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Petroleum Technology and Chemical Industry

IF we survey the course of evolution of petroleum technology, particularly as it concerns the treatment, refining and utilisation of crude oil and its products, it is an impressive fact that despite a magnitude of growth and ramifications of the industry it supports in modern life, equally an obvious dependence throughout on the functions of certain applied major sciences, it has long maintained, outwardly at all events, a remarkable measure of autonomy. No one ever seriously suggested, because chemistry and physics, for example, enter largely into the technique of manufacture of innumerable products from the raw material, that this technology is *ipso facto* an offspring of co-ordinated influences of these or any other sciences. On the contrary, oil technology has grown in an almost unique fashion. It has been urged by an overwhelming but universal impulse. It has rapidly strengthened from an innate knowledge of its inherent power as a world force, casually absorbing, but diligently applying, just those established principles of appropriate natural science as would meet its needs. It has known few of the struggles of just as important, but none the less subservient, industrial technologies.

No one science nor the more mundane interests of international, economic and political life, which petroleum has profoundly influenced in latter years, can legitimately claim any fundamental control over the technology even now. There are signs, however, that this order of things is destined to change, if indeed the change is not now actually taking place.

In a welter of conflicting difficulties through which the industry has been and still is passing, certain facts stand out as pre-eminent in any consideration of the situation. Over-production, not only of crude oil but also of many of its products ; waste ; curtailed consumption ; increasing competition with commodities serving similar purposes but derived from different raw materials ; vicissitudes of current international commerce ; all these combine to create within the industry an acute self-consciousness of stifled activity, probably for the first time in its history. The repercussions of this have not been without their corresponding reaction on the technology. No one can really see far ahead with precision. Even the convictions of those who profess to know carry little more than temporary weight, since they seem to lack firm

and definite foundation in a much disturbed ground.

Into this bewildering maze of circumstances there has been flung, with considerable force recently, the challenge of synthetic oil from hydrogenation process. What is the significance of this incursion? It is inconceivable, aside from all economic argument, that this factor in the situation can be other than one to be seriously reckoned with; it is disturbing even now; it is bound to be formidable ultimately in the petroleum industry, and to have far-reaching consequences on the technical operations involved therein.

The history of chemical industry is rich in examples of new processes in which the established commercial success was achieved among the ruins of discarded doubts and scepticisms at the outset. Hydrogenation is a long-tried process; it has, as a technical procedure, been brought to a high state of efficiency. It is chemical engineering at its best. Oil production from coal, whether by this or by any other means is, and must inevitably be, on whatever scale achieved, a product of chemical industry. To this extent, the product differs fundamentally from anything realised by the petroleum industry.

The coal industry *per se* is non-existent in the same sense in which we contemplate and assess the activities of the oil industry to-day. It discarded individuality long ago in favour of second-hand recognition through the medium of dependent products such as gas, coal-tar, dyes and allied substances, the enormous developments of which not only built up relevant commercial activities, but also have contributed more to the growth of chemical industry as a whole than probably any other branch of it. Hydrogenated coal-oil when it arrives as an accepted economic commodity will simply add another weapon to the already powerful array of forces which chemistry commands in the sway of modern civilisation.

The moral to the petroleum industry in general, and to the technology in particular, is surely obvious. There has for long been the broadest possible overlap between research within the petroleum and chemical industries, at least as technically interpreted, and where basic substances common to both have been involved. Research, temporarily retarded as it may have been by prevalent conditions, has none the less forged ahead in chemical industry, as keenly animated as ever by the desire to conquer fresh fields and produce new outlets for natural resources at the present time only partially or extravagantly exploited. The trend of petroleum technology, if it is to compete with the incidence of an independent and biased chemical industry, must, apart from the actual winning of oil, inevitably lead in the direction of finding new and extended uses for its raw material and basic products.

It is insufficient to point to a succession of highly refined products of crude oil such as petroleum, paraffin, lubricating and fuel oils, wax and asphaltic bitumen—the high standard of production of which to-day is freely acknowledged—as though these represent monuments to final achievement. There can be no such finality, and research must aim far beyond the mere improvement of technique of production, the multiplicity of types and qualities of distillates, and the goal of supplying markets with what they have been accustomed.

In point of fact, the domain of petroleum technology is no longer inviolable; and if it does not of its own initiative expand actively into the realm of chemical industry, then assuredly will the latter gradually stretch the tide-mark of overlap until the merger is complete.

Petroleum, like coal, is a wasting asset. It is no longer the prerogative of the oil industry alone and, as a natural resource still possessing immense latent possibilities of more efficient development, it must come into line with other basic raw materials and be subject to that vigorous independent investigation which is afforded by intensive chemical research. Only in this way will it avoid some of the calamitous happenings which have led to the acute problems of efficient coal exploitation and utilisation, for which, it is to be noted, chemical industry has gone a long way to find a practical and economic solution. H. B. M.

Age of Retirement in India

UNDER the title "The Fifty-five Year Rule", the November issue of the Indian monthly, *Current Science*, contains a long leading article advocating the abolition of retirement from educational posts at the age of fifty-five, as is now compulsory under the fundamental rules, and the raising of the age limit to sixty years in the first instance, or making such appointments for life. We have read the article with some surprise, since we are convinced that the concensus of opinion of

those engaged in educational work in Great Britain regards the comparatively recent introduction of the Universities' Superannuation Scheme with its corollary, a compulsory age of retirement, as a distinct contribution both to the efficiency of the universities and of the schools.

Although it is not uncommon for men of mature age to make valuable direct contributions to knowledge, there is no doubt that with increasing years their teaching, whether it be in the school class room or the university lecture theatre, tends to become stereotyped and lacking in inspiration. Furthermore, they show less and less inclination to initiate young students into the methods of research, although they themselves may continue to be actively engaged therein. A not unimportant feature of the superannuation scheme has been to accelerate the promotion of the younger men and so stimulate employment. So far as we can gather, the main objection to compulsory retirement is that it deprives the university of the services of men of mature experience, but we doubt if this is actually so in practice. It is now almost invariably the custom to confer upon the retiring professor the title of emeritus, which is recognised as carrying with it the right to laboratory accommodation in his old department, a privilege of which advantage is frequently taken.

The writer of the article in *Current Science* appears to be under the impression that professorships in European universities are life appointments. As a matter of fact, there remain a few professorships in Scottish Universities and at Oxford and Cambridge where a definite age of retirement has not been assigned, but as these fall vacant the general practice of retirement at sixty is being adopted. It is true that the German universities do not fix a date for retirement, but in that country a professor's pension is the same as his salary, and consequently there is not the same temptation as there is in Great Britain and in India to continue in office after effective service can be rendered.

It is suggested in the article that, as the result of the great advances made in preventive medicine, retirement at the early age of fifty-five is no longer necessary in India. Whilst the increased security of life in the East might be used as an argument for raising the retiring age to sixty, we doubt whether this is actually the case. Climate cannot be altered. The Indian matures much earlier than the European and he ages correspondingly earlier, so that as a general rule the present retiring age seems to be comparable to that prescribed in England.

It is pointed out in the article that though the Government has decided to terminate the services of professors and others in the educational service at fifty-five years of age, this is not the practice in the judiciary or administrative posts of cabinet rank. Though this suggests unjust inequality of treatment, we think the conditions are different in the two groups. One of the main essentials for success in education is originality, a gift more common in youth than in age; this qualification is scarcely required on the Bench. In the field of higher administration we note a growing tendency to find room for the younger men, and we think this is likely to increase in the future.

While we agree with the view expressed in the article that a man is not necessarily disqualified physically or mentally for further useful service in India when he reaches the age of fifty-five, we believe it is not usually desirable for Europeans to remain at work in that country beyond that age. If, however, a university finds it to the advantage of a department to retain a teacher after the age of fifty-five, a man who is still active at that age ought to be able to expect to have his period of service extended to the age of sixty. It is the practice in some educational institutions to make these extensions by one year at a time, and we suggest that if the universities could extend the services by such a period, not exceeding five years in all, after considering the merits of each case, there could be little cause of complaint.

Evolution and Mechanism of Hearing

Hearing in Man and Animals. By R. T. Beatty. Pp. xi+227. (London: G. Bell and Sons, Ltd., 1932.) 12*s*. net.

THE study of the evolution of the sense-organs has a fascination for the general reader as well as the scientific worker. Our knowledge of the world around us is dependent on the reaction between various forms of physical energy and the appropriate sense organs. Some of the latter, such as touch, smell, taste and sight, are common to all vertebrates and are found in much lower forms of life, but hearing is relatively uncommon and may be regarded as a 'recent' development. In many of the lower forms of life, for example, in insects and fishes, the sense of hearing is either entirely absent or exists in a most rudimentary form.

For its proper understanding, audition requires a knowledge of anatomy, physiology, physics and

psychology. Specialists working in one or other of these sciences clearly have difficulty in following developments in the others. This tendency has resulted in the accumulation of a large mass of detailed and highly specialised information which is not easily accessible or intelligible to workers in a different scientific branch of the subject. The need has long been felt that such information should be collected and correlated.

The first important step to this end was made by the Physical Society in its published discussions on "Audition" and "Vision". In these publications the work of physiologists, physicists and psychologists is collected under the same cover. But this is not sufficient. A further important step is still required, namely, to present the collected data in the form of a connected whole, written in a language which all can understand. This work has been carried out in a remarkably efficient manner by Dr. R. T. Beatty in the work under notice. Here one may read for the first time, in clearly expressed terms, a coherent description of fascinating researches in widely different fields of science.

In the preface, the purpose of the book is stated "to convey in plain terms to the general reader a connected account of the phenomena of audition in living creatures, and of the various mechanisms by which animals are made sensitive to the range of sounds which is important for their welfare". Dr. Beatty has fulfilled his purpose in a very satisfactory manner. The literary style is delightful and the information contained in the book will be satisfying and instructive not only to the general reader, to whom it is primarily addressed, but also to a wide range of scientific workers, teachers and research workers. The two-page list of acknowledgments at the beginning of the book is in itself interesting, indicating as it does the wide field over which the author has collected his material. This is further supported by the comprehensive list of references at the end of each chapter of the book.

The opening chapter gives a detailed description of the human ear and the functions of the various parts. The function of the chain of ossicles in the middle ear is particularly interesting as it involves a principle frequently occurring in technical acoustics. The flexible diaphragm, the ear drum, receives sound energy from the surrounding air and transmits it to the liquid-filled cochlea. The efficient transmission of this energy from a relatively light and yielding medium to a heavy, resistant fluid, requires the intermediary of a mechanical transformer, a lever, having the correct lever ratio. This is provided by the chain of bones.

One of the most fascinating chapters of the book is that which describes the evolution of the ear. Commencing with the primitive auditory mechanisms in fishes, evolutionary growth is traced through amphibians, reptiles and birds, to mammals. A later chapter of equal interest deals particularly with hearing in animals. These chapters abound with new and interesting information. For example, the ears of insects are never found on the head. The external ear, which takes the form of a stretched membrane covering an opening in the exterior shell of the insect, may be placed in some cases on the thorax, or the abdomen, or, as in grasshoppers and crickets, just below the knee-joint of the forelegs. Cases are recorded in which the external hairs of insects play a part in the reception of sound, and certain types of caterpillar respond to the human voice by suddenly raising the front part of the body.

Dr. Beatty explodes a few time-honoured beliefs. Fishermen should note, in spite of Isaac Walton's statements to the contrary, that fish cannot hear air-borne sounds. The angler is at last released from bondage and he may now converse freely whilst plying his rod. The sounds produced by his boots, knocking against the hull of the boat or tramping on the river bank, are on the contrary conveyed readily to the fish's auditory apparatus with disastrous results to the catch! It is a little disappointing to learn that snakes are deaf to air-borne sounds and that the piping of the snake charmer charms only the audience. Dogs, on the other hand, are extremely sensitive to sounds. Pavlov's experiments indicate that they have a sense of absolute pitch which considerably surpasses that of human beings. Furthermore, their frequency range of audibility is much greater, extending from very low sub-audible (that is, to human ears) to supersonic frequencies. Experiments reveal also that they can readily discriminate between the pitch of two tones only a quarter of a semi-tone apart. Such remarkable observations on the dog's auditory apparatus have led to the suggestion that hearing in man is on the downward grade, not due to imperfection in the ear, but from defect of nerve connexions in the brain. "We must remember that man stands alone in the animal kingdom in his power to interpret speech, and that large cortical areas have been

given over for that purpose, no doubt at the expense of the perception of subtle variations in pitch and rhythm which is so clearly manifest in the case of the dog".

A short but interesting chapter deals with the happenings in the human brain when the nerve endings in the cochlea are stimulated by an external sound. The nerve impulse is relayed from one station to another until it reaches the 'conscious' part of the brain. These relay stations not only pass on information to the brain but also inform other nerve centres which control the automatic reflex movements of the eye and other parts of the body. At its maximum sensitiveness, the ear can respond to a sound intensity of 10^{-9} microwatt per square centimetre, a quantity of the same magnitude as light from a candle at a distance of eight miles, assuming perfectly transparent air. The ear is a more efficient receptor than the eye.

Two chapters are devoted to the study of theories of hearing. Although the resonance theory holds the field, there are still many discrepancies in detail which require further investigation. Interesting experiments on animals are described in which degeneration of certain parts of the organ of Corti over a limited region is produced by a long-continued tone. Pavlov's experiments on dogs and Held's work on guinea pigs show that surgical operations in which a small portion of the cochlea is destroyed, result in localised deafness the frequency range of which depends on the point of operation.

The book concludes with three interesting chapters on music, noise and defects of hearing. The chapter on music, dealing as it does with origins, in respect of style and subject matter, would form a fitting chapter in Wells's "Outline of History". The treatment of noise is essentially modern, bringing the reader into touch with the special problems of civilisation, with its roar of machinery and traffic. The effects of noise on working power and on the nervous system are examined critically, and an estimate is made of the 'cost' of noise. The final chapter on defects of hearing appropriately follows the chapter on noise.

Dr. Beatty deserves unqualified congratulation on his success in producing this excellent book on hearing. It is well written, well illustrated and well reproduced. Readers will look forward to a companion volume on "Sight in Man and Animals".

The Spiders of Denmark

The Biology of Spiders: with Especial Reference to the Danish Fauna. By E. Nielsen. Vol. 1. Pp. 248 + 32 plates. Vol. 2. Pp. 724 + 5 plates. (Copenhagen: Levin and Munksgaard; London: Williams and Norgate, Ltd., 1932.) 30*s*.

THIS substantial work is a record of observations of the habits of Danish spiders, and appears in a somewhat unusual form. The full accounts are contained in the second volume, written in Danish and fully illustrated; the first volume is a slightly condensed translation, almost without illustrations save for a collection of plates at the end. Thus the first volume forms an English guide to the second. The Danish preface is dated May 1, 1928, and the English preface September 1, 1931, so that the first volume includes some recent observations not contained in the second. On the other hand, the very complete Danish account of the structure of spiders is omitted from the English volume.

Part I of this work is a general account of the life history of spiders; Part II records the author's observations on the individual species, arranged according to Simon's classification. It is unfortunate that the book was written just too soon to adopt the system contained in Prof. Petrunkevitch's "Systema Aranearum", as it may lead to a tendency to perpetuate Simon's now obsolescent method.

The observations consist chiefly in descriptions of the webs, the cocoons, and the feeding and mating habits. It would not be possible to study spiders as long and as carefully as Mr. Nielsen has done without breaking new ground, and there is much that is new in this work. The most striking is undoubtedly the careful account of the separate functions of the claws and tufts of 'hair' on a spider's foot as it grasps a silk thread or runs over a web. The author describes how the set of the claws gives a twist to the thread, and how the hair-tuft forms a springy pad which detaches the claw as the spider runs—a very careful analysis of a process which is unexpectedly elaborate. A large section of the work, Part III, deals with the parasites of spiders. Mr. Nielsen writes of these with the authority of a specialist, and this account of his work is extremely welcome. Other features which will be of interest to English readers are his descriptions of the triangle-spider, *Hyptiotes*, and the water-spider, *Argyroneta*, of

the burrowing wolf-spiders, and of the temporary egg-teeth on the palpi of *Zilla*, which help the young to burst the egg-membrane.

The author is a skilled photographer and the work contains more than four hundred reproductions of his work of quite outstanding merit. Photographs of spiders are never easy to obtain and there is no other book known to us in which the photographs approach the excellence of those used to illustrate these volumes.

Mr. Nielsen is content to describe what he has seen, and his book would more accurately be described as a natural history than a biology. There is very little discussion of the general significance or broader aspects of the facts observed, save for some careful analyses of various cocoons. Indeed a blemish on the work is the naive way in which the author endows spiders with mental attributes. He describes a female *Agelena* as "very affectionate", and says that young wolf-spiders can cling to their mother's back, "being from birth acquainted with the laws of inertia".

The second volume ends with a list of Danish spiders, and a supplement to this in the first volume brings the total to 372 species. About four-fifths of these are also British. This is a valuable addition to the book, and makes Denmark more fortunate than England, for no list of British spiders has appeared for more than thirty years. Both the author and his publishers may thus be congratulated on the production of a most acceptable book. T. H. S.

Diphtheria

Diphtheria, Past and Present: its Ætiology, Distribution, Transmission and Prevention. By Dr. J. Graham Forbes. Pp. xx+832. (London: John Bale, Sons, and Danielsson, Ltd., 1932.) 45*s*. net.

DIPHTHERIA is one of the best understood human bacterial diseases and its study has enriched bacteriology with several ideas of prime importance. The isolation of the bacillus by Loeffler (1884) provided a means of precise diagnosis: the discovery of antitoxin by Behring (1890) opened up an entirely new field in prevention and therapy. Theobald Smith (1907) saw the possibility of making people immune by the inoculation of toxin: Schick (1908) made this practicable by devising his simple test for individual immunity. Diphtheria is also the disease in which it was first shown that the lesions could be produced by toxin without the bacilli and in which the possibility of becoming immune by subinfection without any actual illness was first clearly recognised.

Pathologist, bacteriologist and hygienist therefore all know a great deal about the diphtheria bacillus and what it does, which is set out in the monograph published by the Medical Research Council in 1923. Since almost anyone can be deliberately immunised (nowadays with toxoid-antitoxin mixtures) and scarcely any patients will die if they are given antitoxin at the outset, it seems that the disease might well be abolished altogether if practical hygiene and medicine were a sufficiently accurate reflection of bacteriological knowledge. In fact, children still catch diphtheria and a proportion of them still die of it, and Dr. Forbes's book consists of a very detailed account of the occurrence of the disease, what has been done in the way of prevention and what we may hope to achieve in the future. It seems clear from his account that the failure to get rid of diphtheria is due almost entirely to difficulties in practical application rather than to imperfections in knowledge.

The book is a voluminous expansion of the Milroy Lectures of 1929 and consists almost wholly of facts and figures; we could wish that Dr. Forbes had not been so sparing of commentary. It is, however, cheering to find that the intensive campaign of immunisation started by Park in New York in 1913 is at last having an effect on the diphtheria death-rate sufficient to satisfy the statisticians—"unfeeling men" as the late Sir Frederick Andrewes calls them in his preface.

Surface Catalysis

Von Davy und Döbereiner bis Deacon: ein halbes Jahrhundert Grenzflächenkatalyse. Von A. Mittasch und E. Theis. Pp. 278 + 16 Tafeln. (Berlin: Verlag Chemie G.m.b.H., 1932.) 18.50 gold marks.

DRS. MITTASCH AND THEIS have provided a charming record of work on surface catalysis during a period of half a century from Davy and Döbereiner to Deacon, and have dedicated it to Wilhelm Ostwald. The book is illustrated by portraits of the three workers whose names appear in the title and of twelve of their contemporaries, together with a more recent portrait of Prof. Horstmann, who died at Heidelberg in 1929. The

narrative is also illustrated with some fourteen diagrams, including a series of Döbereiner lamps and allied devices for ignition with the help of spongy platinum or the like.

The scope of the work has been restricted by excluding the modern developments which have brought surface catalysis to the forefront as an industrial method of first-rate importance, and by omitting the important subject of homogeneous catalysis. The latter is referred to briefly in a "Review of Related and Separated Fields" (Chap. xiv) as well as in the final "Retrospect and Prospect" (Chap. xv). In this final chapter it is pointed out that a lull in the study of heterogeneous catalysis between 1875 and 1890 was followed by an intensive study of homogeneous catalysis; this preceded the great modern applications of surface catalysis, the foundations of which form the subject of the present monograph.

One of the earliest of these foundations was Davy's 'night lamp' (1818); in this lamp a platinum spiral was maintained in incandescence over the wick of a spirit lamp, of which the flame had been blown out. Döbereiner's discovery of the oxidation of alcohol to acetic acid by platinum black followed in 1831; and the ignition of oxyhydrogen mixtures, leading to the development of the Döbereiner lamp, in 1832. The term 'catalysis' was introduced by Berzelius in 1835, and was followed by a controversy with Liebig as to the nature of 'catalytic force'.

The application of catalysis to the preparation of sulphuric acid by the 'contact process' can be traced back to an English patent taken out in 1831 by Phillips, who proposed to use platinum for this purpose, whilst Robb in 1853 introduced the use of 'peroxide of iron'. In the same way, the catalytic oxidation of ammonia to nitric acid can be traced back to the work of Kuhlmann, who discovered in 1838 that nitric acid was formed when air and ammonia were passed over platinum heated to about 300°.

The early period in the history of surface catalysis closes with the technical development of Deacon's process for making chlorine by the catalytic oxidation of hydrogen chloride. This method can be traced back to the work of W. Henry in 1826, but was only developed into a practical process about 1870. The technical conditions in this case were not too difficult, since there was no need for the drastic purification by which alone success was finally achieved in the contact process for sulphuric acid; and the high temperatures and pressures which are required for the synthesis of ammonia, and for many other processes of catalytic hydrogenation, were also not yet needed. There was therefore a natural sequence in the industrial development of surface catalysis, and the authors are to be congratulated on the success with which they have brought out the logical character of this important chapter of chemical history.

Short Reviews

Traité de pyrométrie optique. Par Prof. Gustave Ribaud. (Encyclopédie photométrique, Cinquième section, Mesures sur l'émission, Tome 4.) Pp. xvi + 485. (Paris: Editions de la *Revue d'Optique théorique et instrumentale*, 1931.) 95 francs.

IT is a remarkable sign of the progress of theoretical and experimental knowledge in a single branch of physics that a volume of nearly 500 closely printed pages should be required to give an account of modern optical pyrometry. In an interesting preface, M. Charles Fabry points out that the production of high temperatures in industrial and laboratory operations outstripped for a long period the methods of measuring such temperatures. For example, the gas thermometer, theoretically the simplest form, failed because no reservoir could be found which would retain its shape and remain absolutely impervious to gas at extremely high temperatures. The problem of measuring these temperatures was only effectively solved when the use of a material thermometer was abandoned and attention was concentrated on the radiation emitted by the body the temperature of which was to be found.

All the methods based on the examination of the associated radiation may be included under the name optical pyrometry. These methods are based on the laws of radiation of a black body due to Stefan, Wien, and Planck—laws which are discussed by Prof. Ribaud in the earlier part of the volume. The most valuable method is that of the disappearing filament optical pyrometer. The importance of this instrument is illustrated by its use in determining the temperature of tungsten lamps for an intercomparison of the high temperature scales of the leading standardising laboratories. For any point of the entire range from about 1,400° to 2,700° K. the maximum difference found in such an intercomparison was only a few degrees (W. E. Forsythe). Prof. Ribaud's book should be in the hands of all those who are concerned with high temperature measurements. H. S. A.

Prout's Hypothesis. Papers by Dr. William Prout (1815–16), J. S. Stas (1860) and C. Marignac (1860). (Alembic Club Reprints, No. 20.) Pp. 58. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1932.) 2*s.* 6*d.* net.

SOON after the classification of the chemical elements by Lavoisier, and the decomposition of the alkalis by Davy, the latter, in 1812, suggested that the "undecompounded substances" may be composed of hydrogen "with another principle yet unknown in the separate form". If we identify this principle with the electron, we have in this speculation (not mentioned in the present Alembic Club Reprint) an anticipation of the modern theory of atomic structure as striking as the prediction of isotopes by Crookes in 1886, and of the packing effect by Marignac in 1860. The logical development of Davy's idea was found in the papers of Prout (1815–1816), which are reprinted in the present volume, suggesting that atomic weights are whole multiples of that of hydrogen, and that "we may almost consider the πρώτη ὕλη of the ancients to be realised in hydrogen".

Stas's criticism of Prout's hypothesis (1860), on the basis of exact atomic weight determinations, leading him to the conclusion that it is "nothing but an illusion, a pure hypothesis contradicted by experiment", follows. The thoughtful commentary on Stas's paper by Marignac (1860), in which it is suggested that "while preserving the fundamental principle of . . . the hypothesis of the unity of matter", we might "suppose that the cause which has determined certain groupings of the atoms of the sole primordial substance" may have exercised an influence such that "the weight of each group might not be exactly the sum of the weights of the primordial atoms composing it", was entirely disregarded.

The further progress of the matter is very ably summarised in a historical introduction to the booklet, which is one of great interest and fully maintains the high standard of the Alembic Club Reprints.

The Standard Natural History: from Amœba to Man. Contributors: G. J. Arrow, M. Burton, Dr. W. T. Calman, J. G. Dollman, Dr. F. W. Edwards, C. C. A. Monro, J. R. Norman, H. W. Parker, W. P. Pycraft, N. D. Riley, G. C. Robson, Theodore H. Savory. Edited by W. P. Pycraft. Pp. xiv + 942 + 12 plates. (London and New York: Frederick Warne and Co., Ltd., 1931.) 15*s.* net.

IT is somewhat of a venture to compress a knowledge of the animal kingdom, with its three-quarters of a million species, into a single volume, and preserve at the same time a balance between the different groups. But here the attempt has been successfully made, the more obscure groups receiving due place, the more familiar groups, such as birds and mammals, properly being singled out for relatively more expansive treatment.

The systematic cast of the book gives a false impression of its contents, for bare description has been reduced to a minimum and living interest has been sustained by the accounts of habits and of the links between structure and environment; the section on Diptera is a fine example of condensed biological survey. In most of the sections there is a freshness of treatment traceable to the specialised knowledge of the contributors and among the 900 odd illustrations we are grateful for a great many new figures, although several of the pictures of mammals and birds, from indifferent museum specimens, might have been bettered.

Bentham's Theory of Fictions. By C. K. Ogden. (International Library of Psychology, Philosophy and Scientific Method.) Pp. clii+161+3 plates. (London: Kegan Paul and Co., Ltd., 1932.) 12*s.* 6*d.* net.

IN a public lecture recently given in London, Prof. Schlick, of Vienna, said that if philosophers had given more consideration to linguistics, the history of our civilisation would have been different. Indeed, it seems that only a realistic analysis of language could purify philosophy and the special sciences of much of their misleading verbiage. The modern schools of mathematical logicians have done useful work in this direction. Yet the developments of the present should not make us forget the attempts of the past. A thorough study of Bentham's "Theory of Fictions" will prove it to be a mine of information and suggestions. Mr. Ogden has done a real service to philosophy by publishing this book, which will be considered by many as a revelation and as a valuable basis for further research. The actual interest of Bentham's "Theory of Fictions" is enhanced by Mr. Ogden's very able introduction. T. G.

The Spirit of Language in Civilization. By Karl Vossler. Translated by Oscar Oeser. (International Library of Psychology, Philosophy and Scientific Method.) Pp. vii+247. (London: Kegan Paul and Co., Ltd., 1932.) 12*s.* 6*d.* net.

LANGUAGE is viewed at an unusual angle in this work, which describes the interweaving of language with the other activities of mind. It is the philosophy rather than the analysis of language it presents. The author has striking conclusions to put forward on a variety of subjects such as "Language and Life", "Language and Nature", "Language and Science", "Language and Poetry", "Language and Religion". To quote but one of them, he thinks that mathematics might be called a language which allows only pronouns in place of nouns, imperatives in place of verbs, copulative equations instead of adjectives and adverbs. The purpose of mathematical co-ordination of language and concept is the liberation of the concept from the senses. But there is danger in an extreme liberation, because too much reason and abstraction scarcely allow thought to find the way back to itself.

Edmond Halley*

By DR. ALLAN FERGUSON

THE contributions of Shoreditch to the advancement of science are neither many nor varied; the occasional visitor to that cabinet-making region is usually drawn thither by the fame of the parish stocks and whipping-post, or of that oddly inscribed tombstone which marks Dr. John Gardner's "last and best bedroom". But the district has made one contribution of primary importance, for it was in the parish of St. Leonard's Shoreditch that Edmond Halley was born in 1656. Shoreditch was then a suburb of that pre-fire London of which so few traces remain. The London that Halley knew was a London cheerful, noisy and dirty, to modern eyes incredibly small, with narrow, fetid, kerbless streets and rat-ridden, overhanging houses; with a steep descent to the Fleet river, then practically an open sewer, where Holborn viaduct now stands; with an equally steep ascent to Tyburn along that *via dolorosa*, now called Oxford Street; with one ancient many-arched bridge joining the city to Southwark, its gateway crowned with frowning and blackened heads, its piers and starlings damming the river so effectively as to produce at certain stages of the tide several feet difference of level in the water above and below the bridge; with Whitehall still crossed by a Tudor gateway, and the banqueting house of Inigo Jones alive with recent memories of the royal execution.

The ghastly plague pit at Aldgate, hard by the Three Nuns hotel, comes clearly enough even now before the minds of those who turn eastwards from Houndsditch along the little alley that skirts St. Botolph's church, and swings southward through Church Row to join Aldgate. A Three Nuns' hostel still stands near the church, the graveyard of which is significantly raised some feet above the level of the surrounding streets. Pit, inn, church, and the vanished Pye Tavern "over against the end of Houndsditch" where an obscene crowd of roysterers was wont to gather and to jeer at the passing dead-cart must have been very vivid in the memory of Halley, who passed, apparently unscathed, through these fateful years. He was educated at St. Paul's School, under Dr. Thomas Gale, and at fifteen years of age was captain of the school. In 1673 he was admitted a student of Queen's College, Oxford, "having already acquired not only good skill in the Latin, Greek and Hebrew Tongues, but being also well acquainted in the Principles of Geometry and Astronomy, in which he . . . so early distinguisht himself, that we find a Piece of His, called, *Methodus directa et Geometrica cujus ope investigantur Aphelia, Excentricitantes, Proportionesque Orbitarum Planetareorum, absque supposita æqualitate Anguli motus ad alterum Ellipeos Focum, ab Astronomis hactenus usurpata*, . . . publish't in the *Philosophical Transactions* for the Months of August and September, 1676." Kepler had, as we know, enunciated many years before this date his laws stating that the path of a planet is an ellipse, with the sun in one focus; and that the motion of the planet round the sun is not uniform, but is such that the line joining sun to planet sweeps out equal areas in equal times. It was assumed, and it is in fact nearly true, that the motion about the empty focus of the ellipse was exactly uniform; that Halley, at nineteen, should be able to attack critically such a problem shows that he was already highly skilled in the use of the imperfect mathematical apparatus of his day.

Halley did not stay long enough at Oxford to take his degree. His was one of those prescient characters that realises almost instinctively the direction in which knowledge is advancing, and which field it profits best to cultivate. His tastes lay in the direction of astronomy, and he well knew that trustworthy star-charts were one of the pressing needs of the day. But several explorers, Flamsteed and Hevelius in particular, had already set out to chart the northern stars, and Halley, now a skilled mathematician and observer, knew the advantages of a clear field; he therefore decided to make a beginning in the southern hemisphere.

Halley's father, a wealthy London tradesman, settled on his son an allowance of £300 a year, and in 1676, armed with "an excellent brass sextant of 5½ feet radius, with Telescopic Sights and indented Semicircles of the same Metal, and Screws for the ready bringing it into any Plane; a Quadrant of about 2 foot Radius, which he chiefly intended for observations to adjust his Clock; a good pendulum clock; and a Telescope of 24 feet; some lesser ones; and two Micrometers", Halley set sail for St. Helena, where he had decided to set up his observatory.

The climate of St. Helena proved to be very much what it was a century and a half later when the island became the scene of Napoleon's exile. Nevertheless, though the skies were cloudy and rain frequent, Halley stayed there for about a year; and the title of the 'Southern Tycho' was given to him in virtue of his star catalogue, published in 1679.

In this last-named year, Halley embarked upon another adventure. To-day it appears absurdly obvious that far greater accuracy in determining stellar positions is obtained by sighting a star through a telescope than by using the naked eye and the sighting rods in the manner of the older

* "Correspondence and Papers of Edmond Halley." Preceded by an unpublished Memoir of his Life by one of his Contemporaries, and the 'Éloge' by d'Ortous de Mairan. Arranged and Edited by Eugene Fairfield MacPike. (History of Science Society Publications, New Series 2.) Pp. xiv+300+9 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1932.) 21*s.* net.

astronomers. This was not so obvious in 1679; ordinary pinhole sights were certainly crude, but Tycho, one of the great pioneers in exact measurement, had improved this type of sight almost beyond recognition. An example of his measurements may serve to show the accuracy attainable by the use of naked eyesights. Tycho, alive to the necessity for accurate charting, selected seven stars, the most important of these being α Arietis, as standard stars, the positions of which on the celestial sphere he determined with the highest possible accuracy. These measurements of position must, of course, be made with reference to some definite starting point, and it is the intersection of the sun's apparent yearly path in the heavens with the equator of the celestial sphere which determines the position of the Greenwich of the heavens. Tycho's task, therefore, was that of linking up the position of the sun with that of any one of the selected stars. This was done by means of an intermediary, Venus, visible both in the daytime and at night. Tycho determined the relative positions of the sun and Venus, and afterwards of Venus and one of the selected stars, making due allowance for the motion of Venus in the period intervening between the two observations. Some notion of Tycho's accuracy may be gleaned from the fact that the Right Ascension (the analogue of terrestrial longitude) of α Arietis was fixed by him at a mean value of 26° 0′ 30″, the modern estimate for the year 1585 being 26° 0′ 45″. Dreyer gives the probable errors of the positions of Tycho's standard stars as ± 24″·1 in Right Ascension and 25″·9 in Declination (when corrected for refraction).

With possibilities of consistency in observing indicated by figures such as these, it is not surprising that older observers, cognisant of the crudity of the new telescopic sights, should elect to continue to make their observations by the older methods. Foremost among them was Hevelius of Dantzig and, the better to make a critical comparison of the two methods, Halley visited Dantzig in 1679. He was duly impressed with the skill displayed by Hevelius in the use of his instruments, and, in a letter to Flamsteed under date June 7, 1679, he says, after describing the equipment of Hevelius's observatory:—"... As to the distances measured by the Sextans, I assure you I was surpris'd to see so near an agreement in them, and had I not seen, I could scarce have credited the relation of any; Verily I have seen the same distance repeated several times without any fallacy agree to 10″, and on Wednesday last I myself tryed what I could doe, and first I at the moveable sight, and the Printer at the fixt did observe the distance of Yed Ophiuchi from Lucida Aquilæ 55°–19′–00″; then we removed the Index, and my Lord at the moveable sight and I at the fixt did observe the same 55°–19′–05″, and you will find the same distance 6 times observed in Page 272 of ye fourth book of his Machina Coelestis, so that I dare no more doubt of his veracitye." Nevertheless, Halley was too sagacious not to realise that ultimate victory lay with the users of telescopic sights. As for Hevelius, the writer of a memoir of Halley remarks that "the old Gentleman was too much rivetted to his Opinion of those he had so long and so successfully used; and had besides been too much sour'd by the manner in which Dr. Hooke had too freely treated his Labours to think of altering his method or opinion".

It is interesting to note that in a hitherto unpublished letter in the Royal Society's archives Halley, writing under date 1686 to Molyneux concerning "the state of the Controversy between Mr. Hevelius and Mr. Hook about Telescope Sights wherein I am so much concerned", remarks that this controversy "does, as Hevelius manages the matter, affect all those observers that use Telescope sights, and myself in particular, and it is our common concern to vindicate the truth from the aspersions of an old peevish gentleman, who would not have it believed that it is possible to do better than he has done".

Halley's next piece of sustained practical work lay in a study of the variation of the compass. Here again we see illustrated his habit of seizing on a pioneer piece of work, and rounding it off neatly and thoroughly. Provided with a vessel, the *Paramour Pink*—did ever other astronomer sail in so romantically named a ship?—Halley set sail in 1698. True to her romantic name, the ship was the scene of a mutiny, and Halley was forced to return to England. A mutinous lieutenant duly cashiered, Halley again set sail, this time accompanied by a consort, and returned the possessor of a unique mass of data, which he exhibited graphically after the modern manner, being in this matter again a pioneer.

Halley was appointed Savilian professor at Oxford in 1703, and in 1719, promoted to the position of Astronomer Royal, this indefatigable worker found himself in command of an observatory almost unprovided with instruments. He refurnished the observatory and optimistically set out at the age of sixty-three on an eighteen year cycle of lunar observations. He was, as ever, fortunate in his plan which he lived to complete, dying at the patriarchal age of eighty-five years. His interest in cometary orbits led him to study in detail the paths of several of these bodies and he concluded that the comets seen in 1531, 1607, and 1682 were not three separate bodies, but one and the same. The matter is, of course, considerably more complex than is indicated by a mere comparison of periods. Halley had, with immense labour, worked out the elements of the orbits of twenty-four comets. Three of these—those just mentioned—were sufficiently similar to make their identity probable, and this possibility was strengthened by the records of cometary appearances in 1305, 1380, and 1456. Nevertheless, the variations in the periods, and the differences in the inclinations of the orbits, amounting to as much as a degree, made recognition of their identity by no means certain. Halley was, however, too good a

Newtonian not to recognise that irregularities might be introduced by the gravitational pull of the giant Jupiter and, taking due cognisance of this, he ventured on his prophecy. "*Quo-circa*," says he, "*si secundum predicta nostra redierit iterum circa annum 1758, hoc primum ab homine Anglo inventum fuisse non inficiabitur acqua posteritas.*" This prediction of its return in 1758, and its reappearance on Christmas Day of that year, near upon twenty years after Halley has been laid to rest in Lee Churchyard, is one of the dramas of the eighteenth century.

Halley, too, first showed from a comparison of ancient and modern observations that Aldebaran, Arcturus and Sirius had 'proper motions'.

Remarkable, however, as may be the sum of these achievements, his place in the history of the development of astronomical science depends largely on his friendship with Newton and on his connexion with the Royal Society. He was elected a member of that body in 1678, and in 1685, when one Mr. Aston resigned his position as secretary in something of a passion, the Council, in order to avoid future contretemps, decided to appoint a paid clerk who "shall be a single man without children . . . shall be master of the English, French and Latin tongues, . . . shall be able to write a fair and legible hand, and shall be completely seen in the Mathematics and Experimental Philosophy". His duties were carefully defined, and his emoluments fixed at £50 per annum at least, with a lodging in "the College where the Society meeteth". Halley was appointed to the position after a contested election.

About this period the inverse square law of gravitation was in the minds of many astronomers. Kepler had laid the foundations in the statements that :—

(*a*) The planets move in ellipses having the sun in one focus ;

(*b*) The radius vector sweeps out equal areas in equal times ; and

(*c*) For different planets, the squares of the periodic times are proportional to the cubes of their distances from the sun.

It is not a very difficult matter to deduce the inverse square law from Kepler's third statement, and Hooke, Halley and Wren had each, apparently, accomplished this feat. But the inverse problem—given the law of force, what will be the path of a planet ?—proved too much for all of them. In a well-known letter from Halley to Newton we find the statement that "in January 1683–4 I, having from the consideration of the sesquialterate proportion of Kepler, concluded that the centripetal force decreased in the proportions of the squares of the distances reciprocally, came on Wednesday to town (from Islington), where I met with Sir Christopher Wren and Mr. Hooke and falling in discourse about it, Mr. Hooke affirmed that upon that principle all the laws of the celestial motions were to be demonstrated, and that he himself had done it". In the same letter he chronicles an offer made by Wren in a sporting spirit which we do not usually associate with his name. We read that "Sir Christopher, to encourage the enquiry said that he would give Mr. Hooke some two months' time to bring him a convincing demonstration thereof, and besides the honour, he of us that did it should have from him the present of a book of forty shillings. Mr. Hooke then said he had it, but that he would conceal it for some time, that others trying and failing might know how to value it when he should make it public. However, I remember that Sir Christopher was little satisfied that he could do it, and though Mr. Hooke then promised to show it him, I do not find that in that particular he has been so good as his word".

It was Halley who took the problem to Newton, to find that Newton had long ago solved this and other problems of planetary motion, and it was Halley's enthusiasm that overcame Newton's constitutional aversion to publication, and drove him to put forward his views in connected form. On April 28, 1686, Dr. Vincent laid before the Royal Society the MS. of the first book of the "Principia", and on May 19 the Society resolved that "Mr. Newton's *Philosophiæ Naturalis Principia Mathematica* be printed forthwith in quarto in a fair letter". On June 2 we hear a different note ; the Council orders that "Mr. Newton's book be printed, and that Mr. Halley undertake the business of looking after it and printing it at his own charge" ; and Halley undertakes the task.

The Society was, in fact, in financial straits. It had, some time before, published "Willoughby de Historia Piscium", doubtless a learned volume, and one which then excited as much attention as a similar volume would do to-day. The Society made desperate efforts to minimise its loss, and the phrase "books of fishes" recurs in the Council minutes of the period like "the owercome o' a sang". The salaries of their officers fell into arrears, and the Council resolved to pay the unlucky philosophers in "books of fishes". Halley was agreeable ; Hooke more cautiously desired six months time to consider the acceptance of such payment ! Again, when the Society asked Halley to undertake the measurement of a degree of longitude, it was resolved that he "be given £50, or fifty books of fishes".

Newton, who could on occasion show what in a lesser man would be called peevishness, did not make Halley's task any easier by desiring to suppress the MS. of the third book of the "Principia", on hearing that Hooke was putting forward claims to priority. But Halley's perseverance triumphed over all difficulties and on July 5, 1686, the book received the *Imprimatur* of the then president, Samuel Pepys ; it was published about the middle of 1687.

Such is, in bare outline, the history of Halley's share in the publication of the "Principia". Rigaud does not put it any too high when he writes of "the immense obligation which the world owes . . . to Halley, without whose great zeal, able

management, unwearied patience, scientific attainments, and disinterested generosity, the *Principia* might never have been published".

The book before us does not call for detailed review. It is a model of its kind, and, while not a life of Halley, it brings together a mass of material which, interesting in itself, should prove of immense value to any future biographer of Halley. The volume contains a memoir, possibly written by Martin Folkes, an *éloge* by de Mairan, a chronological list of Halley's correspondence, and a large quantity of hitherto unprinted letters and papers arranged in order of date. An appendix of about a hundred pages is concerned with a valuable series of Halleiana. Scholarly, relatively inexpensive, and well produced, the book should find a place on the shelves of every serious student of astronomy.

Recent Radio Research

THE Department of Scientific and Industrial Research has recently issued the report of the Radio Research Board for the year 1931,* summarising work carried out during the year. The investigations described are concerned mainly with the fundamental study of the electrical state of the upper atmosphere and its influence on the propagation of radio waves of all frequencies; the principles and improvements of method of radio direction-finding; the study of atmospherics from the point of view of radio communications and meteorology; the development of radio frequency standards; and the improvement of electrical measurements at high frequencies. This work is carried out mainly at the Radio Research Station, Slough, and at the National Physical Laboratory, Teddington, but a certain amount of research has also been fostered at universities.

The study of the ionisation of the atmosphere and its influence on the propagation of radio waves has been continued both by the frequency-change method which was originated in Great Britain by Prof. E. V. Appleton, and also by the pulse-emission or group-retardation method, first developed by G. Breit and M. A. Tuve in the United States. To assist in this investigation, which includes the systematic collection of data on the electrical properties of the upper atmosphere, a special transmitting installation has been designed and is in course of construction at the National Physical Laboratory. Concurrently with the experimental work, a theoretical analysis is being made of the effect of the upper atmosphere on radio waves, and the mathematical formulæ are being evaluated numerically for typical cases, so that the results can be used by the practical radio engineer. In all this work the effect of the earth's magnetic field is being studied, the necessity for this having been confirmed in an interesting manner in the year under review by experiments carried out in the southern hemisphere under the Australian Radio Research Board.

The report describes also the extension of the study of wave propagation to wave-lengths of less than 10 metres. In the first instance, the transmission of these ultra-short waves along the earth's surface has been investigated, and from the resulting measurements, values of the effective conductivity and dielectric constant of the earth have been obtained by wave-lengths between 1·6 and 10 metres. In addition, experiments have been carried out on a wave-length of 5·5 metres over a distance of 44 miles. In these experiments the absence of any downcoming radiation from the upper atmosphere was clearly indicated, and it was apparent that only the direct or ground waves were effective in securing communication, although the reception obtained was definitely not confined to the rectilinear or so-called 'optical' path between transmitter and receiver. Certain diurnal variations were found on hot, sunny days which were not experienced on dull, autumn days. The theoretical and practical investigation of the whole subject is being continued. Progress is also recorded in the study of improved means for generating electron oscillations giving rise to wave-lengths of less than 1 metre.

The report indicates that considerable progress has been made towards the development of the perfect direction-finder for medium wave-lengths, free from errors caused by downcoming waves occurring mostly at night. The behaviour of direction-finders on shorter wave-lengths is being studied, and the application of the cathode ray oscillograph to a direct-reading instantaneous direction-finder has met with considerable success. This is undoubtedly due to the large amount of experience previously obtained in the use of these instruments in the study of atmospherics at the Radio Research Station.

In the present crowded state of the ether, it is specially important that every radio station should accurately maintain its allotted wave-length or frequency. The precise measurement of frequency, therefore, has become of great practical importance. The primary national standard of frequency is maintained at the National Physical Laboratory, and, as the report explains, is based on a tuning-fork maintained in continuous and steady vibration. The rate of vibration of the standard tuning-fork is now directly referred to that of an astronomical clock by an electrical arrangement, and can be obtained accurately to within one part in ten million. Experiments are in progress to determine the short-period constancy of the fork, that is, the constancy for one or two minutes at a time. It is not easy to compare frequencies to an accuracy of one part

* Department of Scientific and Industrial Research. Report of the Radio Research Board for the Year 1931. Pp. iv + 123. (London: H.M. Stationery Office, 1932.) 2*s*. net.

in a hundred million during an interval of only one minute, but such tests as have already been made indicate that the fluctuations due to the action of the thermal regulation are less than one part in a hundred million.

"Sufficient experience has now been accumulated," the report says, "to enable the statement to be made that properly designed and steadily operated tuning-forks form a primary frequency standard of reliability of about one part in ten million, a result fully equal to that of the best pendulum clocks. It is an interesting fact that the slight earthquake experienced in the south-east of England on June 7, 1931, caused a small change in rate of the pendulum clock of about four parts in ten million, which was revealed on the tuning-fork chronograph, the tuning-fork being unaffected by the shock."

It has now become necessary to develop apparatus to resolve the differences between the tuning-fork and the clock to enable short period fluctuations to be accurately observed. For this purpose radial vibrations of a small quartz crystal very carefully cut in the form of a ring are used to control the oscillation of a valve generator. The experiments carried out give good hope that a standard which is permanent and accurate to one part in a hundred million may be obtained in the near future.

The above review is by no means exhaustive of the contents of the report, which shows that the organisation controlled by the Radio Research Board continues the active pursuit of radio research and development, which in the past few years has placed Great Britain in a world-renowned position.

Obituary

Prof. James Johnstone

JAMES JOHNSTONE, the distinguished zoologist, oceanographer and philosopher, died at the age of sixty-two years at his home in Lochwinnoch on December 27 after a sudden attack of influenza. He appeared to have recovered from his former dangerous illness, so that his loss from an apparently accidental infection is felt the more keenly. He was not married.

There can be no doubt that he was a man of exceptional ability with an unusually wide knowledge of science; and a fearless and original thinker. Though reticent and even shy, "J. J.", as he was familiarly called, endeared himself to all those who had much to do with him by his kindly and sympathetic manner and his philosophical outlook on life's problems. It is characteristic of him that he was especially concerned about the future prospects of the junior staff and servants employed in his Department.

The future philosopher showed his naturalistic leanings as a boy when he roamed the country observing wild animals and collecting birds' eggs; he exhibited the urge of the 'vital impetus'—which was to concern him greatly later—when as a young man he 'emerged' from the environment of a journeyman wood-carver by attending evening classes at Lochwinnoch and at Glasgow. By the encouragement of his teacher and coach, Robert Logan, and the facilities afforded by the local school board and the Board of Education, he was enabled at the late age of twenty-five to begin the study of the biological sciences at the Royal College of Science, London, mainly under Prof. G. B. Howes. Before graduating in 1900 at the University of London he had already written one paper on the thymus in marsupials and two on fisheries subjects.

On his appointment in 1898 as fisheries assistant to Sir William (then Prof.) Herdman on the research staff of the Lancashire and Western Sea Fisheries Committee, Johnstone found a congenial environment; he threw himself with remarkable energy into studies in fisheries and the more general aspects of marine biology with such success that he had become a leading figure in British marine biology in 1908. This early success can be traced to his great interest in fisheries, to his unusually logical mind, and a great capacity for absorbing masses of data while perceiving and retaining a clear recollection of their interrelations, which he was able to expound in simple language. These faculties enabled him to bring together material on the growth and origin of "British Fisheries" (1905). The amassing of this material and his practical fishery experience placed him at once in a commanding position to give valuable support to the work of the newly instituted International Council for Fishery Investigations. The same faculties enabled him to produce an illuminating and classical work (1908) on "Conditions of Life in the Sea". This book was undoubtedly for many years a source of information and inspiration to the rising generation of marine biologists; in it he propounded a surprising proportion of the major problems which have been successfully investigated in recent years.

The basis of Johnstone's knowledge of fisheries lay in his experience in inshore and offshore work and the study of plankton in collaboration with his life-long friend, Andrew Scott. He also helped to lay the foundation for later successful work on the purification of shellfish. Marine bacteria were of great interest to him; his work led him to speculate on the existence in the sea of pathogenic types comparable with those found in terrestrial animals. He described a large number of malignant 'cancerous' tumours in fish, two of these being defined as of a "piscine tuberculosis" type, and accompanied these studies with extended investigations on parasites. His knowledge of this branch of pathology was associated with a vivid interest in human 'cancer', and its treatment by

radium. Probably a real satisfaction in his life—betrayed in unguarded moments—was the success attending his share in the effort to procure radium for the Liverpool Radium Institute and Hospital for Cancer and Skin Diseases.

During the War, Johnstone's work on the dietetic value of fishes gained him an effective position on the Fish Preservation Committee of the Food Investigation Board of the Department of Scientific and Industrial Research.

In 1919, Johnstone was appointed lecturer in oceanography at the University of Liverpool and a year later he succeeded Sir William Herdman to the chair. In this new capacity he was fortunately able to indulge his leaning towards scholarship and philosophy. His works on oceanography brought up to date our knowledge of the physical features of the oceans; at the same time the story of the origin of the oceans is treated in a manner of fascinating interest to the students of geography and geology; "A Study of the Oceans" is indeed a new approach to the study of geography in a wide sense. Along with this work he undertook as director the reorganisation of the Port Erin Marine Biological Station and effected great improvements.

In later life the totality of the relations between things became to our savant—as to many other older scientific workers—of greater interest than lesser relations. He had already in 1914 surveyed the "Philosophy of Biology" and had stated the problems in his usual clear manner. These he elaborated later in "Mechanism of Life", and made what proved to be a final contribution recently in "Essentials of Biology" (1932). Here the fundamental problems of biology are discussed simply and logically with a rare clarity and impartiality. On the problem of the origin of life he refines his views of 1914 to the simple statement that ". . . it may be the case that the problem is only a pseudo one and that it is just as foolish to inquire into the origin of life as it would be to ask what was the origin of the universal tendency to entropy increase. We have no doubt that *the distinction between living and lifeless things is a problem for physics* [present writer's italics]. We have no confidence that the basal conceptions of physics have been established. That being so, it is futile further to continue this discussion".

On this problem—as on many others—the philosopher and research worker discloses the apparent inadequacies of present-day knowledge. In this way James Johnstone leaves his problems and work to posterity, with a satisfying and rare record of achievement; and better still, he leaves a memory of a loveable man, wise and humble, great and unassuming.

Prof. C. M. Thompson

Claude Metford Thompson, emeritus professor of chemistry of the University College, Cardiff, was born at Bridgwater in 1855, and was the son of Alexander and Eleanor Thompson. He died at Cardiff on January 4, 1933, at the age of seventy-seven years. Some of the following particulars of his career are from the *Western Mail*. Prof. Thompson was educated at University College, London; Trinity College, Cambridge, where he was a scholar; and the University of Bonn. At Cambridge he obtained the degree of M.A.; his D.Sc. was awarded to him by the University of London, which university also bestowed upon him a gold medal for distinction in his subject; and the University of Wales conferred upon him the degree of D.Sc. (*honoris causa*) for his services during and after its institution in 1893. He was the last of the original professors appointed in 1883 when the University College, Cardiff, was opened under the principalship of Viriamu Jones, and he retired from the service of the College in 1921, with the title of emeritus professor, after a successful career as professor of chemistry.

Dr. Thompson's assistance and advice to the University and the University College were particularly useful regarding the details of educational organisation and in the preparation of regulations, courses, and schemes of study for degrees. Up to the time of his death he was a member of the Court of Governors of the College, appointed by the Chancellor of the University of Cambridge. He found time to carry on research work, particularly into the constituents and possible uses of rare earths and their application to commercial products, such as incandescent mantles.

Dr. Thompson was a generous supporter of the University College at Cardiff, and the donor of many volumes and publications on chemistry to its library. In his early days he found his chief enjoyment in mountaineering during vacations; he was a member of the Alpine Club. He identified himself with local interests by becoming a member of the Cardiff Naturalists' Society, in the work of which he was particularly active. He took a keen delight in gardening, and many of the amenities to be found in "Cae Syr Dafydd", one of Cardiff's parks, are largely due to his care and attention. A. A. R.

We regret to announce the following deaths:

Mr. T. H. Coward, a well-known naturalist and an authority on British birds, on January 29, aged sixty-six years.

Sir Percy Sargent, C.M.G., formerly surgeon to St. Thomas's Hospital and the National Hospital, Queen Square, London, and Hunterian professor of surgery and pathology at the Royal College of Surgeons in 1928, an authority on brain surgery, on January 22, aged fifty-nine years.

Dr. John Thomas, joint managing director of the Dyestuffs Group of Imperial Chemical Industries, Ltd., a well-known authority on dye-stuffs, on January 18, aged forty-six years.

News and Views

Dr. G. D. Hale Carpenter

THE vacancy in the Hope professorship of zoology at Oxford, caused by the resignation of Prof. E. B. Poulton, has been filled by the appointment of Dr. G. D. Hale Carpenter. Dr. Carpenter is widely known for his investigation of the bionomics of the tsetse fly, *Glossina palpalis*, a work undertaken by him between the years 1910 and 1914. During this time he resided first at Jinja on the north shore of Victoria Nyanza, and afterwards on various islands, especially those of the Sesse archipelago, lying in the north-west corner of the lake. While the primary object of his living in this region was the study of the tsetse fly as the carrier of sleeping sickness, Dr. Carpenter found occasion to make many important observations on the natural history of the islands, especially in regard to the remarkable phenomena of mimicry shown by the swallow-tail butterfly, *Papilio dardanus*, and the series of forms of the nymphaline *Pseudacraea eurytus* mimicking the acraeine genus *Planema*. At the outbreak of the War, he was called upon to act as medical officer to the forces operating on the southern frontier of Uganda, in German East Africa and Portuguese East Africa; and amidst the duties of active service he found opportunities for further fruitful observation, opportunities which were increased and turned to fresh account on his return to Uganda in 1918. His book "A Naturalist on Lake Victoria" was published in 1920. Dr. Carpenter's work has throughout been influenced and inspired by Prof. Poulton; and there is every reason for anticipating that the traditions of the Hope Department will be worthily carried on by the new professor.

Pierre André Latreille

PIERRE ANDRÉ LATREILLE, the brilliant French naturalist, who devoted himself to the study of entomology and made considerable additions to our knowledge of that branch of natural science, died in Paris a hundred years ago on February 6 at the age of seventy-one years. Latreille was born on November 29, 1762, at Brive-la-Gaillarde, in the department of Corrèze. At the age of sixteen years he entered the Collège Lemoine, Paris, where he studied for the church. After he had taken orders in 1786, he retired to Brive, where he devoted himself chiefly to the study of insects. He returned to Paris in 1788, and during the Revolution was imprisoned at Bordeaux; but was released on account of the interest shown in his entomological studies. His great work, "Précis des Caractères génériques des Insectes, Disposés dans un Ordre naturel"—an important step towards a truly natural system of entomology—was published in 1796, and led to his being appointed to arrange and take charge of the entomological collection at the Muséum national d'Histoire naturelle (Jardin des Plantes) in Paris. He became professor of natural history at the Museum in 1830, and succeeded Lamarck as professor of zoology. Latreille wrote the entomological part of Cuvier's "Règne Animal". His other important works are "Salamandres", "Singes", "Crustacés et Insectes", "Reptiles", "Genera Crustaceorum et Insectorum", "Considerations générales sur l'Ordre naturel des Animaux", "Familles naturelles du Règne Animal", and "Cours d'Entomologie".

Geological Society Awards

THE Council of the Geological Society of London has made the following awards for this year: *Wollaston Medal*, to Prof. Marcellin Boule, professor of palæontology in the Muséum national d'Histoire naturelle, Paris, in recognition of the value of his researches concerning the mineral structure of the earth, and especially for his contributions to the geology and vertebrate palæontology of the Tertiary period; *Murchison Medal*, together with an award from the Murchison Geological Fund, to Dr. A. L. DuToit, consulting geologist, Johannesburg, in recognition of the value of his work, especially on the geology of South Africa; *Lyell Medal*, together with an award from the Lyell Geological Fund, to Mr. J. E. Richey, Geological Survey of Great Britain (Scottish Office), for his researches in the Tertiary volcanic geology of the British Isles; *Bigsby Medal*, to Mr. E. J. Wayland, director of the Geological Survey of Uganda, in recognition of the value of his geological researches, particularly in Uganda; *Wollaston Fund*, to Mr. A. Wrigley, for his work on the Tertiary Mollusca of the London district; *Murchison Fund*, to Mr. T. H. Whitehead, Geological Survey of Great Britain, in recognition of the value of his work on the Carboniferous and older rocks of the Midlands; a moiety of the *Lyell Fund* to Mr. A. Broughton Edge, in recognition of the value of his geophysical work in application to geological problems; a second moiety of the *Lyell Fund*, to Mr. W. N. Edwards, Natural History Museum, in recognition of the value of his researches on fossil plants.

Stoke Park (R. G. Burden) Fund for Research in Mental Disorders

MRS. R. G. BURDEN, of Clevedon, Somerset, has offered a sum of £10,000 for research into mental problems and disorders, suggesting that Prof. R. J. A. Berry, Director of Medical Services, Stoke Park Colony, Stapleton, Bristol, shall have general control of the investigations. In view of the munificence of this donation and the importance to the nation of its objectives, it has been deemed advisable to form a strong and nationally representative committee of administration. This committee will be responsible for the general direction of the research, the appointment of the research staff, the determination of salaries, and the publication, from time to time, of such reports as it may think fit to issue. Arrangements have already been made for the representation on this committee of the Ministry of Health (Board of Control), the British Medical Association, the

Francis Galton Laboratory for National Eugenics at University College, London, the Royal Medico-Psychological Association, the Central Association for Mental Welfare, and for other representative individuals specially selected for their scientific or medical attainments. In accordance with the terms of the bequest, Prof. R. J. A. Berry will act as chairman of the committee, which will meet in London at the house of the British Medical Association, with Dr. G. C. Anderson as its honorary secretary. As the committee has not yet met, nothing has been determined as to the nature of the researches to be carried out, though doubtless one line of approach will be the hereditary transmission, or otherwise, of mental deficiency and other disorders. Applications will shortly be invited for a specially selected team of investigators, particulars of which will be made known later.

Preliminary Tests for Everest Flight

A WESTLAND *PV*–3 type two-seater biplane, named the *Houston-Westland*, fitted with a Bristol Pegasus *S*.III engine, piloted by Mr. H. J. Penrose, test pilot at the Westland Aircraft Works, reached a height of 35,000 ft. at Yeovil on Wednesday, January 25. The total time in the air was about 1 hr. 40 min. This constitutes a world's record for a two-seater aircraft. This machine has been specially adapted to undertake a flight over Mount Everest in conjunction with an expedition led by Air-Commodore P. F. M. Fellowes, with Lord Clydesdale as pilot. Specially designed electrical heating apparatus includes not only heated clothing, but also warming devices for the cabin, the valves of the oxygen apparatus for breathing, many of the instruments and jackets for the cameras. The pilot's cockpit is a normal open one, but is fitted with a hooded windscreen as a protection against draughts. The observer's cockpit is roofed over and is provided with sliding windows in either side and the floor for photographic purposes. Williamson Eagle cameras and cinematograph apparatus are to be used. The machine weighs about 5,000 lb. fully loaded as for the Everest flight, and, as is usual with supercharged engines, carries a propeller that allows the full horse power to be developed only after passing 13,000 ft. height. Temperatures down to −40° C. were registered inside the observer's cabin at the extreme altitude reached. The elimination of vibration, to assist the photography, has been specially dealt with, and in this respect the flight was very successful. A second machine is being converted similarly to take part in the expedition.

Aircraft in Relation to Petroleum Technology

THIS subject has recently received a good deal of technical and non-technical publicity, both in Great Britain and abroad. Resulting from the extensive use of aeroplanes during the War for reconnaissance and survey purposes, aircraft operations afterwards gained a firm foothold in the technique of exploration, particularly in inaccessible territory. Developments were rapid and the applications to map-making were perfected and commercialised. The incidence of aircraft as an important factor in geological studies is of more recent date and primarily owes its recognition to the important work carried out in North and South America in connexion with exploration for petroleum, including the survey of pipe-line tracks. Both in the realm of petroleum technology and mining geology, aerial reconnaissance and photography have proved valuable as time- and money-saving factors. The literature on this aspect of the subject has grown extensively during the last few years, and probably one of the most complete accounts of the subject was given by Mr. Donald Gill before the Institution of Mining and Metallurgy recently, when he dealt with "Aerial Survey in Relation to Economic Geology". This paper contains a useful bibliography, which has been reproduced with additions by Mr. H. Hemming, who discussed the commercial aspects of the subject at a meeting of the Institution of Petroleum Technologists on January 10. Mr. Hemming showed clearly that the main value attached to the use of aircraft in exploratory work is for obtaining rapidly information of technical value, and for transporting personnel or material from one place to another. He gave a very succinct account, not only of what has already been accomplished in this direction, but also of the potentialities of further development of air survey.

Empire Broadcasting

SINCE the opening of the Empire Broadcasting Station at Daventry on December 19 (see NATURE, **131**, 16, Jan. 7, 1933) the British Broadcasting Corporation has received a large number of cablegrams reporting reception of the transmissions in all parts of the world. A very large number of letters has also been received from listeners, and extracts from some of these are published in recent issues of *World Radio*, which is now the official organ of Empire broadcasting. Good quality reception is reported from such places as Bagdad, the Federated Malay States, Zululand, Tanganyika, various parts of India, New Zealand, and North and South America. In some places, particularly South Africa, local atmospheric conditions have marred the reception to some extent, but on the whole it would appear from the first few weeks' tests that the inauguration of the new Empire broadcasting service has been a conspicuous success. The aerial arrays and the transmitters for the Empire Broadcasting Station at Daventry were designed, constructed and installed by Messrs. Standard Telephones and Cables Ltd.

Anthropological Survey of Ireland

A FIVE-YEAR plan for an anthropological survey of Ireland has been formulated by anthropological members of Harvard University. It will cover the archæology, social anthropology and the physical characters of the Irish people. In a preliminary account and progress report of the survey (*Science*, vol. 76, No. 1978) its object is said to be "to produce some sort of scientific interpretation of the Irish

people". The proposal has been cordially received in Ireland, and now has the official approval of the President of the Irish Free State. The archæological section of the expedition is already at work and during the past summer, under the leadership of Dr. O'Neil Hencken and under the auspices of the National Museum of Ireland, has been engaged in the excavation of a Viking age crannog at Ballinderry, Co. Westmeath, and of bronze age burials nearby at Knockast, with remarkable results. For the study of social anthropology, Co. Clare has been chosen as the area affording most typically a blend of the old and the new in Irish culture. A preliminary survey has been made by Prof. W. Lloyd Warner, assistant professor of social anthropology in Harvard University, assisted by Mr. Conrad Arensburg, post-graduate anthropological student of the University. It is intended to devote two years with an extended staff to the observation of every aspect of Irish social life. Physical anthropology will be under the charge of Prof. E. A. Hooton, of Harvard University, who will also be responsible for the general oversight of the work of the expedition.

Excavation in Alaska

DURING the past summer an expedition of the University Museum of Pennsylvania, conducted by Miss Frederika de Laguna, has been at work on the coasts of Alaska in conformity with the policy of American anthropology for the intensive study of this area in relation to the problem of the early peopling of America. The expedition was engaged in the excavation of a prehistoric village site in Kachemak Bay, Cook Inlet. Of the finds of the season, Science Service (Washington D.C.) reports that Miss de Laguna regards the outstanding object to be a carved stone lamp. In the bowl of the lamp is a human figure in an attitude of prayer carved in full relief. Four other examples of such lamps are known; but this is the only example to be found by a scientific explorer *in situ*. It is said to come from the last phase of four prehistoric Eskimo settlements; but although the early phase of the 'archaic' culture of the area is remarkable for its carved ivories, stone carving is not known as an Eskimo technique. The lamp was found in a shell-heap close to the sea, which is washed by high tide. Other cultural features of the same settlement were slate mirrors, slate blades for lances, bone harpoons and dart heads, grinding stones, awls, drills, dolls, beads and needles. Rock-paintings were found in caves. Such paintings are known only in southern Cook Inlet and on Kodiak Island, where the culture is similar. The Indians of to-day believe that these pictures were painted by 'whale killers', much feared medicine-men who poisoned their lances with human fat. If there were any foundation for this belief, it might be related to the traces of cannibalism found in prehistoric settlements by the Smithsonian Alaskan expeditions.

Spelling of Place Names

THE United States Geographic Board has published a "First Report on Foreign Geographical Names" (Washington Government Printing Office, 1932. 10 cents). The list of names is prefaced by a long discussion of the problems involved, which is followed by certain general rules that the Board has adopted. The conventional English usage is adopted for the names of countries, dominions, colonies, etc., and for geographical features common to several States in which the official languages are different. For local geographical names in States where a Latin alphabet is used, the names are spelled in accordance with local usage but conventional English forms, where such exist, are accepted as alternatives. Names in non-Latin alphabets are to be transliterated according to either official transliteration, where such exists, or a system adopted by the Board and printed in this report. The practice of translating names is discouraged. The policy adopted by the Board differs little from that used by the Permanent Committee on Geographical Names for British Official Use. The differences lie in the spelling of names in possessions of European powers and in the transliteration of 'j' and 'zh' in certain languages, but it is laid down that in the absence of any specific decision of the United States Board, the decision of the British Committee is to be followed in certain cases. The actual list of names in the Report gives pronunciation in many cases but omits it in several names where its addition would certainly be useful.

Forest Fires in Japan

A PAPER on "Forest Fires and Weather" (*Sci. Papers Inst. Phys. Chem. Res.*, Tokyo, vol. 18), by T. Terada and T. Utigasaki, states that the annual loss due to forest fires in Japan is second in magnitude only to that suffered by the United States. Japanese meteorologists might therefore do good service by studying the weather conditions that precede these fires in Japan, and perhaps eventually organising a system of warnings, following the example of the United States. The authors of this paper were led to study this subject with the aid of synoptic weather charts through the known tendency for the fires to break out practically simultaneously in widely scattered parts of Japan. They conclude that such outbreaks are generally associated with the near approach of the 'squall-line' or principal cold front of a depression following an easterly track north of Japan, when the warmer of the two wind currents yields maximum temperatures of 20° C. or more. There seems no *a priori* reason why the front should have anything to do with the matter; it is easy to imagine that the necessary antecedent conditions are merely a sufficiency of wind and warmth, with no rain and perhaps some special state of the air in regard to its water-vapour content. These conditions might seldom occur except on the approach of a depression. As frequently happens with investigations in which synoptic charts are used, the extent to which the evidence supports the conclusions cannot be gauged accurately unless all the charts are reproduced in great detail. It must have been difficult for the authors to determine the position of the front in

relation to the outbreaks, seeing that they had to rely upon newspaper reports for the times of the outbreaks.

The Disturbing Influence of Science

LECTURING to the Science Federation of the University of Manchester on January 23 under the title "The Irresponsibility of Science", Prof. H. Levy asserted that the problems of unemployment and the distribution of leisure are problems which the man of science must help to solve. It is part of the duty of the scientific man to examine the external properties of science and to face the ethical problems which the application of scientific discoveries is liable to create. The habit engendered in the scientific worker by his very method of endeavouring to isolate objects or causes and consider the influence of single factors in a problem has a very real danger in that it leads scientific workers to assume that all scientific questions are independent of ethics. Practically all scientific work, however, has a social aspect and its social properties cannot be clearly separated from its scientific properties any more than theoretical and applied science can be sharply demarcated. At the present time we are being forced to consider indeed the limit beyond which the process of improving the weapons of production is likely to disturb the structure of the original scientific movement itself. The scientific worker cannot ignore the fact that in practice what is intended as a gift of more leisure for all becomes unemployment and loss of consuming power for some. Scientific men must endeavour to find what factors go to the creation of an unstable society under the impact of science in this way. Prof. Levy suggested that scientific men should analyse the tendencies of science so that they could direct them. Science, which has been a revolutionary factor, has now become a disturbing factor in the world, affecting the stability of communities, and the study of that disturbance is one for international science.

Science and the Textile Industry

SPEAKING on January 26 on the textile industry in the course of lectures on industrial affairs which are being given to the students of the Imperial College of Science and Technology, Dr. Kenneth Lee expressed his belief that the rapid development of scientific research will prove the best investment the textile industry can make. The British Cotton Industry Research Association has undoubtedly the best equipped textile research institute in the world, but although about eighty per cent of those engaged in production contributed to it, in relation to the magnitude of the industry the amount subscribed is negligible. Dr. Kenneth Lee believes that if the necessary financial support is forthcoming, we could dominate to a large extent the cotton textile field in the production of new inventions during the next few years. In addition to utilising science, the cotton industry must also employ men in its mills who can understand the work that science is doing. Dr. Kenneth Lee referred in particular to the way in which science, by introducing means of artificial humidification and ventilation, has not only discounted what was once supposed to be a great advantage of the Lancashire industry—its damp climate—but has made it possible to obtain uniform conditions throughout the year with higher output and more efficient use of automatic machinery.

Direct-Current Generators for Electrostatic Precipitation

IN the English Electric Co.'s *Journal* for October, a description is given of the high-pressure D.C. dynamos it constructs for use in electrostatic precipitation plant. The Whessoe Foundry and Engineering Co., Ltd., specialises in apparatus for fog and mist extraction, and the English Electric Co.'s dynamos are specially designed to work with its plant. The removal of suspended particles from large volumes of gas is an important commercial problem at the present time. Electrostatic precipitation is now regarded as the most efficient and economical method for cleaning gases. The English Electric Co. has designed many high-pressure D.C. machines for radio transmission purposes, and the new dynamos are based on the experience gained in radio work. The generating unit for a typical equipment has to supply a current of about 0·15 amperes at a pressure of 45 kilovolts. The unit consists of a driving motor made to suit the local supply, coupled to three generators connected in series. The frames of the machines are insulated from the earth by individual supports of solid porcelain. The whole of the high-pressure apparatus is enclosed by screens which separate it from the driving motor and prevent unauthorised access. A simple interlock on the door renders it impossible for anyone to enter the high-pressure compartment when the generators are running. As a further precaution, every conductor which is at high pressure when the machine is running is connected with the earth when the set is at 'standstill'. Accidental shocks are thus avoided. A notable feature of the set is its ability to withstand a short circuit without a 'flash-over'. A model precipitation equipment was shown in action at the English Electric Co.'s exhibition last November.

Ship Researches at the William Froude Laboratory

DURING the last ten or twelve years, no fewer than twenty-two papers have been contributed to the transactions of the Institution of Naval Architects, the North-East Coast Institution of Engineers and Shipbuilders and other bodies, by the members of the staff of the William Froude Laboratory, National Physical Laboratory, Teddington. Among these papers are six on the effect of weather conditions on the propulsion of ships, seven on the manœuvring of ships and six on the efficiency of screw propellers. The other papers deal with the hulls of flying boats and ship propulsion data. Needless to say, all the papers are of permanent value and they have now been re-issued as vol. 23 of the Collected Researches of the National Physical Laboratory (London : H.M. Stationery Office. 20*s*. net). Arrangements have also been made to publish them in five groups. Each

paper is preceded by a short abstract and the volume has an adequate index, but the reprint does not contain reports of the discussions, for which reference will have to be made to the transactions of the various societies. The majority of the papers, of course, deal with investigations carried out with models in the Alfred Yarrow Tank, but three of Mr. Kent's papers on the effect of weather conditions on the propulsion of ships contain his observations made on several voyages across the Atlantic in rough weather, when the routine of the laboratory was abandoned for all the discomforts of the sea.

Recent Acquisitions at the Natural History Museum

THE skin and skull of a hybrid between a lion and a leopard, which was bred in the Gardens of Kolhapur, has been presented to the Department of Zoology by Col. F. W. Wodehouse. This specimen, which had reached the age of three years, resulted from a union between a male leopard and a lioness, there being two cubs in the litter, the other one dying when about two and a half months old. These appear to be the only hybrids between a lion and leopard ever recorded. Among a small collection of mammals from Tanganyika Territory collected and presented by Mr. W. G. Cubitt-Currie is a new species of golden mole belonging to the genus *Chlorotalpa*. Purchases for the Department of Zoology include a specimen of the giant squid, *Architeuthis*, stranded in West Bay, Scarborough, on January 14. It is about 20 feet in length, including the tentacles. A notable addition to the Department of Geology is a complete specimen of the ancient shark, *Hybodus Lauffianus*. This is no less than seven feet long, and was discovered in the Upper Lias of Hobzmader, Württemberg. As with some specimens of *Ichthyosaurus* and other creatures found at this famous locality, not merely the skeleton, but also soft tissues, notably the skin, are present. The Department of Botany has received from the Godman Trustees a further collection of 848 specimens of flowering plants collected by Mr. R. G. N. Young in the Lunda province of Angola. The whole collection forms a valuable addition to our knowledge of the flora of this part of Angola and is especially noteworthy on account of the wealth of material of aquatic species. Amongst the purchases are 540 specimens collected in Brazil by B. H. Krukoff and a further series of 268 type specimens of the liverwort family Jubulearum.

Farmers' Guide to Agricultural Research

THE Royal Agricultural Society of England (16 Bedford Square, W.C.1) has issued the seventh of its series of annual summaries of scientific and economic research (1*s*. 3*d*. post free). The volume deals mainly with work carried out in Great Britain but also includes the results of colonial and foreign investigations so far as they have a bearing on British agriculture. This year the publication has been issued under a new title, namely, "The Farmer's Guide to Agricultural Research in 1931" in place of "Agricultural Research", by which it has been known hitherto. The change has been made in order to emphasise the main object of the publication, which is to provide the farmer with the most up-to-date information in all the leading branches of agriculture in a summarised and simple form. Apart from the title, the character of the volume remains unaltered, except that the section on crop and plant breeding is temporarily suspended and a new section on pests and parasites is included. The remaining sections, on dairy farming and dairy work, prevention and treatment of diseases of animals, farm economics, the feeding of live stock, farm implements and machinery, and soils and manures need only be cited to show how wide is the field of inquiry covered. Since each section is prepared by a recognised authority on the subject, the publication cannot fail to be of interest and practical value to the farmer, agricultural organiser and student.

Trout Fishing in New Zealand

AN interesting communication on the effects of intensive angling on the depreciation of trout-fishing in the Oreti (or New River) in New Zealand is given by Prof. E. Percival in Fisheries Bulletin No. 5 of the New Zealand Marine Department. The European trout when introduced into New Zealand showed remarkable fitness to their new environment by their great growth and in the early years afforded excellent opportunities for anglers. In recent years, however, there have been signs that the fishing is falling off to a considerable extent. This had been popularly attributed to a number of causes, such as the removal of the bush, leading to a decline in the food supply, the destruction of grasshoppers and cicadas by imported birds, or a change in the growth rate of the fish themselves. By examining old anglers' diaries, studying the food supply and growth of the trout, and using the statistics of angling societies, the author has shown that in all probability the decline in the fisheries is due to the great increase in the number of anglers themselves in recent years and to the opening up of fresh regions made accessible by modern rapid means of transport. The apparent decrease in size attained by the fish is due to the killing off of the older fish and the rapid removal of the smaller fish before they have time to reach a large size. In this publication Prof. Percival gives some valuable information on the food relations in inland waters of New Zealand, following up the work he has already done on the fauna of the streams of Great Britain.

Tests of Hearing

A COMMITTEE of the Section of Otology of the Royal Society of Medicine which was appointed in 1929 to consider tests of hearing has now issued its report (Longmans, Green and Co., Ltd., London. 2*s*. 6*d*.). Tests of hearing by tuning forks, which are widely used, were first considered. It was found, however, that there is no uniformity in the kinds or construction of forks employed by otologists. The Committee obtained the advice of Sir William Bragg

and a list of requirements was formulated which was laid before Drs. Kaye, Dye, and Davis of the National Physical Laboratory, who undertook to draw up specifications for the manufacture of standard forks, and Messrs. J. and W. Ragg of Sheffield have completed a set which will shortly be available. The chief features of the standard fork are (1) the place where it should be struck is marked, (2) overtones should be inaudible within ten seconds of the fork being struck, (3) the pitch audible through air and bone to be the same, and (4) the rate of decay shall be such that the half intensity period of the vibrating fork in air shall be between three and ten seconds. Recommendations on the use of forks are given, the classical qualitative tests of hearing are surveyed and their clinical significance stated, and quantitative tests are discussed. Several memoranda on various aspects of the subject are contained in an appendix. The report is one of considerable value and interest.

American Association for the Advancement of Science

On December 30 the following officers of the American Association for the Advancement of Science were elected: *President:* Dr. Henry Norris Russell, Princeton University; *Permanent Secretary:* Prof. Henry B. Ward, University of Illinois; *General Secretary:* Prof. Burton E. Livingston, Johns Hopkins University; *Treasurer:* Mr. John L. Wirt, Carnegie Institution of Washington. *Vice-Presidents and Chairmen of Sections:* A (Mathematics), Prof. C. N. Moore, University of Cincinnati; B (Physics), Dr. C. J. Davisson, Bell Telephone Laboratories; C (Chemistry), Prof. Arthur B. Lamb, Harvard University; D (Astronomy), Dr. V. M. Slipher, Lowell Observatory; E (Geology), Prof. Rollin T. Chamberlin, University of Chicago; F (Zoological Sciences), Prof. A. S. Pearse, Duke University; G (Botanical Sciences), Prof. K. M. Wiegand, Cornell University; H (Anthropology), Prof. T. Wingate Todd, Western Reserve University; I (Psychology), Prof. Walter R. Miles, Yale University; K (Social and Economic Sciences), Dr. Wesley C. Mitchell, Columbia University; L (Historical and Philological Sciences), Mr. Waldo G. Leland, American Council of Learned Societies; M (Engineering), Mr. C. F. Kettering, General Motors Corporation; N (Medical Sciences), Prof. Charles R. Stockard, Cornell University; O (Agriculture), Mr. A. R. Mann, Cornell University; Q (Education), Prof. Walter F. Dearborn, Harvard University.

Announcements

It is announced that Sir Charles Reed Peers, president of the Society of Antiquaries, has been appointed a trustee of the British Museum in succession to the late Viscount Dillon, who died on December 18.

The Council of the Institution of Naval Architects has awarded the premium for the year 1932 to Dr. G. Kempf, and Herr H. Lerbs, of the Hamburg Experimental Tank, for their joint paper: "Cavitation Experiments on a Model Propeller".

At the meeting of the London Mathematical Society on February 16 at 5 P.M. at Burlington House, Prof. P. A. M. Dirac will deliver a lecture on "The Relation between Classical and Quantum Mechanics". Members of other scientific societies are invited to attend the lecture.

At the ordinary scientific meeting of the Chemical Society held on January 19 the President announced that Prof. S. Sugden had been appointed honorary secretary until the annual general meeting on March 30, and that the Council had nominated Prof. G. T. Morgan to the office of president and Prof. S. Sugden and Dr. J. M. Gulland as honorary secretaries to fill the vacant places that fall due to be filled at the annual general meeting.

The Council of the National Institute of Agricultural Botany has awarded the Snell memorial medal for 1932 to Dr. Kenneth M. Smith, entomologist of the Potato Virus Research Station, University of Cambridge. The medal is given to mark eminent work in the sphere of potato husbandry and it has been awarded to Dr. Smith in recognition of his valuable research work on the virus diseases of the potato. This has not only thrown much light on the methods of transmission of these diseases but has also had far-reaching influences on the whole plant virus problem.

As a result of further conferences between the "Dechema" (Deutsche Gesellschaft für chemisches Apparatewesen), the Verein deutscher Chemiker, the Verein deutscher Maschinenbauanstalten and the civic authorities of Cologne, it has been decided that, without interfering with the preparations in hand for the chemical plant exhibition "Achema VII", the date should be changed. The date for the exhibition, which will be held in Cologne, has therefore been finally fixed for May 18–27, 1934. The exhibition "Kautschuk" of the German Society for Rubber Industries which was to be held in conjunction with "Achema VII" will take place independently during 1933 in Cologne.

Applications are invited for the following appointments, on or before the dates mentioned:—Lecturers and instructors in various scientific subjects in evening institutes of the London County Council—The Education Officer, The County Hall, London, S.E.1 (Feb. 10). An Esher research student to carry out research in the history or archæology of London—The Secretary, London Museum, Lancaster House, St. James's, London, S.W.1 (March 11). A professor of agriculture at the University of Reading—The Registrar. An engineering workshop instructor and lecturer in workshop processes, drawing, calculations and science at the Borough Polytechnic, Borough Road, London, S.E.1—The Principal.

Letters to the Editor

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

The Whale Shark in the Waters Around Ceylon

FROM time to time since 1862, whale sharks have been reported from the waters around Ceylon. In addition a number of incidental accounts based on erroneous identifications have been published. In the progress of an article on the geographical distribution of this great fish, these references have been looked up and it now seems a good opportunity to set forth the accurate accounts and designate those which are erroneous.

The earliest reference of all is that by Capt. James Steuart in 1862[1]. In writing of the pearl fishery, he noted that sharks were common and specifically stated that " . . . on two occasions my attention has been called to spotted ones of such monstrous size as to make the common ones at their sides appear like pilot-fish".

In 1883, and again in 1884, Haley[2] recorded the capture, at Moratuwa near Colombo, of a comparatively small specimen (23 ft. 9 in. long). This was mounted and is on exhibit in the Colombo Museum; for a figure of this see Gudger[3], 1931, pl. xxx. Haley[2] also recorded (1890) the capture in 1889 of an 18-ft. specimen at Ngombo, on the western shore just north of Colombo. The skin was sent to the British Museum and mounted; for figures of it, see Günther[4] (1889) and Gudger (1931, pl. xxxi). Lastly, Thurston[5] (1894) stated that in April, 1890, another small fish (14·5 ft.) was taken off Bambalapitya. I have been unable to identify this locality, but it is interesting to note that the other two specimens came from the west coast, and that all three were relatively small fish.

These are the substantiated records for Ceylonese waters. Other specimens of the whale shark have been taken off the Indian peninsula not far away. They will be noted in the paper on the distribution of the fish, but in the present article two indefinite and, in my judgment, erroneous references to the presence of this shark in Ceylonese waters must be cleared up.

The first of these is in A. E. Shipley and James Hornell's "Further Report on Parasites Found in Connection with the Pearl Oyster Fishery at Ceylon" (in W. A. Herdman's Report to the Government of Ceylon on the Pearl Oyster Fishery of the Gulf of Manaar, 1905, vol. 3, pp. 53 and 54). On page 53, they listed a trematode "from either a species of *Carcharias* or *Rhinodon typicus*, the 'basking shark' of tropical waters". Here already doubt was expressed and in a footnote the authors showed further doubt as to what is meant by the "basking shark". Herdman's recollection was that "the term was applied by the sea-going men to a *Carcharias*". Now, the form and coloration of the whale shark are so remarkable that no one who has seen even a good figure of it could ever mistake another shark for it. Moreover, the note further stated that such a "basking shark" caught on the pearl banks was sent to Boulenger who identified it as *Stegostoma tigrinum*, a shark somewhat similarly marked.

On page 54, Shipley and Hornell described a *Distomum* "taken from the perivisceral cavity of *Rhinodon typicus*". Here again I doubt the identification of the shark. On this point it should be noted that James Johnstone[6], in his report on the fishes taken by Herdman and Hornell, made no reference to such a shark—the capture of which would have been a notable matter. Further negative evidence will now be submitted.

Thomas Southwell[7], in his "Notes on the Food of Certain Marine Fishes of Ceylon" on page E 49, wrote: "*Rhinodon typicus*. March 14, 1910. One specimen. Stomach empty." Again, in his "Notes on the Fauna of the Ceylon Pearl Banks",[7] on page E 44, under date of March 18, 1910, of trawling in Dutch Bay, he wrote thus: "*Rhinodon typicus*. Stomach empty, but six huge cestodes in gut. Very ripe ovary. Oviduct full of eggs, 16 cases counted, same form as in dog-fish."

These statements interested me because they apparently gave two other records for *Rhineodon* off Ceylon, and particularly because one account indicated the method of reproduction in this rare shark. To verify and clear this matter up, I carried on an extensive correspondence with Mr. Southwell and with Dr. Joseph Pearson, director of the Colombo Museum. Southwell thought that the egg-cases were preserved in the Colombo Museum, but an exhaustive search by Pearson failed to reveal them. Then I turned to the question of identity of the shark. Pearson stated that in long years of trawling with literally thousands of hauls, neither he nor any of his men had ever seen a *Rhineodon*, which he knew well but thought a very rare fish around Ceylon. He suggested that Southwell's shark might be a *Stegostoma*, as Herdman indicated for a similar case above referred to. Southwell replied that he knew *Stegostoma* well and that it was not his fish, that he thought that his identification was correct since it was made from Day's "Fishes of India" (1889, vol. 2, p. 29), but that he might have been mistaken. Now the description of *Rhineodon* on the page cited in Day is so indefinite that it might be applied to almost any of several large barred and spotted sharks. My conjecture is that Southwell's shark might have been a *Galeocerdo tigrinum*. I think that it could not have been a whale shark. Had he seen this shark, its great size and extraordinary markings would most surely have fixed themselves in his mind.

I think that both these references to *Rhineodon* may safely be set down as due to mistaken identifications, and hence may be disregarded in this faunal survey. However, there are left the records of three specimens seen by scientific men, and in addition, Steuart's short account of his encounters with great spotted sharks, which were undoubtedly Rhineodons.

E. W. GUDGER.

American Museum of Natural History,
New York City.

[1] Steuart, James, "Notes on Ceylon", etc. London, 1862. (Whale Shark, p. 156.)

[2] Haley, A., "On the Occurrence of *Rhinodon typicus* Smith on the West Coast of Ceylon". *Ann. Mag. Nat. Hist.*, 5 ser., **12**, 48–49; 1883. "On *Rhinodon typicus*". Rept. Director Colombo Mus. for 1883, in Ceylon Adminstr. Repts. for 1883, pp. 129D–130D; 1884. "On *Rhinodon typicus*". Rept. Director Colombo Mus. for 1889, in Ceylon Administr. Repts. for 1889, p. 14; 1890.

[3] Gudger, E. W., "The Fourth Florida Whale Shark, *Rhineodon typus*, and the American Museum Model Based on It". *Bull. Amer. Mus. Nat. Hist.*, **61**, 613–637, 10 pls., 4 text-figs.; 1931.

[4] Günther, A. C. L., "The Basking Shark [*Rhinodon typus*] of the Indo-Pacific Region". *Graphic*, London, p. 310, text-fig.; 1889.

[5] Thurston, Edgar, "Inspection of Ceylon Pearl Banks". *Bull. Madras Govt. Mus.* No. 1 (Whale Shark, pp. 36–38, pl. IIIA); 1894.

[6] Johnstone, James, Rept. Govt. Ceylon Pearl Oyster Fishery Gulf of Manaar, vol. 2, 201–222, 2 pls., 2 text-figs.; 1904.

[7] Southwell, Thos., Marine Biology, in Ceylon Administr. Repts. 1912–13, Pt. IV—Education, Science, Art.

Properties of X-Radiation

THE published accounts of unsuccessful attempts to find the *J*-phenomenon seem to call for some statement of the present position of investigations on the subject. Our experience of the phenomenon is now so extensive, that the comments and suggestions of experimenters are to us of little more than psychological, or shall we say philosophical, interest. Their results represent, at most, an almost negligible number of observations under conditions which we are able to reproduce at any time ; they add nothing to our knowledge.

These negative results, that is results showing no *J*-discontinuity, are neither more nor less accurate, neither more nor less real, than those which show the discontinuity. Results of one kind follow laws which are now familiar to physicists ; the others are governed by laws which are not as yet generally recognised. It is to the apparent violations of known laws and not to further confirmation under very precise and specialised conditions that we must look for advances in knowledge. The very rigid limitation of the number of variables, usually imposed upon the experimental conditions, is a most effective barrier to discovery in regions which have not been thoroughly explored. These limitations we have tried—indeed experience has taught us—to avoid.

The *reality* of a *J*-discontinuity can be established by an observer in an hour's time ; the wide generality of the phenomenon has however taken months and even years to establish. The laws which govern it have been studied for thousands of working days and certain general conclusions have been reached. How general these laws are, cannot, of course, be told. But they show with certainty that what have previously been regarded as the fundamental laws of X-ray action are not valid ; and they introduce us to entirely new conceptions of X-ray phenomena. It is quite evident that not only is the *J*-absorption-discontinuity conditional on some unidentified factor but that even the *K*-absorption edge (discovered by us some twenty-five years ago, and now perhaps too faithfully accepted) is conditional, and not perfectly general. In fact, the whole activity of a radiation in a substance is not governed solely by the wave-length of the radiation and the nature of the substance. Confirmation of this statement will be found in the work of Lindh and others on the absorption of X-rays by light substances—work which showed as alternative results absorption lines and absorption edges. It is such alternative results which we have frequently described in association with the *J*-phenomenon.

In this laboratory we have observed the disappearance of the *K*-absorption in a way so pronounced that there is no mistaking it.

It may be that many more years must pass before the results discovered can be attributed to one or two simple measurable quantities. The simplest interpretation has yet to be found. But it is important to know that current theories completely break down —that the quantum (or photon) may become impotent ; that an atmosphere of radiation (not independent quanta or harmonic constituents) is effective ; that superposed radiations act as a coherent whole ; that, so far as the radiation is concerned, something analogous to temperature of radiation is the dominant factor ; that the internal state (and history) of a substance (not simply the nature of constituent atoms) determines its behaviour under X-ray action. How far these conclusions apply to the *K* and *L* phenomena has yet to be determined, but even *their* conditional nature has been established. Detailed accounts will be published in other journals.

C. G. BARKLA.

University of Edinburgh.
Nov. 18.

Carbonyls of Lithium, Rubidium and Cæsium

THE carbonyls of certain alkali and alkaline earth metals have been prepared previously by the action of carbon monoxide on a solution of the appropriate metal ammoniate in liquid ammonia. In this way, Joannis[1] obtained sodium carbonyl, NaCO, and potassium carbonyl, KCO ; Gunz and Mentrel[2] barium carbonyl, $Ba(CO)_2$ and Roederer[3] strontium carbonyl, $Sr(CO)_2$. In the course of researches on the carbonyls proceeding in these laboratories, the corresponding compounds of lithium, rubidium and calcium have been obtained.

The carbonyls were prepared by condensing pure, dry ammonia on to a clean specimen of the metal in question by immersing the containing vessel in a bath at $-60°$. After complete dissolution, which occupied about 45 minutes, the excess of ammonia was allowed to evaporate, a gentle stream of pure, dry carbon monoxide being meanwhile passed through the apparatus and continued until the metal ammoniate was wholly transformed into the carbonyl. Because of the highly reactive nature of the metals, ammoniates and carbonyls, all the operations were conducted with the rigid exclusion of both air and moisture.

Lithium carbonyl, LiCO, is a white pulverulent substance quantitatively synthesised by these means : found Li 18·80, 19·62, 21·05 per cent, mean 19·82 per cent ; calculated for LiCO, 19·86 per cent. It darkens on standing owing presumably to the liberation of minute amounts of carbon, and, on heating in a vacuum, it begins to decompose at 300° without detonation but with the separation of carbon. At about 500° this change is completed in a short time, the residue consisting of free carbon, carbonate and oxide, the amount of residual carbon indicating that the reaction takes the course,

$$4LiCO = Li_2CO_3 + Li_2O + 3C ;$$

ratio LiCO mol./C atoms, found 1·57, calculated 1·33 (the high ratio being probably due to the loss of carbon in the colloidal form). When treated with water the carbonyl detonated violently, with instant ignition of the gaseous products, a cloud of soot being produced and a residue of carbonate and carbon left. On the other hand, water vapour was absorbed quietly with the formation of a dirty brown liquid. The carbon from the detonation of the carbonyl gave ratios LiCO mol./C atoms lying between 2·5 and 3·5. These results together with those of Joannis, who showed that the gas from the detonation of sodium carbonyl with water contained 86 per cent hydrogen and 14 per cent carbon monoxide, indicate the probability of more than one reaction : the high proportion of hydrogen, together with the presence of carbonate in the residue accords well with a reaction of the type,

$$2LiCO + H_2O = Li_2CO_3 + C + H_2$$

involving the reduction of water by the carbonyl, which requires LiCO/C = 2.

Rubidium carbonyl is a pure white solid possessing

as ordinarily prepared a nacreous lustre and dissolving readily in water to give a pale yellow solution. Quantitative synthesis gave Rb 76·55, 74·89 per cent; mean 75·72 per cent; calculated for RbCO, 75·35 per cent. The lilac colour attributed to some of these carbonyls only appears when the conversion from ammoniate to carbonyl is incomplete, and is undoubtedly due to a fine dispersion of the former material. When rubidium carbonyl is heated in a vacuum, the usual dissociation sets in about 350°, and proceeds with increasing rapidity as the temperature is further raised, carbonate, carbon and oxide being produced.

Calcium carbonyl is a dirty, cream coloured, pulverulent powder: found Ca 40·75, 43·66 per cent; mean 42·21 per cent; calculated for $Ca(CO)_2$, 41·70 per cent. With water, it darkens in colour and partially dissolves with the evolution of heat, but without detonation. When heated in a vacuum it gives carbon, carbonate and oxide, the reaction commencing about 200° and increasing in velocity as the temperature is raised.

T. G. PEARSON.

University of Durham,
Armstrong College,
Newcastle upon Tyne.
Nov. 14.

[1] *C. R. Acad. Sci.*, **116**, 1518; 1893.
[2] *Bull. Soc. Chim.*, (3), **29**, 585; 1903.
[3] *Ibid.*, **35**, 715; 1906.

Systems of Four Immiscible Liquid Layers

IN a recent letter Prof. J. R. Partington[1] states that the system of four immiscible liquid layers described by me[2] does not appear to be stable, inasmuch as a specimen, that originally separated into the four layers, now forms two only. A little more than two years ago I prepared a sealed tube containing this system, plus mercury. It has been shaken repeatedly, but still separates into five layers. Moreover, there has been no noticeable tendency for any one of the layers to decrease in volume, much less to disappear. A recent photograph of this tube is reproduced as Fig. 1. A second specimen, made about the same time, behaved in precisely the same way.

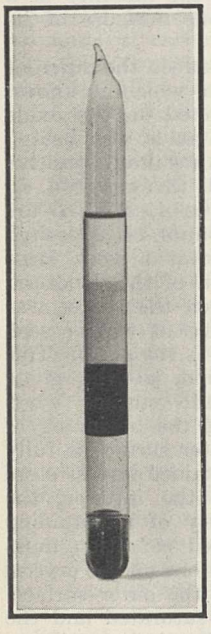

FIG. 1.

It is difficult to account for the instability of Prof. Partington's specimen, unless indeed impure materials were used (for example, the best oleic acid obtainable commercially is impure) or unless precautions were not taken to exclude atmospheric oxygen and carbon dioxide. The latter will decompose the soap, and the four layers will become three. This might conceivably happen within two years through the action of atmospheric carbon dioxide if the specimens were stoppered with cork or rubber; but then under such conditions the hexane might evaporate away. The suggestion that some decomposition has occurred, or that impure materials were used, is supported by the fact that the two layers of the unstable specimen are reported to be brown in colour.

The phase rule does not demand that systems shall remain in equilibrium in the presence of reactive substances not included among the components. Indeed, it is applicable even when slow interaction between the components occurs. For example, Schreinemakers' studies of the system succinic nitrile, water,[3] and my own of the system sodium oleate, sodium chloride, water, ethyl acetate,[4] are not invalidated because the nitrile and the ester respectively are slowly hydrolysed by the water. These systems would certainly not remain in equilibrium for two years, but as it happens the system under consideration is not of this type. Provided that it is prepared with pure materials and suitably sealed, it seems likely that it will remain unchanged indefinitely, thus constituting the first example of a system of four immiscible liquid layers in permanent true equilibrium. This claim is sufficiently established by the single example illustrated in the accompanying photograph, and is not weakened by the fact that the same phenomena may not be manifested under slightly different conditions.

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[1] NATURE, **130**, 967, Dec. 24, 1932.
[2] NATURE, **127**, 91, Jan. 17, 1931.
[3] *Z. Phys. Chem.*, **23**, 418; 1897.
[4] *J. Phys. Chem.*, **36**, 2455; 1932.

Vacant Positions in the Iron Lattice of Pyrrhotite

PREVIOUS investigations on the solubility of sulphur in iron sulphide (FeS) have led to the conclusion that the solid solutions of sulphur in iron sulphide are formed by substituting some of the iron atoms in the original lattice by sulphur atoms. Assuming that the radius of the sulphur atoms is smaller than that of the iron atoms, this hypothesis explains the fact that

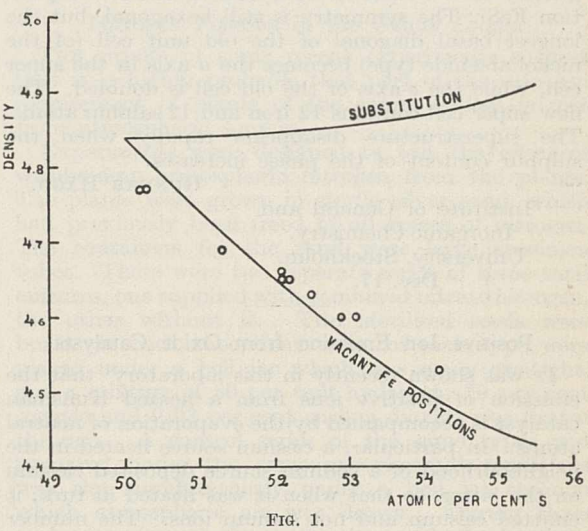

FIG. 1.

the lattice dimensions decrease with increasing sulphur content. It seems, however, doubtful if this relation between the radii of iron and sulphur atoms agrees with reality, and the difficulties are still more increased when one has to explain the analogous (only more pronounced) lattice variations in solid

solutions of selenium in iron selenide (FeSe) in the same way, on the assumption that the selenium atoms are smaller than the iron atoms.

There exists, however, a second explanation of the observed effect, which requires no special relation between the sizes of the two kinds of atoms, namely, that the excess of sulphur is caused by an increasing number of vacant positions in the iron lattice. Recent X-ray measurements carried out in this Institute show that the phase of the 'nickel arsenide type', constituting the solid solutions in question, is homogeneous from about 50 to about 55·5 atomic per cent sulphur, and by means of the lattice dimensions observed, the density has been calculated for a solid solution of the substitution type and for the type characterised by vacant iron positions. The curves are shown in Fig. 1 together with previously observed density values, which strongly favour the assumption of such vacant positions.

Theoretically, it should be possible to decide the question also by intensity measurements of the X-ray interferences, but in this case the difference necessitated by the two theories is too small to be detected. A study of the solutions of selenium in iron selenide, where the difference should be more marked, and also where the density measurements probably will give a still more striking difference, has been begun.

No definite facts indicate a regular distribution of the vacant positions, so possibly they might be distributed at random in the iron lattice. Theoretically, the appearance of random vacancies is as natural as the appearance of random substitution, or of a random adding of dissolved atoms into the interstices of a lattice. These vacant positions make a new type of solid solution like the above possible, and the possibility of their appearing should be kept in mind in the determination of any structure where they are not electrostatically impossible.

In this connexion it might be mentioned that the present study has shown that the phase under investigation exhibits a 'superstructure' at the homogeneity limit richest in iron, that is, at the composition FeS. The symmetry is still hexagonal, but the longest basal diagonal of the old unit cell (of the nickel arsenide type) becomes the a-axis in the super cell, while the c-axis of the old cell is doubled. The new super cell contains 12 iron and 12 sulphur atoms. The superstructure disappears rapidly when the sulphur content of the phase increases.

GUNNAR HÄGG.

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Dec. 17.

Positive Ion Emission from Oxide Catalysts

IT was shown recently in this laboratory[1] that the emission of positive ions from a heated Kunsman catalyst is accompanied by the evaporation of neutral atoms. In particular, a cæsium source heated in the neighbourhood of a sodium source deposited cæsium on the latter, so that when it was heated in turn, it emitted cæsium and not sodium ions. The number of cæsium ions emitted from the sodium source was large in this sense that it corresponded to the deposition on the superficial area of the source of a layer of cæsium a thousand atoms thick.

Cæsium atoms evaporate uncharged from cæsium in bulk and a layer more than two or three atoms thick must behave in the same way. Thus we find that cæsium deposited in varying thicknesses on a tungsten surface, which is then heated, always results in the emission of the same quantity of positive charge. This charge corresponds to the emission of the last layer of the cæsium on the tungsten, which is held to the surface as ions, the overlying atoms being evaporated in the neutral state. In the experiments with the oxide sources, the cæsium must therefore have been distributed on the surface of the microcrystals throughout the source. At temperatures below that at which the cæsium evaporates appreciably, the cæsium atoms must be able to migrate over the crystal surfaces, possibly in the way suggested by Lennard-Jones[2], so that the deposition results in a large surface being covered by a monatomic layer of cæsium ions.

This result suggested that it might be possible to produce positive ion sources of other metals by evaporation on to an iron oxide base, and experiments were made with thallium, indium and gallium. With thallium and indium we obtained very pure sources of the corresponding ions which gave an emission of 20 microamp. per sq. cm. for many hours. With gallium the results were unsatisfactory and the sources soon failed. The ions were identified by mobility measurements in pure nitrogen. In this gas we have

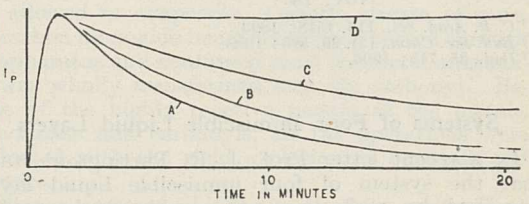

FIG. 1.

found that the determination of the mobility of a positive ion gives an unambiguous measure of its mass[3].

To investigate this difference between the different metals, we made experiments in which a known amount of metal could be deposited on the oxide base. After the deposition, the oxide was heated to a given temperature and the resultant positive ion emission measured. In Fig. 1, this emission, i_p, is plotted against the time. Curves A, B, C, D are for progressively increasing amounts of deposited thallium. The results showed that a very large proportion, probably 100 per cent, of the deposited metal was re-emitted as ions when the source was heated. Secondly, in all the curves it will be seen that the initial maximum current is the same. This maximum current is the emission, at the given temperature, characteristic of the surface when saturated with positive ions. At the beginning of the heating of the source, the outer surface is fully saturated. Unless it can be maintained in this state by the migration of ions from the interior, the emission falls off. The possibility of maintaining the outer surface in the saturated condition must depend upon the concentration of ions on the crystal surfaces in the neighbourhood of the outer surface. With large depositions these are saturated and the emission remains constant (see Fig. 1, curve D).

If for a given metal the emission characteristic of the saturated surface is measured at increasing temperatures, it is found to rise rapidly like the saturated electronic emission from a heated filament. From this curve an approximate value of the positive ion work function can be found. At a certain limiting

temperature the iron oxide sinters and the emission falls and becomes unstable. This temperature limitation defines the maximum emission that can be taken from an iron oxide source with a given metal on it. The higher the work function for the positive ions the lower the maximum current. In the mobility experiments with gallium we must have exceeded this limiting temperature in the attempt to obtain the necessary emission.

Details of these experiments, together with others on the properties of surface ionic layers of other metals on various oxides, will be discussed in another place. We may point out here the significance of these results in connexion with the catalytic action of the Kunsman source in the production of ammonia which we have found to take place at low pressures[3] and which is used as an industrial process. The catalytic activity may be assumed to be directly associated with the presence of alkali ions on an enormous area, and any activity of the oxide in the absence of added alkali to the inevitable presence of traces of the alkalis as impurity, for a small mass of alkali will cover a large area as a monatomic film.

C. F. POWELL.
LUANG BRATA.

The Wills Physical Laboratory,
University of Bristol.
Dec. 20.

[1] Tyndall and Powell, *Proc. Roy. Soc.*, A, **136**, 145; 1932.
[2] Lennard-Jones, *Trans. Faraday Soc.*, **28**, 333; 1932.
[3] Powell and Brata, *Proc. Roy. Soc.*, A, **138**, 117; 1932.

Fusion of Carbon

IN the course of an investigation on the behaviour of the carbon arc in various gases at high pressure, carried out in apparatus provided by Imperial Chemical Industries Ltd., we have obtained large amounts of carbon in a fine state of division. In certain circumstances this carbon is deposited as graphite, all in the form of small spherules of about 0·02 mm. diameter or smaller, having a density 2·25. There seems to be little doubt that these spherules of graphite have been formed owing to the effect of surface tension, the carbon having persisted for a finite time in the molten state. The best yield was obtained at 90 atmospheres in hydrogen with an arc dissipating 20 kilowatts. The temperature of the positive crater at this pressure has not yet been determined. The surface brightness at 10·5 atmospheres was 2·18 times that of the arc at atmospheric pressure for the same wave-length, corresponding to an increase of brightness temperature of 460°. The increase in the thermodynamic temperature must be of the same order, so that the temperature was probably much higher at 90 atmospheres. Further investigations are necessary before the precise conditions under which the spherules are formed are established. The percentage of ash left after burning the carbon of the electrodes was 0·8, that from the carbon collected from the arc chamber less than 3 per cent. It is scarcely likely that this amount of fusible ash could cause the whole of the carbon to adopt spherical form.

Braun[1] has mentioned the formation of microscopic spheres of carbon from thin carbon filaments through which the discharge from a number of Leyden jars was passed, while Lummer's investigations on the peculiar molten appearance of the positive crater in arcs at low pressure described in his book on the "Verflussigung der Kohle" are well known, but no evidence of the melting of carbon is quite so convincing as the appearance of these graphite spherules, obtained in the above manner.

A. EGERTON.
M. MILFORD.

Clarendon Laboratory,
Oxford.
Dec. 15.

[1] *Ann. Phys.*, **17**, 359; 1905.

Liesegang Rings

IN reply to Dr. Bradford's letter[1] I would say that the more comprehensive a theory is, the more general and apparently indefinite must be the terms in which it is expressed. If for my indefinite term 'mobilisation' is substituted the more definite term 'adsorption', my theory of periodic structures becomes almost identical with Dr. Bradford's. But I believe that adsorption is only one of the means by which the substance may migrate towards the structure already formed, and I prefer, therefore, to use the less definite term 'mobilisation' to include all these means.

It is not correct to suppose that in accordance with my theory all systems should give periodic structures, for the critical conditions postulated may be absent or only slightly developed. Nevertheless, it is probable that a system not usually given to periodic structure formation can always be made to furnish periodic structures by alteration of these conditions. This, I believe, is a point also upheld by Dr. Bradford.

ERNEST S. HEDGES.

International Tin Research
and Development Council,
Manfield House, Strand,
London, W.C.2.
Jan. 4.

[1] NATURE, **130**, 1002, Dec. 31, 1932.

Nitrogen Fixation in the Genus *Lolium*

THE results of some recent experiments suggest that it is highly probable that part of the nitrogen requirement of plants of the genus *Lolium* is met from atmospheric sources.

Experiments were designed to test the effect of withholding atmospheric nitrogen from the plants. The plants were grown in sterile silver sand, which had previously been freed of all traces of nitrogen. The containers for the sand were large specimen tubes. There were two separate series of these sand cultures, one supplied with combined nitrate nitrogen, the other without it. Two sterilised seeds were buried in each tube, four tubes of each type were placed under a bell jar which was made gas-tight, and a mixture of 80 per cent hydrogen, 20 per cent oxygen and 0·03 per cent carbon dioxide was drawn through. A control series of the same types and prepared under the same experimental conditions was run simultaneously under a bell jar through which atmospheric air was drawn. During these early experiments the gas mixture of both chambers was drawn through the sand. The gas in the chambers was changed once every twenty-four hours. The hydrogen and oxygen were prepared electrolytically, and the carbon dioxide by the action of hydrochloric acid on marble chips.

The experiment was kept going for seven weeks.

At the end of that time the plants in the air chamber were markedly healthier and bigger than those in the hydrogen chamber.

A similar experiment was afterwards set up, observing the same precautions, but it was modified to yield quantitative data and to give some indication of the effect of hydrogen on the growth of the plant. Bell jars as gas chambers sufficiently large to cover forty tubes were used. A third chamber was added, through which a gas mixture of, in percentage proportions, hydrogen 40, nitrogen 40, oxygen 20, and carbon dioxide 0·03, was drawn. This experiment was kept going for eight weeks, and at the end of that period the lengths of all the leaves and the dry weights on each plant were determined. The lengths of the leaves were measured as indices of area; the small width of the leaves rendered the direct determination of this quantity extremely difficult. The mean total leaf length in centimetres and the mean dry weight in grams per plant are presented in the accompanying table.

Gas Mixture	Culture Solution		
Nitrogen, oxygen and carbon dioxide	+ Nitrate	Leaf length Dry weight	26·4 0·0018 (1)
	− Nitrate	Leaf length Dry weight	21·5 0·00148 (2)
Nitrogen, hydrogen, oxygen and carbon dioxide	+ Nitrate	Leaf length Dry weight	36 0·00322 (3)
	− Nitrate	Leaf length Dry weight	23·1 0·00164 (4)
Hydrogen, oxygen and carbon dioxide	+ Nitrate	Leaf length Dry weight	27·2 0·00228 (5)
	− Nitrate	Leaf length Dry weight	18 0·00136 (6)

The difference between the dry weights of (2) and (6) is only slightly greater than the standard error of the difference of these means, but the difference in leaf lengths is more than twice the standard error of the difference of the means. The latter difference is, therefore, probably significant. The best growth was that made in the gas mixture containing both nitrogen and hydrogen. The stimulating effect of hydrogen under the conditions of the experiment is also evident from series (5) when compared against series (1). The conclusions would therefore seem to be justifiable that the stimulating effect of hydrogen is masking the depressant effect of absence of nitrogen in (5) and (6).

R. BROWN.

Botanical Dept.,
Seale-Hayne Agricultural College,
Newton Abbot.

Ambiguity in Sign of Spearman's General Factor

IN a previous letter,[1] I gave a sketch of a method for obtaining an explicit formula for the general factor g and the specific factors which occur in Spearman's two-factor theory of intelligence. By developing this method, I obtain the following results.

If the tetrad relations hold, the factors exist. If two more conditions hold, the factors are real. If a fourth condition holds, they are unique except in sign. In the case which occurs most often in actual experiment, when all the coefficients of correlation between the tests are positive, the value of the general factor with one sign seems to correspond to something like general ability and the value with the other sign to the lack of that ability. But in other cases, when some of the coefficients of correlation are negative, it is not clear how to distinguish between the interpretations of the two possible values of the general factor.

After a discussion of the effects of pooling tests, the results have been applied to a dice problem, and to actual sets of mental tests. It is found that both for the dice throws and for the mental tests, the general factor exists and is real, but is not unique, even in numerical value. The comparison between dice throws and mental tests, when examined closely, breaks down in one important respect. Finally, the possibility is examined of making the numerical value of the general factor approximately unique, by making the ratio of the standard deviations of the indeterminate and determinate parts a given small fraction. I have shown that to do this by merely multiplying the number of tests is quite impracticable; the only method available is to choose one or more tests that correlate very highly indeed with g. In the case of Kelley's tests, it is found that the fraction which we wish to make small appears to be 0·09, but that this value is very doubtful on account of the tetrad relations not being satisfied exactly. The use of figures corrected for attenuation leads to the conclusion that either some of the factors are imaginary, or, what is more probable, that the correction for attenuation is not reliable.

A full account of this work will be offered to a psychological journal in the near future.

H. T. H. PIAGGIO.

University College,
Nottingham.
Dec. 21.

[1] "The General Factor in Spearman's Theory of Intelligence," NATURE, 127, 56, Jan. 10, 1931.

Spectra of Bromine: Br V, VII and IV

IN continuation of our previous work on the spectra of arsenic and selenium, the spectrum of bromine has been investigated by a study of photographs taken under different conditions of excitation. The chief multiplets belonging to the higher spark spectra of bromine have been easily identified. The characteristic intervals of the deepest ^2P terms in Br V and Br VII have been found to be 6090 cm.$^{-1}$ and 7580 cm.$^{-1}$ respectively, while $4p\ ^3P_0 - 4p\ ^3P_1$ and $4p\ ^3P_1 - 4p\ ^3P_2$ of Br V are 2115 and 4906 units.

A full report of the analysis will be published shortly.

The experimental data referred to above have led one of us (A.S.R.) further to the identification of many of the chief groups of Br IV arising from the transition of the electron from the $4p$ to the $5s$, $4d$ and sp^3 states. The intervals of $5s\ ^3P_{0,1,2}$ are found to be 1281 cm.$^{-1}$ and 4688 cm.$^{-1}$. This classification does not agree with the scheme suggested by S. C. Deb[1], which the writer thinks is out of step in the iso-electronic sequence Ge I to Br IV.

A. S. RAO.
K. R. RAO.

Science College,
Andhra University,
Waltair, Nov. 1.

[1] *Proc. Roy. Soc.*, A, 127, 197; 1930.

Research Items

Hawaiian Feather Cape. In *Man* for January Mr. H. G. Beasley figures in colour and describes a feather-cape from Hawaii, which he acquired for the Cranmore Ethnographical Museum, Chislehurst, in 1932. The cape measures 62 in. round the base and is 25 in. in depth, thus falling into the intermediate series, in which the base-line measurement is that of a full-sized cloak, but the shallow depth that of a cape. The ground-work is of red Iiwi feathers (*Vestiaria coccinea*) and the pattern and border are of yellow Oo (*Acrulocercus nobilis*). The main body of the foundation is somewhat coarse; but the six-inch border is of finer meshed work. The cloak belonged to Sir Joseph Banks and was given by him to his private secretary, Mr. R. K. S. Durham, from whose grandson it was obtained by Mr. Beasley. It is to be presumed that Banks obtained the cloak from one of the officers who sailed with Cook in his later voyages; but the connexion with any one of Cook's voyages cannot be established. In a supplementary note Mr. H. J. Braunholtz adds that the birds from which the feathers were taken were captured alive and often released after they had been plucked. The popular belief that the Oo bird had only two yellow feathers is erroneous: actually the yellow feathers form axilliary tufts containing 15–20 feathers. The feathers are attached to a net of fibre, each separately, by a finer thread of the same material. The use of cotton thread is a sign of modernity. The British Museum now has twenty-six of these feather capes or cloaks, presumably the largest collection in existence. They were first described by Capt. King in his account of Cook's third voyage when the Hawaiian group was discovered in January 1778.

Gods of Maya and Aztec. In an appendix to a study of the calculations of the solar year in Mayan inscriptions on stone stelæ at Quirigua, Guatemala (Field Museum of Natural History, Chicago, Pub. 315, Anthropological Series, vol. 17, No. 4), Mr. J. Eric Thompson considers how far any resemblance may be detected between the Aztec 'Lords of the Night' and the equivalent Maya glyphs of the gods. The sun god is unmistakable. Xiuhtecutli, the fire god of the Aztec, is the Maya glyph in which a flame bracket branches from the god's mouth. In one instance, three balls of flame are shown above the head. Itzli, the second in the Aztec series, has no known Mayan equivalent. Piltzintecutli, the Aztec sun god, in the Maya series is Kinich Ahau, both being associated with a flower or leaves. The fourth Aztec god Centeotl is the maize god, corresponding to the Maya glyph showing a head with the numerical co-efficient of nine and a large human hand, which, the evidence goes to show, denotes an agricultural deity. Mictlantecutli, the Aztec death god, is represented by the Maya glyph with the coefficient of three. Only two examples of the glyph are known and the connexion with death is not clear. The Mayan equivalent for the sixth Aztec 'Lord of the Night', Chalchihuitlicue, goddess of water, through the month sign Mol and day sign Muluc, may also be connected with water. One of the closest parallels is that between Tlazolteotl, the Aztec earth goddess and the Mayan moon goddess, wife of the sun. Both are connected with agriculture, the Aztec through maize, the Mayan through flowers, and both are also concerned with sexual indulgence. The eighth Aztec god, Tepeyollotl, is an obscure earth and mountain deity, who as a jaguar-like animal has a conch shell as symbol. This connects him with a Mayan mountain deity. The ninth and last in the Aztec series is Tlaloc, the rain god. The equivalent Mayan glyph is a young deity with an ear-flap, of which only two examples are known. The association is not clear. Thus in six out of the nine, a remarkable coincidence between Aztec and Maya is apparent.

Making Whole Mounts of Vertebrate Skeletons. Mr. M. Rahimullah and Prof. B. K. Das, of Osmania University College, Hyderabad, have sent a communication describing a method of preparing the whole skeleton, free from soft parts, of a vertebrate, such as a snake or a rat, by a modification of the well known alizarin and caustic potash method. The chloroformed animal is fixed and hardened in strong alcohol (about 92 per cent) for four days, then rinsed in tap water and transferred to a 1 per cent solution of caustic potash. After a period of at least eight days, the bones can be seen through the translucent skin and muscles. The animal is then transferred to a solution of alizarin and caustic potash (made by dissolving 0·1 gm. or less of alizarin *S* in 1,000 c.c. of 1 per cent potash), where it remains for at least twelve days, until the bones take a deep pink hue. The macerated muscles are then dissected away, leaving the skeleton intact. It is not clear from the communication whether the connective tissues uniting the bones have escaped maceration, or whether the articulation of the parts of the skeleton remains to be done in the usual way, but the former claim seems to be made. The hairs of mammals remain opaque, but after a few days in the potash solution they are loose enough to be scraped away with a section lifter or similar instrument. In this way albino rats and young rabbits have been successfully treated.

Early Stages of Hispine Beetles. While there remains still very much to be done in the morphological and anatomical studies of insects in the adult stage, this work is progressing much more rapidly than the study of their immature stages. Researches in the morphology of the latter, however, can be of great interest and value since a number of general biological problems are suggested by them. This is shown very clearly by recent detailed work of S. A. Maulik on the larval and pupal structures in the beetles of the subfamily Hispinæ (*Proc. Zool. Soc. Lond.*, 1932). These larvæ live in tunnels inside leaves and their morphology presents numerous cases of remarkable specialisation due to this mode of life. Thus, the legs show a complete gradation from a well-developed condition to one of great degeneracy, where the claws disappear altogether. The position of the spiracles presents various significant modifications in the larvæ, while their number also varies with the species. In one case the number of larval spiracles was found to vary even within the species and, moreover, there appeared to be a correlation between the number of spiracles in the larva, and the colour pattern of the adult beetle. Some observations point to the possibility of two or more species of the same

genus living together in the same tunnel, and this may lead to interbreeding and hybridisation, which would supply a hypothetical explanation of the great variety of colour-patterns in the adults.

Growth of Corals. T. Tamura and Y. Hada record observations (*Science Reports*, Tôhuku Imp. Univ., vol. 7, No. 3, 1932) on the growth of corals in the Caroline and the Pelew Islands respectively. They found that the average annual growth in *Acropora pulchra* was 226 mm. and in *A. digitifera* 12 mm.; the former has a light skeleton, the latter a dense and heavy one. Massive corals, for example, *Porites*, *Montipora*, *Favia*, showed an average annual increase in length of about 6 mm., and in weight of about 33 per cent. *Fungia* showed an increase in length of about 9 mm. and in weight 23 per cent. The rate of growth in both localities is similar to that recorded for Hawaiian corals. Each species has a characteristic growth rate; after a specimen reaches a certain size growth ceases. In the preceding paper in the same journal, Y. Hada gives an account of the early stages of growth of *Pocillopora cespitosa*, the planulæ of which are extruded probably throughout the year but most actively during December. The youngest colony found was 1·5 mm. in diameter and consisted of three polyps. The next period of growth results in lateral spreading of the colony until about thirty polyps have been formed; then the colony begins to grow vertically and to branch. The number of polyps now increases about three times as fast as in colonies which are still undergoing lateral extension.

Some Noteworthy Irish Plants. Dr. Lloyd Praeger's paper (*Proc. Roy. Irish Acad.*, 41, Sec. B, No. 7, Dec. 1932) contains much of interest to students of topographical botany, whilst his account of the genus *Cochlearia* in Ireland will be of value to British botanists as ecological observations on the species and notes on hybrids of *C. officinalis* with *anglica*, *danica* and *grœnlandica*, are given. A revised distribution of these species in Ireland is given, the previous confusion with regard to *C. anglica* being attributed to the frequency with which it hybridises with *C. officinalis*. Investigations on the distribution and associates of *Arbutus* at Lough Gill lead to the conclusion that the plant is native in Sligo, thus extending by 160 miles its northernmost Irish and European limit. The occurrence of *Arctostaphylos alpina* in Ireland and the record of *Euphorbia hiberna* from Roscommon are discredited, whilst the status of *Tamus* as an indigenous plant is re-examined, the author inclining to regard it as native in Sligo. *Polypodium Robertianum* is established as a native species new to Ireland whilst many new stations are given for the hybrid *Equisetum litorale*, and *Scrophularia alata* is recorded from Limerick and Londonderry. Other notes deal with introduced species including *Sarracenia purpurea* from Roscommon and Westmeath, *Erica stricta* from Antrim and Londonderry and an unconfirmed record of *Selaginella Kraussiana* from Donegal.

The Ankole Tinfield. Memoir No. II of the Geological Survey of Uganda is devoted to "The Geology of South-west Ankole and Adjacent Territories, with Special Reference to the Tin Deposits". Apart from an appendix on the petrology of the rocks of the region contributed by A. W. Groves, and a postscript by W. C. Simmons, the memoir is the work of A. D. Combe. It contains a well-illustrated, authoritative account of the geology of south-west Uganda and north-west Tanganyika based on ten years' detailed field work. Cassiterite is the only mineral of economic value that occurs in workable quantities in this area, and though production did not begin until 1927, more than a thousand tons have so far been exported. The mineral occurs in quartz-muscovite-pegmatites and in hydrothermal veins associated with them, veins of hydrous micas and muscovite having proved to be the most important producers to date. All the veins are found in the metamorphosed rocks of the Karagwe-Ankolean system adjacent to the margins of various masses of the so-called Younger Granite. Much of the muscovite with which the tin is associated is thought to have been produced by metasomatic alteration of the phyllites. Combe and Simmons suggest that the alkaline liquors responsible for this alteration also acted as carriers for the tin, but Groves believes that fluorine was probably an active agent in the introduction of tin, despite the absence of topaz. This opinion has also been expressed by Stheeman in a recent book on the same area. The memoir contains a wealth of information on one of the most interesting parts of Uganda and is of importance to stratigraphers because of the attention given to the Karagwe-Ankolean formations and their distribution and correlation, as well as to geologists in general because of the wide range of problems that come under discussion. The memoir is obtainable from the Government Printer, Entebbe, Uganda, price 35*s*.

Meteoric Craters. In a paper to the Royal Geographical Society on January 16, Dr. L. J. Spencer discussed the origins of meteoric craters such as that in Arizona, those in Central Australia and in Estonia or the one recently discovered by Mr. H. St. J. Philby on the site of Wabar in the Arabian desert and described by him in the *Geographical Journal* for January 1933. Little is known about the mode of formation of these craters but the suggestion that they are merely holes formed by the projectile force of the meteor is not an adequate explanation. Meteorites of which the fall has been observed have all been small and their velocity, reduced by resistance of the air, has been about seventy metres a second. They have never penetrated far into the ground. The largest discovered meteorites, the fall of which has not been noted, have not formed craters but lie either on the surface or with their tops flush with the surface. Dr. Spencer suggests that meteoric craters are formed by explosions due to the sudden vaporisation of part of the material both of the meteorite and the surface of the earth as a result of the intense heat generated by the impact. He showed how the destruction of material within the crater agrees with this theory, which also explains the formation of silica-glass found in association with the crater (see also NATURE, Jan. 28, p. 117).

Physical Atomic Weights. In the Liversidge lecture to the Chemical Society (*J. Chem. Soc.*, December 1932), Dr. F. W. Aston described some recent results obtained with the mass-spectrograph. In the case of elements which are mixtures of isotopes, a measurement of the relative intensities of the lines in the mass-spectrogram will lead to an average atomic weight of the element which may be compared with the chemical value. This operation is, however,

experimentally very difficult, owing to the circumstances that the source of the positive rays is never reproducible and seldom constant for more than a very short time and also that the relation between relative abundance of isotopes and blackening of the plate is completely different for different elements. Dr. Aston described the experimental procedure adopted in overcoming these difficulties. The results, based on $O^{16} = 16$, require correction by 2 in 10,000 to reduce them to the chemical scale, O = 16, since ordinary oxygen contains the isotopes O^{17} and O^{18}, and a comparison of the two sets of values shows that the agreement is in the great majority of cases exceedingly satisfactory. There is a discrepancy in the case of hydrogen, which cannot be removed by the recent discovery of an isotope of mass number 2, which is present only to the extent of 1 part in 35,000. Scandium, niobium and tantalum, which are simple elements, show discrepancies, their chemical atomic weights being too high, and the same is true, to a less degree, of phosphorus and cæsium. The serious difference in the case of selenium has been removed by Hönigschmid, whose chemical value is identical with the physical one. The physical value for tellurium, which differed from the chemical one, has been corrected by Bainbridge, whose result agrees with the chemical one. The values for osmium and uranium are also abnormal.

Simple Molecules and Elementary Processes. Two lectures by Prof. A. J. Allmand on the above subject have been published by the Institute of Chemistry, and form a very clear and concise introduction to a field of research which has recently been actively studied. In the first lecture the experiments of Stern and his collaborators on molecular rays are briefly considered, and then an account is given of molecular spectra, the text here being illustrated by several useful diagrams. The parts played by the electronic, vibrational and rotational energies of the molecule in producing the spectra are clearly explained, and the importance of Raman spectra in deciding the natural frequency is emphasised. The second lecture dealt with a miscellaneous group of phenomena giving information about the mechanism of individual chemical molecular processes. The evidence for the existence of free radicals such as OH, NH, CH, etc., from spectroscopic results is considered in connexion with the energy of linkage. The chemical reactions of atomic hydrogen and atomic oxygen, the chemical evidence for the existence of free radicals given in the experiments of Paneth and F. O. Rice, chain reactions, predissociation, and three body collisions are topics dealt with in this lecture. Prof. Allmand's lectures will be found to constitute an admirable introductory survey of a highly interesting field of modern physical chemistry.

Astronomical Topics

Comet Peltier-Whipple. This was probably the brightest of the numerous comets that were observed in 1932. It was on the verge of naked-eye visibility at the end of August. *Astr. Nach.*, 5905, contains observations of it made by R. M. Aller of Lalin Observatory on twelve nights between August 25 and September 19; also drawings of the comet on August 27, 28, September 2 and 7. The tail is multiple; the main branch is triple and was traced to the length of a degree on August 28. Its position angle changed from about 300° on August 27 to about 330° on September 7. A short, but bright, tail was inclined at about 45° to the main tail, on the side of greater angle. The sketches show a coma about 3′ in diameter round the nucleus.

Mr. H. Jensen of Copenhagen finds 287·2 years as the period, and Mr. F. Koebcke of Poznan 286·8 years (Copenhagen Circulars 403, 404). Search in the catalogues does not show any previous apparition of the comet.

A determination of the light-curve of the comet has been published by K. Himpel (*Astr. Nach.*, 5913). It was of magnitude 6·7 on August 12, and slowly rose to a maximum of 6·3 on August 24: it then declined rapidly, being 7·7 on September 9. A very thorough investigation of its orbit, by Dr. Allan D. Maxwell (Publ. Univ. Michigan, vol. 5, No. 2) gives the period as 302·5 years. Comparison with other determinations suggests that this is unlikely to be more than some ten years in error.

Galactic Rotation. *Lick Observatory Bulletin* No. 448 contains an investigation on this subject by Miss Phyllis Hayford. It is necessary for this purpose to observe the radial velocities of distant objects. This investigation made use of a large number of spectrograms of stars in the Milky Way clusters, obtained with the 36-inch refractor; Dr. Trumpler took many of the plates, but all were measured by Miss Hayford. The clusters are all within 10° of the galactic plane, and are distributed fairly uniformly from galactic longitude 311° through 0° to 206°. 116 of the stars are of type *O*5 to *B*5, 32 of type *B*6 to *A*2, and 13 of later type. Their magnitudes range from 5·3 to 12·2; their adopted distances range from 940 to 3,680 parsecs.

As is to be expected, the solar motion relatively to these distant stars is higher than that derived from neighbouring stars; it is about 30 km./sec. The longitude of the galactic centre, 333°, agrees well with other determinations. The investigation confirmed the result of Dr. Plaskett and others that the interstellar calcium lines indicate a smaller distance than that of the stars in the spectra of which they are measured.

The distance of the galactic centre is found to be of the order of 1,800 parsecs from the sun, a much smaller distance than that found by Dr. Oort, which was about 6,000 parsecs. But the new distance, being derived from a limited number of objects, does not claim to be final.

Mutual Eclipses and Occultations of Jupiter's Satellites. Every six years the system of Jupiter is turned edgewise to us; at such times, numerous eclipses and occultations of one satellite by another take place. Until recently these phenomena were unpredicted, and in consequence they were very seldom observed. The Computing Section of the British Astronomical Association now makes predictions which are published in the B.A.A. Handbook; very many have been observed during the past twelve months. *L'Astronomie* for September contains an illustrated account of the occultation of IV by I observed by M. Schlumberger at Mulhouse on March 14, 1932; the occultation was very nearly total. The surface of IV is so much darker than that of I that it is easy to distinguish the two bodies when the discs are overlapping; at the maximum phase a very narrow segment of IV remains uncovered.

Prize Awards of the Paris Academy of Sciences

AT the annual public meeting of the Paris Academy of Sciences, held on December 12, the prizes and grants for 1932 were awarded as follows :

Mathematics.—The Poncelet prize to Raoul Bricard, for his work in geometry ; the Francœur prize to Henri Milloux, for his work on analytical functions.

Mechanics.—A Montyon prize to Jules Haag, for his work on chronometry ; the Fourneyron prize to Maurice Roy for his work in applied mechanics ; the Henri de Parville prize to Joseph Pérès, for his work in hydrodynamics ; the Henry foundation to Dimitri Riabouchinsky for his work in aerodynamics and hydraulics.

Astronomy.—The Lalande prize to Abel Pourteau for his studies on the statistics of the double stars ; the Damoiseau prize to Nicolas Stoyko for his studies on the measurement of time and allied problems ; the Benjamin Valz prize to Jean Dufay for his work in astronomical photometry ; the Janssen medal to Alexandre Dauvillier for his studies on the aurora polaris and allied phenomena ; the La Caille prize to Eugène Antoniadi for his work on planets.

Geography.—The Delalande-Guérineau prize to Ernest Benoit for his theoretical works and geodesic operations in the field ; the Gay prize to Emile Hasse for his calculations and discussions of geodesic and astronomical work carried out by the geographical service of the army ; the Tchihatchef prize to Mme. Tardieu for her memoir on the ferns of Tonkin ; the Binoux prize to the late Jules Hansen for his map of "L'Ancien Pays de Luxembourg".

Navigation.—The Navy prize to Pierre Malaval for his work on the resistance of materials ; the Plumey prize to Henri de Leiris for his memoir entitled : "Experimental Researches on the Fatigue and Expansion of Steam Pipes".

Physics.—The L. La Caze prize to Eugène Darmois for the whole of his work ; the Hébert prize to Charles Lavanchy for his work on the calculation and construction of high tension aerial cables ; the Hughes prize to Emile Henriot for the whole of his work, especially on the radioactivity of the alkaline metals, the double refraction of compressed glass, high angular velocity cathode and magneto-cathode rays : the Clément Félix foundation to Gaston Dupouy for assisting his researches on magnetism.

Chemistry.—A Montyon prize (unhealthy trades) to Eugène Burlot for his work dealing with the safe handling of explosives and compressed gases ; Raymond Horclois received a mention (1,500 francs) for his researches on the application of negative catalysis for extinguishing fires ; the Jecker prize to the late Marc Bridel for his work in biological chemistry ; the L. La Caze prize to Louis Hackspill for his researches in inorganic chemistry ; the Cahours foundation between Paul Thomas and Paul de Graeve for work on fermentation ; the Houzeau prize to Dimitri Ivanoff for his work on Grignard syntheses.

Mineralogy and *Geology.*—The Fontannes prize to Gustave Sayn for his palæontological work ; the Victor Raulin prize to Louis Royer for his crystallographic work ; the Demolombe prize to Paul Bertrand for his work in palæobotany.

Botany.—The Desmazières prize to René Morquer for his work entitled : "Morphogenic Researches on *Dactylium macrosporum*" ; the Montagne prize to Gontran Hamel for his work entitled : "*Chlorophyceæ* of the French Coasts" ; the de Coincy prize between Alfred Saint-Yves and the late John Briquet.

Anatomy and *Zoology.*—The Cuvier prize to Pierre Fauvel for his researches on annelids ; the Savigny prize to Armand Billard for his work on the hydroids of the Bay of Suez ; the Thore prize to Pierre de Boissezon for his memoir entitled : "Contribution to the Study of the Biology and Histophysiology of *Culex pipiens*".

Medicine and *Surgery.*—Montyon prizes to Paul Chevallier for his work on Hodgkin's disease, Philippe Lasseur and Mlle. Andrée Dupaix for their microbiological work, Victor Veau and Mme. Suzanne Borel for their work on palatal division ; honourable mentions to Jean Albert Weil for his book on the poisons of the tubercle bacillus, to Grégoire Ichok for his book on work for the sick and infirm, and to Raoul Leroy and Georges Médakovitch for their book on general paralysis and malaria therapy ; citations to Henry Chabanier and Carlos Lobo-Onell for their book on diabetes and to Charles Dubois and Noël Sollier ; the Barbier prize to Stefan Jellinek for his researches on apparent death produced by electric shock ; the Bréant prize (in equal parts) between Pierre Delanöe for his studies on the Moroccan spirochæte and Jean Sabrazès, Georges Jeanneney and René Mathey-Cornat for their book on bone tumours ; the Godard prize to Mlle. Marthe Lamy for her book on gonococcic coxitis ; the Mège prize to Henri Bouquet for his illustrated encyclopædia of medical knowledge ; the Bellion prize to Edouard Imbeaux for his statistical and descriptive annual of the distribution of water and drainage in France, Algeria, Tunis, Morocco and French Colonies, Belgium, Switzerland and Luxembourg ; the Baron Larrey prize to Jules Beyne, for his studies in aviators' sickness.

Physiology.—The Montyon prize to Henri Fredericq for his researches on the nerve control of the heart ; the L. La Caze prize to Emile Abelous for his work in physiology, especially chemical physiology ; the Pourat prize to Louis Rapkine for his work on the energetics of development, oxido-reduction potentials in cells and the chemical processes in the course of cell division ; an honourable mention to Gabriel Laniez ; the Martin-Damourette prize to Paul Fleuret for his work on the nutrition of animals ; the Philipeaux prize to Paul Kucharski for his researches on audition.

History and Philosophy of Sciences.—The Binoux prize to Abel Rey, for the whole of his work on the history of science.

Works of Science.—The Henri de Parville prize between Jules Rouch, for his work on oceanography, meteorology and polar expeditions, and Georges Kimpflin, for his publications on artificial resin and the problem of heating.

Medals.—The Berthelot medal to Eugène Burlot and to Louis Hackspill.

General Prizes.—The prize founded by the State to Jacques Soula for the whole of his work ; the Alhumbert prize to Francis Myard for his work on articulated systems ; the Bordin prize to Gabriel Arnaud and Mme. Madeleine Arnaud for their treatise on plant pathology ; the Lallemand prize to François Kiss and Jules Botár for their work on the physiology of the nervous system ; the Serres Prize to Edouard Chatton for his work on the evolutive cycle and the

determinism of sexuality in the Protozoa; the Vaillant prize to Maurice Gevrey for the whole of his work on partial differential equations; the Houllevigue prize to Albert Policard for his work in histophysiology and histochemistry; the Saintour prize to Albert Vandel for his work in zoology and general biology; the Lonchampt prize to Etienne Canals for his study on the physiological rôle of magnesium on plants; the Wilde prize to Ernest Chaput for his geological work; the Caméré prize to André Coyne for his work in civil engineering; the Gustave Roux prize to Pierre Bonnet for his thesis on sloughing, autotomy and regeneration in spiders with a study of the European Dolomedes; the Thorlet prize to Adolphe Richard; the Albert I of Monaco prize to Louis de Broglie for his researches in wave mechanics.

Special Foundations.—The Lannelongue foundation between Mmes. Cusco and Raphaël Rück; the Hélène Helbronner-Fould prize to Mme. Gustave Ferrié.

Prizes of the Grand Ecoles.—The Laplace prize to Jacques Desrousseaux; the L. E. Rivot prize between Jacques Desrousseaux, Georges Périneau, Jean Crussard and Jacques Aubriot.

Foundations for Scientific Research.—The Trémont foundation to Lucien Malassis for his inventions and work in connexion with calculating machines; the Gegner foundation to Wladimir Margoulis for his work in nomography with applications to aerodynamics and aviation; the Jérôme Ponti foundation to Jean Orcel for his work in metallography and opaque minerals; the Hirn foundation to Adolphe Buhl for his studies on the transformations and invariances of multiple integrals; the Henri Becquerel foundation to Henri Galbrun for his work on the calculus of probabilities and other mathematical researches; Mme. Victor Noury foundation between André Lwoff for his work on the physiology and nutrition of the Protozoa, Louis Corbière for his work in systematic botany and his contribution to the study of Norman flora; François Raoult for his analytical researches on rocks and Joseph Repelin for his geological work in Provence; the Henry Le Chatelier foundation to Paul Bastien for his researches on the alloys of calcium, niobium and gallium; the Roy-Vaucouloux foundation to Albert Brault for his studies on glycogen in the development of tumours, normal tissues and organised beings; the Charles Frémont foundation to M. and Mme. Albert Thomas for their researches on a photo-electrograph for the use of the blind.

The Loutreuil Foundation

1. *Researches on Definite Problems.*—5,000 francs to Marcel Brillouin for carrying out numerical calculations relating to the theory of dynamic tides; 2,000 francs to Paul Dechambre for continuing his researches on the physical properties of wool; 5,000 francs to M. and Mme. Joliot-Curie for travelling and other expenses in connexion with their work on physics at the Jungfraujoch station; 2,000 francs to Gustave Lesbouyries for the study of the diseases of birds due to filtrable viruses; 2,500 francs to Lucien Panisset and Goret for their researches on infectious anæmia of the horse; 5,000 francs to Marcel Petit for assisting his researches in comparative anatomy; 5,000 francs to Mme. Lucie Randoin for researches on vitamins; 2,000 francs to Victor Robin for researches on radiodiagnosis and radiotherapy in animals; 3,000 francs to Mme. de Vomecourt for assisting work to be done in the New Hebrides.

2. *Voyages and Explorations.*—15,000 francs to Camille Arambourg as a contribution to an expedition to eastern Africa; 9,000 francs to Auguste Chevalier as a contribution to a botanical expedition to Central Africa; 5,000 francs to Jacques Petit for an expedition to Madagascar.

3. *Purchase of Material.*—8,000 francs to the Lyons National Veterinary School for the purchase of a cinematograph apparatus; 3,000 francs to Augustin Mesnager for the purchase of an apparatus showing the distributions of strains in elastic solids; 5,000 francs to Albert Granger for the purchase of a furnace.

4. *Libraries.*—4,000 francs to the Toulouse National Veterinary School for its library; 6,000 francs to the Polytechnic School for its library; 10,000 francs to the Botanical Society of France for the establishment of a card catalogue of its library.

5. *Publications.*—5,000 francs to the National and University Library of Strasbourg for preparing and printing a catalogue of periodicals; 4,000 francs to the Astronomical Observatory of Zô-Sé, for its publications; 9,000 francs to the National Acclimatisation Society of France for the publication of a book by (the late) Rollinat on the biology of the reptiles of central France; 5,000 francs to the widow of Jean Thomas for the publication of a book dealing with his work resulting from the expedition between the Congo and Lake Tchad.

Instability of Liquid Surfaces

THE problem of the instability of the 'liquid surface' separating two media has fascinated and attracted many investigators but the complexity of the phenomenon as seen in the laboratory and in everyday life, as well as the difficulty of the mathematics, have made progress very slow in the direction of a solution.

A reference to the instability of the surface of separation between two fluids is first found in a paper by Helmholtz[1], and Kelvin[2] in an investigation of the influence of wind on waves in water, supposed frictionless, discussed the conditions under which a plane surface of water becomes unstable. Adopting a suggestion due to Kelvin, Rayleigh[3] investigated the instability of such a surface and obtained results which by now are classical. To a first approximation, the system is unstable for all wave-lengths and the amplitude of an initial displacement of the form $y = a\cos kx$ increases exponentially with the time. The first approximation, however, shows no tendency in the direction of the formation of vortices, but a recent investigation by Rosenhead[4] shows that the tendency towards rolling up is apparent if account is taken of second order terms in the approximation. In order to obtain the ultimate form of the surface of discontinuity, Rosenhead departs from the Rayleigh method and by means of an approximate numerical process demonstrates the formation of vortices. This method, however, does not discover the wave-length which ultimately becomes dominant in the system and so fixes the distance between successive vortices.

Banerji and Ghatage have now investigated the motion of the 'liquid surface' separating two portions

of the same medium which are at different temperatures.[5] The account of the investigations is illustrated by a number of excellent photographs showing the rolling up of the surface of discontinuity into vortices, and the separate convolutions can easily be seen. There are also several tables of numerical results which can be used when we have a complete theory capable of explaining the rolling up and of giving the value of the dominant wave-length or wave-lengths.

Previous investigators, theoretical and experimental, seem to have concentrated on discussing the surface separating two streams of equal temperature but differing velocities. Banerji and Ghatage supplement the existing information by investigating the effect of a difference in temperature in addition to the difference in velocity. The results, some of which might have been expected on general grounds, are interesting. A discontinuity in temperature alone, and hence a discontinuity in density, was introduced by making a cylindrical or rectangular column of water in a large tank differ in temperature from the adjoining fluid. Discontinuities in velocity as well as in density were produced by making two streams of water meet at various angles under different thermal conditions.

In all cases the initial surface of separation was in a vertical plane and not, as in most previous work, in a horizontal plane. This makes the basic motion unsteady, so that the surface of discontinuity has a tendency to change its position quite apart from its inherent instability. The instability, however, was quite apparent. The surface assumed a wave pattern, each crest or trough took up the form of a breaker and rolled round itself, thus producing a vortex and a series of spiral-shaped three-dimensional vortices was formed. "In the direction of motion the vortices showed a progressive increase in dimensions and number of convolutions. The greater the difference of temperature at the surface of discontinuity, or the greater its slope, the smaller was the diameter of the vortices. For very small difference of temperature the vortices had enormous diameters. The greater the difference of temperature at the surface of discontinuity, the more rapidly did the vortices develop." The shape of the surface of discontinuity was obtained by colouring various parts of the liquid and by photographing the visible stream lines in horizontal and vertical sections. The paths of the particles at the surface of discontinuity were also photographed but the actual material used to make the motion visible probably has some small influence on the paths of the particles of fluid.

L. ROSENHEAD.

[1] Helmholtz, *Phil. Mag.*, **36**; 1868.
[2] Kelvin, *Phil. Mag.*, **42**; 1871.
[3] Rayleigh, *Proc. London Math. Soc.*, **10**; 1879.
[4] Rosenhead, *Proc. Roy. Soc.*, A, **134**; 1931.
[5] Banerji and Ghatage, *Indian J. Phys.*, **7**; 1932.

Population Density and Egg-Laying in Flies

IN a paper of much interest, Prof. Raymond Pearl has made a study of the influence of density of population upon egg production in Drosophila (*J. Exp. Zool.*, vol. 63, No. 1), which is a continuation of his investigations on the biological relations underlying the growth of populations.

The flies were placed under standard conditions and deposited their eggs on an agar surface of fixed area where they could be counted. In general, the higher the number of pairs of flies in a bottle of given size the smaller the number of eggs laid per individual. This result, obtained with different populations of flies, was then repeated by comparing the egg production of the same flies when kept for alternating twenty-hour periods under conditions of high or low population density. More than 100,000 eggs were counted in these experiments.

The decrease in the rate of egg production with increasing density of population is described by the same type of mathematical equation as that which relates the density of a gas to the mean free path of its molecules. From numerous observations of the behaviour of single flies under isolated conditions, they are found to go through regular cycles of feeding, walking or flying, resting and cleaning their legs. These rhythms are easily disturbed and the flies are found to be extremely sensitive to slight environmental disturbances. The denser the population the more they interfere with each other's rhythmic activities, thus decreasing the amount of food intake and oviposition and increasing their muscular activity. That the area of agar surface for feeding and egg-laying, and not the volume of air, is the significant factor, was shown by comparing the oviposition in bottles of twice the size but with the same area of agar.

In the same journal, Dr. Alpatov has investigated egg production in vestigial- and long-winged flies under different conditions of development, the former showing much lower productivity. The influence of temperature and underfeeding in the larval stage were investigated. At a low temperature, egg production begins earlier. Underfeeding reduces productivity, and a negative correlation is found between length of life and egg production.

Mycorrhiza on Conifer Roots

A VERY thorough study of the root system of young conifers has been made by Dr. E. V. Laing for the Forestry Commission, and an account of this work is published by the Commission as Bulletin 13 under the title of "Studies on Tree Roots" (1932). This account contains an interesting contribution to our knowledge of mycorrhiza on these roots.

There are two forms of mycorrhiza; the ectotrophic, in which the fungus grows mainly on the surface of the root, and the endotrophic, in which it penetrates the cells of the cortex practically as far inwards as the endodermis. Dr. Laing points out that whilst both forms may occur on the same tree yet, on the whole, the ectotrophic type is common in pine, spruce and larch, whilst the endotrophic type is characteristic of *Cupressus*, *Thuya* and *Taxus*. This distribution of the fungus correlates in an interesting manner with differences in cortical structure. In the first group of conifers the cortical cells have thin walls and contain little starch; in the second group characteristic girdle thickenings occur on the walls of the cortical cells and these cells usually contain starch; this is the type of cortex which is usually invaded by the fungus.

Dr. Laing's investigations also point to the significance of aeration conditions in the soil and manurial treatment in determining whether fungus and root system shall enter into the characteristic mycorrhizal relation. The conditions favouring mycorrhizal infection of the roots also favour vigorous growth of the young tree, so that it remains difficult to assess the significance of the fungus partner in the development of the tree.

A progress report upon investigations into the same problem was presented to Section K (Botany) of the British Association at the York meeting by a committee, of which Dr. M. C. Rayner acted as secretary and Mr. F. T. Brooks as chairman. The work initiated under this committee is now being continued with the aid of a grant from the Forestry Commission, and the results of this work will doubtless be published more fully by Dr. Rayner in due course.

In the report it is stated that soil innoculation experiments have now provided convincing evidence of a direct relation between mycorrhiza formation and satisfactory seedling growth in the case of three species of pines, Scots pine, Corsican pine and maritime pine. From the practical side, the work of the committee has been devoted largely to an examination of the effect of the addition of humus to the nursery beds of tree seedlings, with the view of improving root development and mycorrhizal infection.

University and Educational Intelligence

CAMBRIDGE.—The Sir William Dunn readership in biochemistry has become vacant by the resignation of Prof. J. B. S. Haldane. Candidates for the readership, the stipend of which is £600 a year, are requested to communicate with the Vice-Chancellor on or before February 18.

EDINBURGH.—The Cameron prize for advance in knowledge in practical therapeutics for 1933 has been awarded to Dr. George F. Dick and Dr. Gladys H. Dick, of the John M'Cormick Institute for Infectious Diseases, Chicago, jointly, in recognition of their work on the etiology and treatment of scarlatina.

LONDON.—Prof. L. N. G. Filon, Goldsmid professor of applied mathematics and mechanics in the University (University College), has been elected Vice-Chancellor for the remainder of the year 1932–33 in succession to the late Mr. J. L. S. Hatton.

The title of reader in experimental physiology in the University has been conferred on Mr. H. P. Gilding, in respect of the post held by him at University College.

Mr. Frank Arnold Greene has been appointed a fellow of King's College. Mr. Greene was a student in the faculty of engineering from 1891 until 1894; he is treasurer of the Institution of Chemical Engineers, and a member of the College Chemical Engineering Committee.

IN the eighth annual report to the Court of Governors of the London School of Hgyiene and Tropical Medicine, Keppel Street, W.C.1, various changes in the personnel of the Court and of the Board of Management are recorded. Sir Austen Chamberlain becomes chairman of the Court in succession to Sir Holburt Waring, who becomes honorary treasurer to the Board of Management. The minimum annual expenditure to which the School is committed is £60,000, towards which there is a reasonably assured income of £50,000, leaving a deficit of £10,000 to be met by subscriptions and donations. A grant of 25,000 dollars for 1932 was received from the Rockefeller Trustees. In the report by the Dean, Prof. W. W. Jameson, on the year's work of the School, the teaching and research activities are surveyed, examination results are recorded, and a list of papers published by members of the staff is appended. It is announced that the Prudential Assurance Company has endowed for a term of seven years the chair of public health, which will henceforth be known as the "Prudential Chair of Public Health". A syllabus containing full particulars of the post-graduate instruction in preventive medicine given at the School is issued and may be obtained on application to the Dean.

Calendar of Nature Topics

The First 'Buchan Cold-Spell'

February 7–14.—In 1869 the late Dr. A. Buchan, from an analysis of observations of temperature in Scotland, concluded that "there are certain periods more or less well-defined, when the temperature, instead of rising, remains stationary or retrogrades; instead of falling, stops in its downward course, or even rises; and at other times falls or rises respectively for a few days at a more accelerated speed than usual". Buchan attributed these variations to the alternations of cold and warm air currents, but several other more or less fanciful explanations have been put forward by different authors, all of whom took the reality of the 'spells' for granted. A recent investigation has shown, however, that in London since 1870 there has been no definite tendency for temperature to be abnormally low on the dates of Buchan's cold spells, the period February 7–14, for example, having been warm as often as it was cold.

Fish Culture

"Feb. 9th, 1863.—Eggs of first lot of Rhine salmon hatched out in my bath." (Buckland, Diary.) The middle of last century saw a great revival in European countries of the ancient art of pisciculture. The work of Coste and the establishment by the French Government in 1848 of a hatchery at Huningue near the Rhine and Rhône Canal led to a wide-spread interest in salmon and trout rearing. In 1853, Dr. Garlick of Ohio first bred fish artificially in the United States, and in the same year the well-known Stormontfield establishment on the Tay came into being. In England, Buckland, later H.M. Inspector of Fisheries, took up the idea with great enthusiasm. During the past eighty years, fish culture has developed commercially on a very large scale especially in America.

Partridge Disease

The partridge season which has just closed will be memorable for the prevalence and the investigation of partridge disease. Beginning noticeably in the autumn of 1930 the disease spread widely and caused heavy mortality. Examples of its incidence in 1931 on various estates are—in Hampshire of a

stock of young and old birds numbering 3,000, 2,000 perished, in Norfolk 4,200 perished out of 5,000, in Suffolk 2,600 out of 3,467, in Derbyshire 2,200 out of 2,500, in Nottinghamshire 10,100 out of 12,000. *Country Life* appointed a committee under the chairmanship of Major M. R. Portal to investigate the disease and the findings have recently been published under the editorship of Major Portal and Dr. W. E. Collinge. While partridges have several internal parasites, the cause of the widespread disease is a nematode worm, *Trichostrongylus tenuis*, a near relative of the agent of grouse disease, *T. pergracilis*. Like the latter, the partridge strongyle lives in the caeca, causing blockage and the production of septic conditions. Exceptionally, as many as 12,226 and 10,500 individuals have been found in single birds, but a count of 1,000 to 2,000 marks a more usual infestation. In the caeca the worms pair and after the eggs are laid they pass out with the fæces and develop into larvæ which make their way up the damp stems of grasses, clovers and such like. With vegetable matter they are swallowed by the partridges and the cycle begins again in the bird's intestine. The Committee has reached the conclusion that predisposing causes of the spread of the disease were interbreeding, the carrying of large winter stocks, an insufficiency of food, and peculiarly unfavourable meteorological conditions.

Fluctuations of Partridge Numbers

It is notorious that the numbers of partridges on an estate may show great changes from year to year, and periods of great plenty and of great scarcity seem to follow each other in cycles. In the game book of one of the great landowners in Britain, ignoring the years before partridge driving began (about 1845), there are enormous swings of the partridge pendulum : in 1864, 634 birds were shot, the numbers rose to a peak in 1870 with 3,741, but by 1879 they had fallen, gradually, to 359 ; another steady rise, and in 1887, 5,360 were shot and in 1896, 5,478. Such totals have not since been reached on these estates and later figures suggest a tendency for the annual bag to become smaller. The complicated factors of weather, food, natural enemies and disease, which influence the numbers from year to year, have not yet been resolved, but there can be little doubt that the modern trends of agriculture and transport are likely to make permanent inroads upon the partridge population. The partridge is a bird of cultivated land, and the intensive cultivation which ploughs a field to its very borders and replaces hedgerows by fences, has destroyed the rough herbage which was a favoured nesting site. Extensive turning of crop land into pasture has removed a source of food, as well as protective cover for the nests and young, and grass conceals the fine grit essential for the grinding of food, which the plough laid bare. New forms of road surface have done away with another source of grit, and have banished favourite dust baths, also reduced by the grass lands. The cleaning up of the roadsides and the removal of hedges have removed former nesting places, and the fast traffic of the roads is directly responsible for a certain amount of mortality. In face of such adverse factors, it would be surprising if the stock of partridges were not to decline, unless steps are taken to minimise their influence. This is a very simple illustration of the way in which the native fauna of the country may be undergoing modification.

Societies and Academies

LONDON

Royal Society, Jan. 26. J. Z. YOUNG : Comparative studies on the physiology of the iris. (1) Selachians (second paper)—*Uranoscopus* and *Lophius*. The sphincter iridis muscle of *Scyllium*, *Mustelus* and *Trygon* contracts in direct response to illumination and is not under nervous control. The iris of *Lophius piscatorius* and also that of *Uranoscopus* is capable of rapid movements under nervous control, the oculomotor dilating and the sympathetic constricting the pupil. S. G. PAINE, F. L. LINGOOD, FREDA SCHIMMER and T. C. THRUPP : The relationship of micro-organisms to the decay of stone. Three groups of bacteria have been distinguished. In the first group are included common organisms of air, soil, and water. These organisms are capable of living on a variety of food materials, and in their metabolism acid substances are formed as waste products ; these acids, even when the food supply is merely the small amount of organic matter present in rain water, can dislodge carbon dioxide from its combination with calcium in the stone. In the second group some confirmation is to be found of the view of Marsh that nitrifying bacteria can be responsible for stone decay. In the third group are the sulphur-oxidising organisms which have been found closely associated with white incrustations of sodium and calcium sulphate on the surface of decaying stones. W. J. ELFORD : The principles of ultra-filtration as applied to biological problems. The several factors concerned in the general process of filtration have been investigated, using typical disperse systems—colloidal dyes, metal sols, protein solutions and suspensions of bacteria and viruses. The relationship between the size of retained particles and the estimated pore sizes of membranes is also discussed. The fact that, for colloidally dispersed systems, the pore-size of the limiting membrane is definitely greater than the size of the retained particle, even under optimum filtration conditions, is in accordance with theoretical expectations. The particle sizes of suspensions, estimated from filtration experiments with carefully graded collodion membranes, agree well with the values obtained by other methods. The method of analysis adopted has proved of great value in virus studies.

PARIS

Academy of Sciences, Dec. 19 (195, 1185–1335). MARCEL BRILLOUIN : Multipolar spherical non-antipodal functions. Recurrences. L. CAYEUX : The existence of a phosphate containing spicules of Calcisponges in the Ordovician of Wales. MARIN MOLLIARD : Experiments permitting an explanation of the attenuation of the chlorophyll shown by parasitic green plants. Results of experiments comparing the growth of the radish in a medium of carrot decoction and in Knop's fluid containing saccharose. About ten times as much chlorophyll appeared in the leaves of the plants grown in the latter medium as in leaves from plants grown in the carrot decoction. L. BLARINGHEM : A case of atavism which appeared in a strain of the opium poppy. One example, in 5,000 strictly isolated individuals, of reversion to a type known three centuries ago, showed a change to white petals bordered with red. CHARLES ACHARD and AUGUSTUS BOUTARIC : Some physico-chemical researches on suspensions prepared starting with

proteins separated from serum by the so-called acetone method. From the results of the experiments described, the authors conclude that the separation of the proteins by the acetone method of Piettre and Vila causes no changes in the protein molecules. R. FOSSE, P. DE GRAEVE and P. E. THOMAS: A new plant principle: uric acid. Uric acid has been found in a mould but, according to Czapek, is not present in the higher plants. Using a technique given in detail, the authors have proved this acid to be present in various plants in quantities ranging from 0·003 per cent in *Glycina soja* to 0·025 per cent in *Melilotus officinalis*. CHARLES CAMICHEL: Transitory [hydraulic] regimes. M. GIGNOUX and L. MORET: The geological structure of the base of the Flysch sheet of Embrunais in the Ancelle valley, near Gap (Hautes-Alpes). JULES RICHARD: The use of the Cattaneo wave pump for utilising the movements of the sea. Diagram and description of the pump, which has raised 495 litres an hour to a height of 51 metres. L. LÉGER and T. BORY: The parasitism of an *Oscillaria* in the intestine of the carp. LALAN: The asymptotic transformations of minimal curves. PAUL MONTEL: A theorem of Rouché. GEORGES BOURION: Ultra-convergence in certain series of analytical functions. J. FAVARD: The topological structure of rectifiable contina. A. KOSTITZIN: A geological application of differential equations. D. BELORIZKY: The representation of certain functions by particular series of polynomials. J. GRANIER: The influence of vibration on the rate of watches. P. DUPIN and M. TEISSIÉ-SOLIER: The vortices produced by obstacles revolving round an axis parallel to the general direction of flow. Reproductions of a photographic film are given showing the changes in the shapes of the vortices. MAX SERRUYS: The determination of some physical characters of detonation showing its local character. A. GREBEL: A diagram representing the true phenomena of compression, combustion and expansion in high speed motors. V. G. SIADBEY: The determination of meteoric trajectories. HENRI MINEUR and ANDRÉ MACHIELS: The distribution of the absorbing galactic material. F. LINK: The photometric study of the partial eclipse of the moon on September 14, 1932. Tabulated results of observations made at the Pic du Midi Observatory (height 2,860 metres). ROLIN WAVRE: The polydromes of the Newtonian potentials of a family of homogeneous bodies. A. LABARTHE and M. DEMONTVIGNIER: Methods of measuring and recording rapidly variable pressures. A ray of light falls on a mirror forming part of the wall of the space in which the pressure is to be measured: the reflected ray falls on a photoelectric cell, the currents from which are amplified in the usual manner. Successful applications to studying the pressure changes inside the cylinder of an internal combustion motor are described. JAMES BASSET: The realisation of a chamber for experimenting at any temperature under permanent gaseous or liquid pressures up to 15,000 kgm./cm.^{2} with visual observation of the phenomena and with photographic or cinematographic registration. PIERRE VERNOTTE: The natural convection of heat in air when the heating is very small. The comparison of the limiting value of the convectance with the thermal conductance of the medium. PIERRE DAVID: The radiation of the radiotransmitter of the Eiffel Tower. A study of the radiation shows that the metallic parts of the Tower are the seat of important currents, modifying the radiation in an unexpected manner. HORIA HULUBEI: Demonstrating multiple Compton diffusion. PAUL WOOG and RENÉ SIGWALT: The use of the Duboscq colorimeter for the definition of colours by analysis in different parts of the spectrum. A. NAHERNIAC: The study of a phenol–OH band in the near infra-red. T. N. PANAY: An integral radiator (black body) of electrically heated carbon. The apparatus described and figured can be worked at temperatures of the order of 2400° K. It embodies a special device to obviate the necessity of the electrical conductors being sealed into the glass container. Q. MAJORANA: The confirmation of the existence of a new photo-electric phenomenon. C. JAUSSERAN: The action of a developer on latent images of different ages. R. COUSTAL and H. SPINDLER: The electrolysis of dry liquid ammonia. GEORGES FOURNIER and MARCEL GUILLOT: The absorption of the β-rays by matter. The relation between absorption and atomic number given in a previous note is now shown to hold for platinum and lead. P. LECOMTE DU NOÜY: Improvements to the hydrogen electrode for the measurement of hydrogen ion concentration in solutions. A method by means of which the platinising and hydrogenation of the electrode can be dispensed with. A. LALANDE: A new cryoscopic method. R. TREHIN: The influence of temperature on the absorption of aqueous solutions of hydrochloric acid in the extreme ultra-violet. The coefficient of molecular absorption is a function of three variables: wave-length, concentration and temperature. J. HERENGUEL and G. CHAUDRON: The sublimation of magnesium in a vacuum and casting in an atmosphere of argon. By means of the apparatus described and illustrated, ingots of magnesium of 26 kgm. can be prepared. PICON: Preparation and properties of thallous thiocarbonate. A specific reaction of thallium. This compound is easily prepared by adding carbon disulphide to thallium sulphide in alkaline solution. It is a vermilion red precipitate, formed in very low concentrations of thallium, and serves as a means of identifying thallium. HENRI LAFUMA: Hydrated bicalcium aluminate. FIRMIN GOVAERT: The estimation of the halogens in organic substances by the sodammonium method. The estimation of fluorine in some organic compounds. The method is shown to be widely applicable. ROBERT CAMBIER and LUCIEN LEROUX: The estimation of organic nitrogen in the presence of nitrates by Kjeldahl's method. The nitric acid is first removed by acidifying with sulphuric acid and distillation in a vacuum at a low temperature. R. SUTRA: The structure of starch. TIFFENEAU: Molecular transpositions in the cyclohexane series: passage to the cyclopentane series. MME. M. GUAISNET-PILAUD: The phenylmethyl-ethyl betaines and the geometrical stereoisomerism of organic compounds containing pentavalent nitrogen. R. PAUL: The stability of the oxygen linkage in the tetrahydrofuryl derivatives. M. BATTEGAY and L. DENIVELLE: The aryl-chlorsulphinates and aryl sulphites. Criticism of a recent paper by P. Carré and D. Liebermann. E. AUBERT DE LA RÜE: Preliminary study of the geology of the Saint-Pierre and Miquelon Islands. R. DELABY, R. CHARONNAT and M. JANOT: The radioactivity of the waters of the Ballon d'Alsace. ALPHONSE LABBÉ: The hydrogen ion concentration and rhythm of the tides. R. GUIZONNIER: The diurnal component of the gradient of electric potential at Val-Joyeux. The variations of its phase and amplitude. ANDRÉ ALLIX: The progressive darkening of the Lyons atmosphere. The visibility of the Alps. A comparison of the

periods 1894–1900 and 1925–1931 shows a distinct decrease in the transparency of the atmosphere. PAUL BERTRAND: Observations on the Saalfeld *Cladoxylon*. ST. JONESCO: The movements and growth of the flower peduncles of *Ipomœa purpurea*. MARCEL LEFÈVRE: The structure of the membrane of *Euglena* of the *Spirogyra* group. PIERRE CHOUARD: The diversity of types of seedlings in *Allium*. MICHEL GRAČANIN: Ion concentration as a factor in resorption. H. COLIN and M. QUILLET: The jelly of the egg of *Phallus impudicus*. J. CHAZE: The exudation of the alkaloids of *Lupinus albus*. MLLE. C. BOURDOUIL: The relation between the synthesis of starch and the weight of the seeds in hybrids of *Pisum*. ROBERT LEMESLE: New researches on *Scabosa Succisa* attacked by *Fusarium anthophilum*. MME. F. FRANCK and D. AUGER: The cinematographic analysis of the movements of protoplasm in relation with the electrical variation in stimulation in *Nitella*. CHARLES PÉREZ: Intersexual anomalies in hermit crabs. MME. JEANNE HENRI-HELDT: The male genital apparatus of North African shrimps of the family of Penæidea. MME. L. RANDOIN and H. SIMONNET: The constitution of an artificial diet for the purpose of long-period experiments on the relations between nutrition and the phenomena of growth, subsistence and especially reproduction. RAYMOND-HAMET: The action of tyramine on the excitability of the cardiac pneumogastric and the influence of this amine on the effects of nicotine. MLLE. M. L. VERRIER: Comparative physiology of the cones and rods. Indications given by behaviour.

Forthcoming Events

Monday, Feb. 6

UNIVERSITY COLLEGE, LONDON, at 5.30.—H. W. B. Joseph: "Space Perception" (succeeding lectures on Feb. 13 and 20).

SOCIETY OF ENGINEERS, at 6—(at the Rooms of the Geological Society, Burlington House, W.1).—J. D. Hawort: Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Capt. Ejnar Mikkelsen: "The Blosseville Coast of East Greenland".

Tuesday, Feb. 7

KING'S COLLEGE, LONDON, at 5.30.—Dr. F. T. Chapman: "Induction Motor Theory" (succeeding lectures on Feb. 14 and 21).

Thursday, Feb. 9

BEDFORD COLLEGE, LONDON, at 5.15.—"Contemporary Developments in Science." Prof. E. T. Whittaker: "The Development of the Concept of Energy in the Twentieth Century".

Friday, Feb. 10

ROYAL ASTRONOMICAL SOCIETY.—Dr. H. Knox-Shaw (Presidential Address): "The Distance and Motions of the Extra-Galactic Nebulæ".

ROYAL INSTITUTION, at 9.—Prof. A. V. Hill: "The Physical Nature of the Nerve Impulse".

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Report of the Forest Products Research Board; with the Report of the Director of Forest Products Research for the Year 1931. Pp. vii+51+8 plates. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Journal of the English Folk Dance and Song Society. Vol. 1, No. 1, December. Pp. vii+72. (London.)

Proceedings of the Royal Irish Academy. Vol. 41, Section A, No. 4: Multiply Charged Large Ions. By J. J. Nolan and J. G. O'Keeffe. Pp. 25–40. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 18, No. 2, January. Pp. 435–753. (Plymouth.) 17*s*. 6*d*. net.

Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1931. Part 2. Pp. v+166+4 plates. (London: H.M. Stationery Office.) 3*s*. net.

Proceedings of the Society for Psychical Research. Part 128, Vol. 41, January. Pp. 89–119. (London: Society for Psychical Research.) 4*s*.

Department of Scientific and Industrial Research: Water Pollution Research. Summary of Current Literature. Vol. 6, No. 1, January. Abstracts Nos. 1+120. Pp. 36. (London: H.M. Stationery Office.) 2*s*. net.

OTHER COUNTRIES

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