfactory tests. A cable insulated with ordinary rubber broke down after one hour's similar treatment. Typical examples of test pieces after breakdown are shown. It is stated that with ordinary ignition cable, corona discharge begins when the crest value of the voltage is 7,000. Under normal conditions the crest value is double this, and to prevent its formation it would be necessary to increase its diameter from 0·28 in. to 0·44 in., which would require 2·5 times as much material.

Mechanism of Salt Absorption by Plant Cells

By F. C. STEWARD, Birkbeck College, University of London

FEW problems in plant physiology have more general implications than that of the mechanism of salt absorption. The outstanding feature which requires explanation is the means whereby certain salts, which occur in extreme dilution in the medium bathing the cells, attain considerable concentrations in the vacuole, where they are maintained, apparently, in true solution. The obvious analogy between this process and the mechanism of secretion in the animal body is alone adequate justification for again directing attention to this question.

In recent years there have been many physico-chemical speculations which suggest devices whereby living plant cells might evade those simple equilibrium conditions which they rapidly approach after death or injury. The tendency has been to stress mainly the properties (real or hypothetical) of the functional membranes, and to pay but scant attention to the metabolic activities of the living system. One of the most prominent of such theories is still that of Osterhout[1,2]. The principal features of this view and those relevant to this discussion are as follows.

(1) The functional protoplasmic membranes are fluid, lipoidal and non-dissociating.

(2) Salts enter principally, if not exclusively, as undissociated molecules. Cations penetrate only in association with hydroxyl in the form of undissociated free base.

(3) The gradient of 'thermodynamic potential' of free base ([K] × [OH] ; [Na] × [OH]) determines the rate and direction of movement of K and Na respectively.

The theory is largely based upon experiments with the marine cœnocytic green alga, *Valonia macrophysa*, which, like the closely related form *Valonia ventricosa*, occurs in warm seas under highly specialised conditions of light, temperature and aeration.

V. macrophysa occurs at Bermuda and has been investigated mainly in winter, whereas both species are found at Tortugas, either in the specialised environment provided by the moat of Fort Jefferson (mainly *V. macrophysa*) or on the open reef (*V. ventricosa*). The Tortugas material has been examined in the summer months and the criticism has been raised by the workers at Bermuda that it is not 'healthy' at this season. This is not borne out by my own experience, especially in the case of *V. ventricosa*, which is on morphological grounds the most useful species.

In recent years the theoretical views have also been developed by experiments on 'models'[3,4] purporting to represent the living cell, on the implicit assumption that the fundamental postulates are correct. In the light of recent work, one may query this from two points of view, namely :

(1) That the theory is not an adequate explanation even for the special case of *Valonia*.

(2) That it exploits unduly the peculiar features of *Valonia* and its environment in a manner which could not possibly apply to plant cells in general.

Until recently[5], the direct evidence for the theory has rested largely upon experiments in which the *internal* reaction of *Valonia* was modified by the penetration of ammonium hydroxide from ammonium chloride - sea-water[6]. Granted that the theory accounts qualitatively for the *direction* of the subsequent movement of potassium and sodium ions (K out, Na in) it is evident that it cannot account for rates. Contrary to expectations, sodium enters in presence of ammonium chloride much faster than in normal sea-water. Furthermore, in this experiment, one of the most significant of those which test the theory on *living cells*, rather than models, the observed change in sap composition is in the direction of attainment of equality of concentration between sap and external solution. Consequently, potassium and sodium ions each moved *with*, rather than against, the prevalent gradients, not only of potassium hydroxide and sodium hydroxide but also of the respective ions. The crucial test of the theory is its ability to explain and foretell movements in the *reverse* direction. Despite attempts to evade this objection (see ref. 6, p. 310), it seems that the more probable explanation is that the ammonium hydroxide produced changes for which injury is the only, but unsatisfactory, designation. That ammonium chloride in the concentrations employed has such irreversible effects upon *both* species of *Valonia* (*V. macrophysa* and *ventricosa*) as they occur at Tortugas is now quite evident[8,9]. Unless differences between the Tortugas and Bermuda types of *V. macrophysa* without morphological or taxonomic basis are postulated, it is difficult to believe that such did not apply in the earlier experiments of Osterhout[6]. This is in fact indicated, since some cells were actually so far from normal that they died, and considerable corrections were necessary in the volume data of the ammonium chloride series (see ref. 6, pp. 308, 309). In the light of this the evidence that the remainder were completely uninjured is not convincing.

Recent experiments[10] with potato tissue which imitated the essential features of the above *Valonia* experiments have shown that the effect of ammonium penetration from ammonium salts is to reduce the capacity for the accumulation of *all ions*, namely (K, Na, Cl, Br, phosphate), and this is reflected in decreased water absorption. This occurred although considerable internal concentrations of ammonium produced only a small change of internal *p*H in the more strongly buffered cell sap of potato. The penetration of ammonium seems to depress the accumulation mechanism. Any other superimposed effects were readily interpreted as simple exchanges involving cations.

Experiments involving ammonium chloride solutions are therefore but a dubious proof of the theory of Osterhout, although from the prominence given to them[1,2] they are apparently regarded as its best confirmation.

The theory in question also demands that changes in external reaction, as well as internal, should affect the distribution of potassium and sodium ions between sap and sea-water. Considerable prominence has been given to the fact that an external *p*H of 5·5, which causes irreversible injury and death, also induces loss of potassium ions. For reasons already stated, this has little or no value as a confirmation of the mechanism of *accumulation*. Jacques and Osterhout[5] also claim that a recent examination of the effects of external reaction substantiates the theory. It is again apparent that very small

concentration changes have been transformed by using volume data to what appear to be considerable differences of *total amount*. In other words, there is no evidence that the internal *concentration* of potassium ions is a function of external *p*H, but rather to the contrary. If the external *p*H really does determine the growth of the cells and hence the total salt content, this is not necessarily a proof of the suggested mechanism of entry and accumulation of potassium ions, but merely another indication of the connexion between the processes of growth and metabolism and that of salt absorption. Unfortunately, the most significant data refer to experiments in the light, where there is considerable uncertainty as to the exact *p*H which prevailed and the nature and extent of its drift[5]. The apparently large magnitude of the suggested difference in absorption of potassium ions (see ref. 5, Fig. 1), which is attributed to the small difference in *p*H between two cultures (one of *p*H 8·8 and the other which "started at 8·2 and rose somewhat but apparently not as high as the other"), strongly suggests to me that some other variable and not the concentration of hydroxyl ions was really the determining factor in this case. This is the more probable when one recalls that, though this organism in its normal habitat may withstand considerable fluctuations (diurnal and otherwise) of certain factors (oxygen concentration, external *p*H, etc.), yet in its growth and distribution it is clearly limited by subtle differences not easy to specify completely. This has been impressed upon me by observations in the moat of Fort Jefferson at Tortugas. Attempts to demonstrate the effect of external *p*H upon the absorption of potassium ions by *Valonia macrophysa* in the dark were inconclusive. One of the reasons suggested may be incorrect since, contrary to the statement that it lacks carbohydrate, *Valonia* may be abundantly supplied with small starch grains[11].

Fortunately, quite apart from its ability to grow conspicuously, *Valonia ventricosa* (not available at Bermuda) will absorb potassium from sea-water enriched with potassium chloride either in the dark or the light. External *p*H's ranging from 9·0 to 5·5 may be produced and maintained by control of the carbon dioxide tension. Under these conditions, it is now apparent[8,12] that an approximately threefold increase of external concentration of potassium ions can produce a definitely significant gain by the cells both of concentration and total amount, and this is but slightly affected by an external *p*H range from 9·0 to a reaction only slightly more alkaline than 5·5. Moreover, a slight but significant maximum occurred not at *p*H 9·0 (as the theory referred to would demand) but at approximately *p*H 7·0. The theory of 'thermodynamic potentials of free base' demands that the tendency for potassium entry, measured by the value of the product [K] × [OH] for external surroundings should be determined equally by the concentration of the potassium and hydroxyl ions. It appears, therefore, that entry of potassium is more closely related to the potassium ion concentration than the hypothetical [KOH]. Similarly, when sea-water is enriched with sodium chloride, some gain of potassium may be observed, which also suggests a closer relation between potassium absorption and [Cl] than [OH], since the [KOH] remained undisturbed[12].

It is submitted that these facts are in accord with other views which show that the rôle of *p*H is not the dominant one which the theory suggests. Hoagland[13], using both *Nitella* and the roots of barley, has shown repeatedly that they can accumulate both ions (for example, potassium and bromide) from solutions more acid than the vacuole. Similarly, I have stressed that the existing *p*H gradients could not explain the behaviour of storage tissues, which accumulate salts from solutions almost identical in reaction with their cell sap. Such facts controvert the theory of Osterhout. In view of its dubious utility in the interpretation of the special case of *Valonia* and the abundant evidence to the contrary, especially where more active systems are concerned, there seems to be little justification for continued emphasis upon the idea that cations (particularly potassium and sodium) penetrate cells in general only in the form of undissociated free base.

The experiments at Tortugas, already referred to, suggest that the obscurity which surrounds the manner of growth of *Valonia* and the extremely low level of its metabolic activity more than outweigh its apparent morphological advantages. That the latter are more apparent than real is suggested by even a casual experience with these organisms. It is an interesting anomaly, both morphologically and physiologically, rather than a typical case from which generalisations may be drawn safely. To my mind, *Valonia* finds its parallel with cells like red blood cells or those storage tissues which have permanently ceased active growth and synthesis, rather than the more vigorously metabolising plant cells like those of rapidly growing roots or certain storage tissues[7] which display greater capacity for salt absorption. In the latter cases, it is still difficult to avoid the view that cells do osmotic work in the simultaneous absorption of both anions and cations by virtue of their metabolism and capacity to grow. Nor does the rôle of growth merely involve cellulose synthesis and wall extension, but rather is the ability for salt accumulation inherently a property of cells still capable of constructive protein metabolism and a turnover of carbohydrate far in excess of that involved in mere cellulose synthesis. Thin discs of potato tissue in dilute aerated solutions of potassium salts may metabolise carbohydrate equivalent to 4·27 kgm. cal. per 45 gm. fresh weight in three days. This is equivalent approximately to one sixth of their original total heat value, and most of this decrease in total energy may be due to heat production. Whether a fraction not yet accounted for is more specifically associated with accumulation of salts is a problem at present under investigation.

Whatever the rôle of carbohydrate metabolism may prove to be, it is difficult to follow Osterhout so far as to believe that, if the necessary metabolic activity were available, the still extensible walls of *Valonia* could not be distended without cellulose synthesis, so that further increment of salt *concentration* (without corresponding water absorption) could be accommodated by an increase of wall pressure. Despite even the evidence of slow cell extension[5] in the recent Bermuda experiments, it seems that the large cells of *Valonia* as commonly used retain the essential properties only in relatively slight degree. Consequently, the rôle of respiration and metabolism as a potential source of energy has been minimised and the chief stress laid upon its possible effect as a determinant of internal reactions. The theoretical manipulations of ionic products (for example, [K] × [OH] ; [Na] × [OH]) are based essentially on equilibrium criteria and create the illusion that rapid metabolism and energy exchanges are

unnecessary for salt accumulation *per se*. It is in these operations that undue weight seems to have been given to certain special features, not applicable to cells in general, of what is after all an obscure organism.

Lastly, there seems grave danger that the admittedly ingenious and extensive work devoted to models[3] may divert attention from the fundamental facts that, not only are they far removed from physiological reality, but also that the very principles upon which they are based are such that judgment must be reserved concerning their applicability to the general problem of salt absorption *in vivo*.

[1] Osterhout, W. J. V., *Biol. Rev.*, **6**, 369; 1931.
[2] Osterhout, W. J. V., *Ergeb. Phys. und exp. Pharm.*, **35**, 967; 1933.
[3] Osterhout *et al.*, numerous papers in *J. Gen. Physiol.*, **16** and **17**.
[4] Osterhout, W. J. V., and Stanley, W. M., *J. Gen. Physiol.*, **15**, 667; 1931–32.
[5] Jacques, A. G., and Osterhout, W. J. V., *J. Gen. Physiol.*, **17**, 727; 1934.
[6] Jacques, A. G., and Osterhout, W. J. V., *J. Gen. Physiol.*, **14**, 301; 1930.
[7] Berry, W. E., and Steward, F. C., *Ann. Bot.*, **48**, 395; 1933.
[8] Steward, F. C., and Martin, J. C., Carn. Inst. Wash. Yearbook, 33; 1934.
[9] Blinks (private communication from W. J. V. Osterhout) reports that ammonium in low concentration causes the formation of spores (the so-called aplano spores) by aggregation of the protoplasm. As far as the parent cell is concerned, this represents an irreversible change which is frequently caused by injury—mechanical and otherwise—as emphasised by recent experiments of Kopac at Tortugas (see Carnegie Yearbook, 1933).
[10] Steward, F.C., unpublished data.
[11] Doyle, Wm. L., Contrib. from Tortugas Lab. (In press.)
[12] Steward, F. C., Carn. Inst. Wash. Yearbook, 32, 281; 1933.
[13] Hoagland, D. R., Symposium on Salt Absorption, A.A.A S. Berkeley, Cal.; 1934.
[14] Steward, F. C., Wright, R., and Berry, W. E., *Protoplasma*, **16**, 576; 1932.
[15] Steward, F. C., *Protoplasma*, **17**, 436; 1932. **18**, 208; 1933.

Conference on Industrial Physics

THE first Conference on Industrial Physics to be held in Great Britain took place in Manchester under the auspices of the Institute of Physics on March 28–30. The subject chosen for the Conference was "Vacuum Devices in Research and Industry", and its chief object was to direct attention to the important part which physics and physicists can and do play in modern industrial life. Nearly six hundred people registered as members of the Conference, of which about a hundred were members of the Institute. The majority of the others were engaged in Government and industrial research laboratories and works, some coming from a considerable distance to attend the meetings. The outstanding success of this new venture of the Institute of Physics has demonstrated beyond all possible doubt that there exists a very large number of men who are engaged in applying physics to the solution of industrial problems, in addition to many who are employing its methods for industrial work of a more routine character. One of the objects of the Institute is to provide facilities for the interchange of ideas among those engaged on industrial physics problems by means of meetings and special journals. Many propositions towards the achievement of these objects will doubtless come to earlier fruition as a direct result of this Conference.

The sessions were held in the University of Manchester. The Conference was formally opened by Sir William Clare Lees and the Vice-Chancellor, and was presided over by Prof. W. L. Bragg. The lectures were all informal in character, and consequently they are not being published; each lecture was followed by a useful discussion. The titles and lecturers were as follows: "Modern Electrical Illuminating Devices" by Mr. J. W. Ryde, of the General Electric Co. Ltd.; "Applications of Photocells" by Mr. T. M. C. Lance, of Messrs. Baird Television Ltd., and Mr. R. C. Walker, of the General Electric Co. Ltd.; "The Cathode Ray Oscillograph in Research and Industry" by Mr. L. H. Bedford, of Messrs. A. C. Cossor Ltd.; "Recent Applications of Mercury Vapour Rectifiers and Thyratrons" by Mr. L. J. Davies and Mr. A. L. Whiteley, of the British Thomson-Houston Co. Ltd.; "High Tension Vacuum Tube Devices in Research and Industry" by Dr. J. D. Cockcroft, of the Cavendish Laboratory, Cambridge; "X-rays in Industry" by Dr. G. Shearer, of the National Physical Laboratory. It was interesting to record that, almost without exception, those who took a leading part in the various activities of the Conference, including the lecturers, were quite young men. The Organising Committee also received considerable commendation for its care in the selection of the lecturers, who were in each instance associated with industrial practice; the Committee preferred to extend the invitations to lecture to such men rather than to distinguished pioneers of the devices who, it was felt, would be more familiar with them in the laboratory stage, as distinct from their adaptation for industrial purposes.

On March 29 the members of the Conference spent the afternoon at the research laboratories and works of Messrs. Metropolitan-Vickers Electrical Co. Ltd., and the next day visits were paid to the Shirley Institute of the British Cotton Industry Research Association, and to the Post Office Telephones.

An exhibition of apparatus, instruments and books cognate to the subject of the Conference was held in the laboratories of the University, in which twenty firms and research organisations took part, and in addition some of the important work which is being carried on in the physical laboratories of the University was demonstrated. A special section intended to exemplify the multifarious uses and utilitarian value of vacuum devices was a feature of the exhibition, and aroused great interest. The specific function of the whole exhibition was to demonstrate that apparatus such as the cathode ray tube and the photocell, for example, are now utilised in devices which are practically fool-proof and can be used as tools in all manner of manufacturing processes. Unlike other exhibitions, it was not so much concerned with demonstrating the underlying physical principles of instruments or details of their mechanism, but rather with the fact that the devices shown were not mere scientific toys that had been brought from the laboratory and disguised, but that these devices were real and necessary industrial tools, which the more enterprising manufacturers are already employing. A limited number of copies of the catalogue of the exhibition is still available from the Institute of Physics, London, S.W.7 (1*s*. 3*d*. post free).

On Saturday morning some 65 parties from local schools visited the exhibition, and in the afternoon and evening it was thrown open to the public. It is estimated that 3,500 people visited the exhibition during the three days.

Prof. W. L. Bragg broadcast a talk about the

Conference and exhibition on the evening of March 29 and it also received considerable attention from the Press. On Friday evening, March 29, Mr. R. A. Watson Watt delivered a public lecture, which was attended by about 350 people, on "Cathode Ray Tubes in Industry". The lecture was given in the Great Hall of the College of Technology. It is hoped, in these ways, to bring to the notice of all, the great possibilities of existing inventions and scientific knowledge of a physical character, and the important part which these play in everyday life.

The social events included a Conference dinner in the College of Technology, at which Sir Henry G. Lyons, the president of the Institute, presided, and the guests included the Lord Mayor and the Lady Mayoress of Manchester, and a number of other distinguished persons.

The great success of this Conference renders it likely that similar conferences will be held from time to time in the future. Apart from the value of the information gained from the various lectures and discussions, as well as from the exhibition and the visits, the contacts made between physicists and those concerned with the technical developments of industry cannot but prove a fruitful source of lasting mutual benefit. Herbert R. Lang.

University Education

The inaugural address of the president of the Royal Statistical Society, Prof. M. Greenwood, delivered on November 20, 1934, contained many points of interest concerning the past history and probable future of the universities of Great Britain (*J. Roy. Statistical Soc.*, **98**, 1–37, 1935).

By consideration of birth-rates, there should be a decline in numbers at the universities in 1935–36, a recovery in 1938–9, and then, unless there is a change of policy, a steady decline. The present entrance requirements are not unduly severe; in fact, if we adopt the view of some university teachers, that failure to obtain first or second class honours shows unsuitability for university training, more than fifty per cent of the unassisted students should have been excluded, and also 10–25 per cent of those assisted by scholarships and similar benefactions. Dr. A. Flexner, who considers that a university suitable for the present and future of the world should be concerned with the conservation and interpretation of knowledge and ideas, the search for truth, and the training of students, concedes that Oxford and Cambridge have touched the fringe of these ideals, but he finds it impossible to give even this faint praise to any other English university, least of all to London. Mr. H. G. Wells doubts whether the universities and the conceptions of education they embody are destined to any very prolonged predominance over the intellectual processes of mankind, and considers the ordinary arts course in our older universities to be "merely a wasteful prolongation of puerility". Even Dr. H. Rashdall, who cannot be accused of prejudice against the ancient universities, observes that "Universities have often had the effect of prolonging and stereotyping ideas and modes of thought for a century or more after the rest of the world has given them up".

However, Prof. Greenwood considers that Dr. Flexner's ideals are too narrow, and are capable of realisation only in small and cloistered communities like Oxford and Cambridge. For large cities such as London, he considers that the loss of intimacy may be compensated by a gain in continuity, and that requirements should be made less rigid, so as to have no chasms between matriculated and non-matriculated students, or between graduates and non-graduates. In the past, one supported education largely on the ground that an educated nation would be better fitted to secure advantages in the international struggle for markets. But there has been a fundamental change in economic conditions. Now that productive man-power is in excess of demand, and millions of man-hours are running to waste, higher education should be considered, not for the material or social advantage it confers, but as a path to happiness.

In the discussion that followed the address, Mr. Udny Yule deprecated some of the sterner judgments on the University of London, and suggested that it differs from the older universities in degree rather than in kind. The research worker is the evolutionary successor of the hunter and is not a being apart, stripped of emotion, an intellectual machine. On this view we can understand his psychology, his blunders, his emotions. In fact, it is impossible to draw a sharp line between the investigations of a detective and those of the best type of fellow of the Royal Society. Even a poor piece of investigation may have taught much to the investigator himself, and have given him many happy hours.

University and Educational Intelligence

London.—Dr. John Gray, since 1934 director of pathology and Lyle research scholar at Queen Mary's Hospital for the East End, has been appointed reader in morbid anatomy at the British Postgraduate Medical School, as from April 1.

On his retirement from the professorship of surgery at St. Bartholomew's Hospital Medical College at the end of the present session, the title of emeritus professor in surgery in the University will be conferred on Prof. G. E. Gask.

The Senate has approved a proposal to hold the School Examinations (General School and Higher School) overseas in and after 1936.

St. Andrews.—The Senatus Academicus has resolved to confer honorary degrees on the following, among others: *LL.D.*, the Right Hon. Lord Alness; Andrew Bennett, secretary of the University since 1903, and secretary of the Scottish Universities Entrance Board; Prof. C. H. Browning, Gardiner professor of bacteriology in the University of Glasgow; Prof. A. H. Gibson, Beyer professor of engineering and director of the Whitworth Laboratories in the Victoria University of Manchester; Sir John Boyd Orr, director of the Rowett Institute, Aberdeen.

The Fifth Quinquennial Congress of Universities of the Empire, organised by the Universities Bureau of the British Empire, will be held at Cambridge on July 13–17, 1936.

University education in the United States is breaking free from the traditional system of semester-hour credits with compulsory class attendance and teaching by textbooks. More than a hundred universities and colleges have, says Dr. McNeely of

the Federal Office of Education in a paper contributed to *School and Society*, adopted in varying degrees devices for substituting voluntary learning on the part of the student for external compulsion. Among the leaders are the University of Chicago, Harvard, Cornell and Buffalo Universities and Swarthmore and Goucher Colleges.

Of German professors expatriated owing to Nazi intolerance, thirty-four have, it appears, migrated to the United States, and sixteen of them have been assigned to various universities by an "Emergency Committee in Aid of Displaced German Scholars". The remainder have combined in New York to form under the leadership of Dr. Alvin Johnson, director of the New School for Social Research, an association known as "The University in Exile". An article in *School and Society* of February 23 announces the appointment of a permanent board of trustees for the association. The association aims at perpetuating "the free German culture, which it had become traditional that post-graduate students from America and all over the world should seek, as a complement to the facilities of their own lands" : the words are quoted from a statement by the chairman of the board, Mr. I. A. Hirschmann.

The Royal Institute of Science, Bombay, which began teaching work in 1920, has recently issued a report (Bombay : Government Central Press, pp. 74, gratis) covering the period 1926–34. The declared policy of the Institute has been : (1) to interest the public by popular lectures and demonstrations, (2) to qualify undergraduates for scientific investigation, (3) to provide the means for carrying out original work, to guide beginners in research and to co-operate, on occasion, with other scientific institutions and assist industry by investigating industrial problems. The staff comprises, in addition to the principal, Dr. T. S. Wheeler, sometime senior research chemist with Imperial Chemical Industries, Ltd., eighteen professors, lecturers and demonstrators in chemistry, physics, botany, zoology and mathematics. The students, excluding courses in physics for first-year arts students, number about 300 and the annual cost of their education is Rupees 608 per student. There has been in the past ten years a steady increase from 26 (being 15 per cent of all full-time students) to 91 (31 per cent) in the number of post-graduate students. Progress in developing the Institute's research activities is further indicated in a list of 128 papers published and abstracts of 101 researches in progress. Both staff and students are, the report says, keen on their work, and the library and laboratories are open until late in the evening, even during vacations. A frontispiece to the report gives a view of the impressive façade, 400 yards long, of the Institute building, a wing of which was handed over in November 1933 to the University of Bombay to house the new University Department of Chemical Technology.

Science News a Century Ago

Monument to Telford

In *The Times* for Tuesday, April 7, 1835, it was stated that "At a general meeting of the Dundee Harbour Trustees on Wednesday last, it was moved by Mr. David Baxter that the harbour trustees do subscribe 10 guineas to the general subscription in London for a monument to the memory of Thomas Telford, Esq., Engineer, to be erected in Westminster Abbey, in consideration of the valuable services rendered by that distinguished engineer to the harbour of Dundee, first, in giving the very excellent plan for the construction of the first wet dock now called King William's-dock ; 2nd, in the valuable professional and practical advice which he gave for carrying the work into effect ; 3rd, in procuring from Government, by the Exchequer Loan Commissioners, at a time when the erection of the harbour was considered to be a work of speculation, a loan of the sum of £30,000 (nearly all this has since been repaid) ; and lastly for giving his able assistance in carrying the perpetual bill of 1830 through Parliament, which has placed the harbour establishment in a situation that has made it at once the cheapest and one of the most improved harbours in this kingdom".

Lardner on Halley's Comet

On April 10, 1835, Lardner gave the first of two lectures on Halley's comet at the Royal Institution. In the course of his lecture, he said that in 1757 Lalande proposed to Clairaut the calculation of Halley's comet, which was expected to return shortly. They were assisted by a French lady, the wife of a chronometer maker. The calculation was enormous, because the orbit must be divided into degrees, and each degree required as great a calculation as the whole orbit. They tell us, he said, that they were employed from morning to night, not excepting meal hours, incessantly for six months in this computation. Clairaut was so nervous that he hurried his calculations before the Institute. "Although Clairaut was not quite correct to the day, the only wonder was, that he should have been so accurate, for as he said, when a body traverses a space of 1,500,000,000 miles beyond our sphere of observation, how do we know but that some other planet may act upon it, and influence its course. In 25 years the planet Herschel was discovered, which it was proved, did actually operate in producing the effect which Clairaut had surmised".

Railways in France

According to the *Mechanics' Magazine* for April 11, 1835, the French Minister, M. Thiers, had just presented to the Chamber of Deputies "a project of law relating to railroads. He announced that the Government engineers had fixed upon three principal lines for railroads—one from Paris to Havre, via St. Denis, Pontoise, and Gisors, with branch lines to Rouen and Dieppe ; a second from Paris to Lyons and Marseilles ; and a third from Paris to Lille, Bourdeaux and Strasbourg. Surveys have it appears been made, and plans drawn out for these three several lines ; but one only, that from Paris to Havre, is recommended to be at first undertaken. It is proposed to throw open the work to public competition, and to entrust it to any company who will offer the best conditions, and sufficient securities". A fortnight later the *Mechanics' Magazine* said that there were in operation in France railroads from St. Etienne to the Loire (thirteen miles), St. Etienne to Lyons (thirty-seven miles) and Andrezieux to Roane (forty-two miles), while two other lines under construction ran from Alais to Beaucaire (forty-three miles) and from Epiney to the Canal of Burgundy (seventeen miles).

Societies and Academies

Edinburgh

Royal Society, March 4. A. M. Cockburn: The geology of St. Kilda. The islands of the St. Kilda group appear to represent the peripheral relics of a larger complex of intrusive igneous rocks perhaps some seven miles in diameter. The intrusions are sheet-like and, in order of age, consist of gabbros (including olivine-eucrite), coarse- and fine-grained dolerites, basalts and three granophyres. On St. Kilda these masses, the eucrite excepted, are inclined outwards from the supposed centre of intrusion, suggesting ring-dyke structure. A very abundant series of variously dated, thin, gently inclined sheets are suggestive of cone intrusion. Arcuate structure, however, has not been observed in the field owing to the fragmentary nature of the exposures. J. L. Bhaduri: The anatomy of the adhesive apparatus in the tadpoles of *Rana afghana*, Günther, with special reference to the adaptive modifications. A histological description of the cement organs is given and attention is directed to the 'brush-border' fringing the gland cells. The muscles of the disc are described and their homologies discussed. The diaphragm is shown to be modified; not only has it a thickened tendinous ridge in its central part, but in addition it possesses two distinct apertures for the passage of the diaphragmatobranchialis medialis muscles. An account of the histology of the skin of the disc is given. The cornification, and later tuberculation, of the posterior region of the disc is shown to be correlated with the habits and habitats of the tadpoles. The rim of the sucking disc encloses a lymph space which is considered to be another adaptive modification for counteracting the pressure of the rushing current. A. C. Aitken: Least squares and linear combination of observations. The paper deals with the equivalence, in practical outcome, of two different approaches to least squares, one based on the assumption that errors are normally distributed in such a way as to give the observations the greatest probability, the other on the postulate that the values to be adopted should be weighted means of the observations, with smallest standard error. Dr. W. F. Sheppard had proved this equivalence for representation by polynomial curves. The present paper confirms it for general functional representation, as well as for the case of correlated errors.

Paris

Academy of Sciences, February 18 (*C.R.*, **200**, 597–700). L. Lecornu: The return in space. Jules Drach: Logical integration and the transformation of the equations of dynamics with two variables. Conservative forces. Cubic integrals. H. Deslandres: A simple and general relation of the molecular spectrum with electrons and rings of electrons of constituent atoms. J. Haag: The mathematical theory of mechanical and electrical filters. Louis Roy: The deformation of an elastic line round one of its points. Jean Baptiste Senderens: The catalytic decomposition of monochlor fatty derivatives. Study of the decomposition of normal butyl chloride, normal propyl chloride and isopropyl chloride with various catalysts. All the catalysts, with the exception of active carbon, cause splitting up into hydrochloric acid and the corresponding olefine. Šmidov and Verčenko: Some geometric properties of ensembles. W. Brecka: Multiply monotone polynomials which diverge the least from zero, the two first coefficients being given. Soula: An interpretation of Picard's theorem on integral equations. J. Rey Pastor: Series of integrals of successive orders of a function. Jean Delsarte: A general principle of development of functions of a real variable in series of integral functions. Nicolas Cioranesco: The development of an analytical function of an analytical function and on some consequences. Julius Wolff: The representation of a demi-plane on a demi-plane with an infinity of circular incisions. Edouard Lainé: Kinetic moment and dynamic moment. Georges Bouligand: Some processes of partial determinism. Miroslav Nénadovitch: The corrections to be applied to the aerodynamic characteristics of a biplane cell under experiment in an air blast with guided or free circular vein. Emile Merlin: Two inequalities and the flattening of an equilibrium figure of a homogeneous fluid in rotation round a fixed axis. Combier and Poidebard: Contribution to the study of sand storms. The photography of sand storms. P. Lejay: Observations of the intensity of gravity in the Philippines, the Malay Archipelago and the Dutch Indies. Emile Sevin: Waves, spin and numbers. Maurice Lévy: Selective transformations. The properties of transformation curves and selectivity curves. Georges Dèchéne: The electrical resistances at the contact of two semiconducting substances. The results described resemble those obtained when a semiconducting substance is in contact with a metal, and can be interpreted in the same way. Pierre Jolibois: The chemical equilibrium in tubes containing rarefied gas in the neighbourhood of the cathode and in the positive column. Study of the dissociation of carbon dioxide in a Geissler tube, arranged so that gas circulates in a closed system. Mme. Lucie Lefebvre: The absorption spectrum of ozone at a low temperature. The absorption spectrum of ozone in the visible region (4400 A.–6500 A.) cooled to about $-80°$ C. is identical with that at the ordinary temperature. This does not accord with the results of Chappuis published in 1882. Antoine Goldet: The thermal variation of the magnetic double refraction and molecular electrical electric moments. Louis Henry: The photo-chemical decomposition of nitrous oxide and the energy of dissociation of nitrogen. The energy of dissociation of the nitrogen molecule into two normal atoms has a lower value than that deduced by Dutta (200,400 cal.). It lies between 158,000 and 169,000 cal. André Boullé: Study by means of X-rays of the anhydrous sodium metaphosphates. Wojciech Swietosławski and Ignace Zlotowski: A method of measuring the heat evolved by the absorption of γ-radiation. The apparatus described and illustrated, which is a modification of the calorimeter described by Swietosławski and Bartoszewicz, is capable of measuring the heat evolved by γ-radiation within two or three per cent. Paul Demougin: The absorption of iodine vapour by activated carbon and by silica gel. The quantities of iodine vapour absorbed in the neighbourhood of the saturation pressure for a given specimen of carbon do not vary with the temperature, whether the temperature is above or below the melting point of iodine. The quantities are proportional to the absorptive powers for other vapours, such as ether. Gustave Ribaud and Anatollah Rochan Zaer: The calculation of flame temperatures. Georges Fouretier: The direct measurement of low pressures

of saturated vapours. GUY GIRE and FRANÇOIS PUCHE: The thermal decomposition of the chlororhodates. JEAN AMIEL: The complex compounds formed by cupric perchlorate and cupric bromate with some primary amines. CHARLES COURTOT and ALFRED BARON: Contribution to the study of the halogenation of wool. JOSEPH WIEMANN: The hydrogenation of a mixture of two α-ethylenic aldehydes. PAUL GAUBERT: Anisotropic liquids. Rapid evaporation of solutions of methylene blue or of neutral red gives liquid residues showing double refraction. EDGAR AUBERT DE LA RUE: The first results of a geological expedition to the New Hebrides. PAUL JODOT: The presence at Faverelles (Loiret) of a small horst in the middle of the large crushed vault, between the fault systems of Cosne and Sancerre. ALBERT ROBAUX: The existence of the upper Eocene and the Oligocene in the Flysch series of the south of the province of Cadiz. JEAN MARCAIS: Concerning a deposit of fossiliferous Trias in the eastern Rif. GIORGI: An observation of globular lightning. LOUIS GENEVOIS and MICHEL PAVLOFF: Researches on the fermentable sugars of wheat flour. MME. JEANNE BOUXIN and RENÉ LEGENDRE: Cephalopods of the genus *Vitreledonella* in the stomachs of germons found in the Bay of Biscay. RAYMOND-HAMET: The action of corynanthine on the penial circulation of the dog. MARCEL BADOUIN: Six cases of thoradelphy in the pig and sheep. W. SARNOWIEC: The allergic reaction in acute infections.

BRUSSELS

Royal Academy (*Bull. Classe Sci.*, **30**, No. 12). L. GODEAUX: Involutions of the second order of space (5). J. LEDRUT: Production of hypoglycæmia by intraduodenal injection of dilute hydrochloric acid in *Raia clavata*. The injection causes a drop in the blood sugar, and the effects appear to be the same as in the dog. J. GÉHÉNIAU: Parametric form of a n-ple integral. E. LAHAYE: A class of differential equations of the first order possessing a singular point. J. THIBAUD: Penetrating radiation produced in beryllium by bombardment with α-rays. The absorption curve of a neutron beam in lead, iron, bismuth and paraffin wax shows a series of maxima and minima. Possible conclusions from the observations are considered. M. DE HEMPTINNE and J. WOUTERS: Raman spectrum of silicomethane. Liquid silicomethane shows Raman lines of which $\Delta\nu$ is 2,166 cm.$^{-1}$ and 958 cm.$^{-1}$. A. DE WAELE: Note on the evagination of *Cysticercus fasciolaris*, Rud. L. GODEAUX: Algebraic surfaces of genus zero having elliptic tricanonical curves. TH. DE DONDER: A new generalisation of the wave mechanical equation. An extension of a previous generalisation of Schrödinger's equation to take electron spin into account. A. DELGLEIZE: Minimal surfaces and their transformations. YVONNE DUPONT: Polarisation currents. The fictitious currents due to the electro-magnetic polarisation are defined. J. GÉHÉNIAU: The theorem of momentum and energy in a gravitational field. J.-M. DELFOSSE: Raman spectrum of phosphoretted hydrogen. The principal Raman line, $\Delta\nu = 2306$, agrees well with that found by Fung and Barker in the infra-red spectrum, $\nu = 2327$, allowing for change of frequency from liquid to gaseous state. L. LISON: On the phenomena of metachromatism (2). Spectrophotometric study of metachromatic dyes. It is shown that none of the present theories can account for the change of colour of a metachromatic dye by a chromotropic substance, hydrolytic action and tautomerism being inadequate. J. BORDET: Specificity in biology. G. LEMAÎTRE: The expanding universe.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, **21**, 1–68, Jan. 15, 1935). WILLIAM KING GREGORY: On the evolution of the skulls of vertebrates with special reference to heritable changes in proportional diameters (anisomerism). When local acceleration or retardation of growth rate of certain parts occurs, the process is termed anisomerism. This process is traced in the most primitive known fossil chordates (Ostracoderms). It is concluded that *Poraspis* and *Palæaspis* are the most primitive. The existing cyclostome orders, petromyzonts and myxinoids, show morphological evidence of an ostracoderm ancestry, while *Amphioxus* is a much degraded anaspid ostracoderm. EMMETT REID DUNN: The snakes of the genus *Ninia*. These Colubrid snakes occur in Panama, Costa Rica and Nicaragua, and seem to come between a group of burrowing forms and a group of arboreal forms. FROELICH G. RAINEY: A new prehistoric culture in Puerto Rico. Excavations of middens at three widely separated sites have revealed two or possibly three culture horizons, (3) doubtful recent, (2) Arawak, (1) crab culture, respectively. The latter is new, and is characterised by the use of painted decoration on well-fired vessels of fine-grained clay, generally with negative designs formed in red and outlined in white paint. H. J. MULLER and A. A. PROKOFYEVA: The individual gene in relation to the chromomere and the chromosome. A selected lot of chromosome breaks in close proximity with one another produced by irradiation in *Drosophila* was analysed. Mutually consistent genetic and cytological results were obtained, and maps showing the positions of genes and breaks within a portion of one large chromomere have been made. Apparent 'mutational' changes accompanying gene rearrangements are due to the influence of neighbouring genes, and this position effect can extend over several genes. The total number of genes in the chromatin of a *Drosophila* salivary gland nucleus is 5,000–10,000. (See also NATURE, Feb. 16, 1935, p. 253.) ROBERT W. WILSON: Cricetine-like rodents from the Sespe Eocene of California. WILLIAM BOWIE: Fundamental geodetic surveys in the United States nearing completion. The U.S. Coast and Geodetic Survey is now completing a series of first-order arcs of triangulation and lines of levels spaced at intervals of about 100 miles, with second-order triangulation and levelling in the intermediate areas. It has been found that mean sea-level along the coast is not an equipotential surface, but increases with increase in latitude. The Canadian and Mexican Governments have unified their triangulation systems with that of the United States, so a single triangulation net is available for the whole of North America. RICHARD J. LOUGEE: Time measurements of an ice re-advance at Littleton, N.H. The data afforded by sections, showing sands and varved clays between an upper and lower till, exposed during the construction of a dam, make it possible to follow the retreat, re-advance and final retreat of the ice at this locality. G. A. MILLER: (1) Groups involving a set of as many conjugates as commutators. (2) Sets of group elements involving only products of more than n. C. G. SUITS: The temperature of the copper arc. A condensed discharge between an electrode within the arc and the cathode

of the arc is used as a source of sound. The sound receiver is a non-oscillatory spark discharge, the voltage of which changes abruptly when a sound wave is received; the change is recorded by an oscillograph. Time intervals recorded in this way are plotted for different lengths of the arc, and from this curve the velocity, free from end corrections, is obtained as a slope. From the velocity of sound in the arc, the temperature can be deduced, allowance being made for changes in density due to dissociation and in specific heats due to excitation. The temperature of the copper arc is about 4,000° K. to within 200°; it is very sensitive to metallic vapour content. J. A. Stratton: Spheroidal functions. These functions are defined and their properties discussed from the point of view of physical applications. Philip M. Morse: Addition formulæ for spheroidal functions. They can be used in the study of wave motion in elliptic cylinder and in spheroidal co-ordinates, and in particular in dealing with diffraction problems. Paul S. Epstein: On the bending of electromagnetic micro-waves below the horizon. A theoretical discussion of the transmission of radiations of wave-lengths of the order of 50 cm., based on Huygen's principle. The earth is regarded as a perfectly absorbing screen, and the effect of the atmosphere is neglected. The formulæ derived give results qualitatively in agreement with those obtained by Marconi for radiations from Rocca di Papa on wave-lengths of 50–60 cm.

Forthcoming Events

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

Sunday, April 7

British Museum (Natural History), at 3 and 4.30.—M. A. Phillips: "Fossil Reptiles".*

Monday, April 8

British Museum (Natural History), at 11.30.—M. Burton: "Diving Methods employed in Sponge Fisheries".*

Victoria Institute, at 4.30.—Rev. Samuel M. Zwemer: "The Origin of Religion—by Evolution or by Revelation".

Tuesday, April 9

Royal Photographic Society (Scientific and Technical Group).—Dr. P. W. Cunliffe: "Photography in Wool Research".

Thursday, April 11

Institution of Electrical Engineers, at 6.—N. Ashbridge, H. Bishop and B. N. MacLarty: "The Droitwich Broadcasting Station".

Friday, April 12

Institution of Mechanical Engineers, at 6.—A. Fage: "Aerodynamical Research and Hydraulic Practice" (Extra General Meeting).

Institution of Naval Architects, April 10–12.—Annual Meeting to be held at the Royal Society of Arts, John Street, Adelphi, W.C.2.

April 10, at 10.30.—Lord Stonehaven: Presidential Address.

Official Publications Received

Great Britain and Ireland

University College, Southampton. Avon Biological Research: Annual Report, 1933–34. Pp. 76+4 plates. (Southampton: University College.) 2*s.* 6*d.*

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1620 (A. 157): Abstract—Transverse Tests on Sand Cast Aluminium Alloy Bars. By C. E. Phillips and J. D. Grogan. Pp. 2. (London: H.M. Stationery Office.) 2*d.* net.

The Institute of Physics. Conference on Industrial Physics, Manchester, March 28th, 29th, 30th, 1935: Handbook. Pp. 16. Industrial Physics Conference on Vacuum Devices in Research and Industry: Catalogue of the Exhibition, Manchester 1935. Pp. 40+xxii. (London: Institute of Physics.)

Liverpool Observatory and Tidal Institute. Annual Report 1934. Pp. 15. (Liverpool.)

Proceedings of the Royal Society of Edinburgh, Session 1934–1935. Vol. 55, Part 1, No. 4: On Least Squares and Linear Combination of Observations. By Dr. A. C. Aitken. Pp. 42–48. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 6*d.*

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1934. (No. 83.) Pp. 126+2 plates. (Marlborough: Marlborough College.) Members, 3*s.*; non-Members, 5*s.*

Society of Chemical Industry: Chemical Engineering Group. Proceedings, Vol. 15, 1933. Pp. 136+6 plates. (London: Chemical Engineering Group.) 10*s.* 6*d.*

Other Countries

Second Report of the Royal Institute of Science, Bombay (1926–1934). Pp. ii+73. (Bombay: Royal Institute of Science.) Gratis.

Bulletin of the National Research Council. No. 96: Selected Topics in Algebraic Geometry, II. Supplemental Report of the Committee on Rational Transformations. Pp. xii+84. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

Sveriges Geologiska Undersökning. Ser. Aa, No. 176: Beskrivning till kartbladet Storvik. Av B. Asklund och R. Sandegren. Pp. 150+2 plates. (Stockholm: Sveriges Geologiska Undersökning.) 4.00 kr.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 16, No. 3: On the Growth Rate of Reef Corals and the Sea Water Temperature in the Japanese Islands during the latest Geological Times. By Ting Ying H. Ma. Pp. 25+4 plates. (Tôkyô and Sendai: Maruzen Co., Ltd.)

University of Illinois: Engineering Experiment Station. Bulletin 269: Laboratory Tests of Three-Span Reinforced Concrete Arch Ribs on Slender Piers. By Wilbur M. Wilson and Ralph W. Kluge. Pp. 122. 1 dollar. Bulletin No. 271: Determination of Mean Specific Heats at High Temperatures of some Commercial Glasses. By Prof. Cullen W. Parmelee and Alfred E. Badger. Pp. 24. 30 cents. Bulletin No. 272: The Creep and Fracture of Lead and Lead Alloys. By Prof. Herbert F. Moore, Bernard B. Betty and Curtis W. Dollins. Pp. 50. 50 cents. (Urbana, Ill.: University of Illinois.)

Sudan Government: Wellcome Tropical Research Laboratories. Chemical Section, Publication No. 68: Report of the Government Chemist for the Year 1934. Pp. 13. (Khartoum: Wellcome Tropical Research Laboratories.)

Government of India: Department of Industries and Labour. Functions and Organisation of the India Meteorological Department, 1935. Pp. 25. (Simla: Government of India Press.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 15, Part 2: Crustacea Macrura and Anomura of Porto Rico and the Virgin Islands, by Waldo L. Schmitt; The Amphipods of Porto Rico and the Virgin Islands, by Clarence R. Shoemaker. Pp. 125–262+4 plates. (New York: New York Academy of Sciences.) 2 dollars.

A Manual on the Air Seasoning of Indian Timbers. By Dr. S. N. Kapur. Pp. vii+113+11 plates. (Delhi: Manager of Publications.) 3 rupees; 5*s.* 3*d.*

Annual Report of the Patna Science College Philosophical Society for the Session 1933–34. Pp. 5. Bulletin of the Patna Science College Philosophical Society. No. 5: Dr. K. S. Caldwell Commemoration Number. Pp. iv+71. (Patna: Patna Science College.)

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Hydrografi, Bind 3, Nr. 1: Temperaturmessung mit elektrischem Widerstandsthermometer auf der Kattegatsexpedition im August 1931. Von J. P. Jacobsen. Pp. 22. Serie Fiskeri, Bind 9, Nr. 5: Periodic Fluctuations in the Size of Various Stocks of Fish and their Causes. By Aage J. C. Jensen. Pp. 71. 5.00 kr. Serie Fiskeri, Bind 9, No. 7: Marking Experiments with Cod at the Faroes, 2: Second Report: Experiments in 1923–1927. By A. C. Strubberg. Pp. 36. 3.00 kr. (København: C. A. Reitzels Forlag.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 20, Memoir No. 5: The Triassic, Jurassic and Cretaceous Gastropoda and Lamellibranchia of the Attock District. By L. R. Cox. Pp. v+27+2 plates. (Calcutta: Geological Survey of India.) 1.14 rupees; 3*s.* 3*d.*

Catalogues

The Wild-Barfield Heat-Treatment Journal. Vol. 1, No. 4, March. Pp. 41–54. (London: Wild-Barfield Electric Furnaces, Ltd.)

Botanical Books: Herbals, Monographs, Floras, On Gardens and their Management, Wild Flowers, etc. (Catalogue No. 233.) Pp. 40. (London: Dulau and Co., Ltd.)

The "Wigmore" Epidiascope. Pp. 4. (London: Newton and Co.)

A Selection of Interesting Books on a Great Variety of Subjects. (No. 500.) Pp. 156. (London: Bernard Quaritch, Ltd.)

Micro-Projection Apparatus. (List MP. 1935.) Pp. 12. (Manchester: Flatters and Garnett, Ltd.)

Heffer's Book Adviser. No. 8, March: Spring Announcements. Pp. 56. (Cambridge: W. Heffer and Sons, Ltd.)