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Educational Equipment for the New Age

THE address on the university in civic training, which General Smuts delivered at his installation as Chancellor of the University of Cape Town on March 2, did not receive the attention it deserved outside South Africa. It dealt with a theme which has recurred in many speeches since it was stressed by Sir James Barrett and others at the celebrations of the centenary of the University of London last year, and at the Conference on Academic Freedom at Oxford in 1935. The function of the university, General Smuts insisted, is not merely to give its students a professional qualification; it is to impart the ideals of citizenship and to fit its graduates spiritually into the world in which they had not merely to earn their living but also to play their part worthily. The university must teach the humanities—the things which furnish the student with the larger human equipment for life.

University and humanity together should form the keynote and essence of university culture, and it is in their absence that we suffer from excessive specialization and the narrow outlook responsible for so much mischief and suffering in the world to-day. Universality in its nature implies freedom from the prejudices which arise from ignorance or narrowness of outlook; it means also an impartiality, a willingness to learn and a curiosity to understand whatever life may hold for us. No less than the ordinary citizen does the university student need to avoid a single-track mentality, and his university training should give him above all a vision of harmony in the universe, of the principles of order and beauty, which should remain with him as the most satisfying and outstanding experience of his life. Science, philosophy, poetry, religion can all help to clarify and deepen that experience.

The greatest lesson that science can teach us, General Smuts urged, is respect for facts; and in the present-day tendency to follow slogans or catchwords, to worship ideologies or exalt party politics unduly, a disinterested loyalty to facts is the sovereign remedy. Equally important with this impartial spirit of science is the urbane generous spirit of humanity; and General Smuts believes that the hostility of rival fascist and communist systems to the principles of racial, religious and political toleration is a passing phase, a symptom of the confusion and unrest of the times. He urged that South Africa, more than any other country in the world, is a great human laboratory, where experiments in racial co-operation are essential to success.

If it is difficult for European onlookers to feel as confident as General Smuts of either fascism or communism learning the grace of toleration or respect for facts, his plea for universality and humanism undoubtedly will meet with a widespread response. Its force was undoubtedly recognized, for example, in the discussions at the symposium on the chemist in industry in Manchester last April, where the need for a wide outlook and high ideals, as well as technical or professional efficiency, was stressed by Prof. J. C. Philip. Here again the evils of over-specialization were discussed, though it was pointed out by Mr. F. Scholefield that this danger does not lie in the kind of subject chosen for special study, and that men can be trained for a specific technical occupation, without incurring this evil, if the training is given on right lines.

That these dangers should be recognized is all to the good, but the discussion referred to, at which much was said about the qualifications of the chemist for administrative posts, scarcely stressed

sufficiently the social responsibilities of industrial management at the present time. The growing tendency for industrial efficiency to be considered not merely in terms of dividend-earning capacity or mechanical efficiency but also in relation to industrial welfare and service to the community, enhances the importance of industrial leadership having not merely high ideals and wide sympathies but also some real understanding of social problems. The industrial leader must have the wisdom of a good citizen.

The special responsibilities of the universities in this matter have been frankly recognized of late. They were stressed in the report of the University Grants Committee as well as at the Quinquennial Congress of the Universities of the Empire at Cambridge last July, and the part which the universities have played in the social surveys of the Special Areas as well as the expansion, for example, of the Economics Research Section of the University of Manchester, indicates a desire to make a practical contribution to social science and the solution of social problems on a growing scale.

Important as are these practical studies and investigations, the fundamental problem for the universities in this matter is that to which General Smuts directs attention and on which Sir Ernest Simon challenged them in an address at Cardiff last year. If the universities adequately fill their function of providing leaders and citizens who will give a wise lead to their fellows in the effort needed to eliminate weak spots in our public life and to build a better social order, the redistribution of effort in scientific research or its initiation in new fields will follow. Moreover, effective leadership in a democracy demands a measure of co-operation and understanding from its ordinary citizens which in turn requires far higher intellectual qualities than in the authoritarian State, and here again the university has responsibilities scarcely less important than in the provision of leaders.

The two problems are in fact inextricably linked. Unless the university can provide democracy with leaders capable of taking wide and disinterested views and forming sound judgments in public affairs, and of clear and critical thinking, and able to use the appropriate scientific method of thought in the complex affairs of human society, the challenge of the authoritarian State to-day can scarcely be met. Equally the university cannot be expected to provide such leaders unless the students entering its doors have received a sufficiently wide general training in human and cultural subjects for the university to impart that stimulation and enrichment of the whole mind, independent of any specialized study the student pursues, which enable him to lead a fuller and more interesting human life and to play more adequately his part as a member of the community. Again, unless the training of the ordinary citizen in general science, in social subjects and in public affairs is wide enough to fit him to take disinterested views, to form sound judgments and to recognize and prefer wisdom and integrity in public representatives to the arts of the humbug and the demagogue, even if the supply of competent leaders is adequate, their selection by a democracy is not assured.

The heart of the problem lies accordingly in the pre-university training, especially in the post-primary or secondary school. Only as this is adequate and broad enough can the universities fulfil their own special functions of providing men and women, not merely skilled in some special subject or branch of knowledge but distinguished by a sense of values, a wide outlook, moral courage and a capacity for creative thought which, when ripened by experience, can be at the service of the community in any of the problems with which they may be confronted in their professional, industrial or civic life.

The question of training the university graduate for participation in public affairs cannot therefore be seriously considered apart from the question of educating the community as a whole. Sir Ernest Simon's insistence that the inefficiency of transfer of training implies that citizenship cannot be taught incidentally or indirectly, but that it can only be learnt by the direct study of the thought and life and actions of men in society, while undoubtedly right, should not lead us into any attempt to graft a special course of training in citizenship into the existing curricula of universities. The basic knowledge in these matters must be acquired at school. The university may incidentally extend that knowledge in certain subjects, but its main function here must be to supply the corrective to specialization, to quicken interest in human, social and cultural values, to inspire a vision of life as a whole, and to send out its graduates with a real interest in the affairs of the world, with a standard of values, a capacity for thinking clearly and some knowledge of the more difficult aspects of the problems of citizenship.

None the less, the university has certain special responsibilities in this field. In the first place, the need for developing some effective corrective to

the present excessive and premature specialization is urgent and long overdue. Society cannot afford to wait until the universities are receiving students much more adequately prepared. Internal measures in the universities themselves are undoubtedly called for, even if only as temporary expedients.

In the second place, the influence which the universities exercise on secondary school teaching and curricula, if only through the scholarship system, is enormous. That influence could easily be exerted to repress the premature and disastrous specialization which often takes place in the later years at school. To require that a candidate for a university scholarship in some special subject such as history, classics or a science should attain a high standard in general subjects or even, as Sir Arthur Salter suggests, that any candidate for a degree should be required at some stage in his career to pass an examination in some aspect of the social sciences, might well be decisive. Merely to raise the age of the school-leaving examinations or matriculation so that they become, as they already are in Scotland, actual school-leaving examinations or entrance examinations to a university, might also assist to crush out the deplorable specialization of immature minds at school responsible for some of the most untoward results of the present system.

If, for these reasons, the initiative must largely lie with the universities, there are still other responsibilities in this field which they must accept. We are not concerned only with the students of the future or even with those at present in residence. It is equally important to touch those who have completed their courses and now fill all types of posts in industry or the professions, in some of which they have already assumed responsibilities of leadership. Only as they are awakened to the opportunities which confront them and come to recognize the duties and responsibilities of citizenship can we hope to make democracy safe against its present dangers.

This, of course, is not a task for the universities alone. There is an ample field for the activities of the Association for Education in Citizenship; and the recent conference arranged by this Association at Ashridge on the "Challenge to Democracy" affords an admirable example of what is wanted. A panel of outstanding speakers was drawn from all shades of political opinion, and, excluding party politics, they discussed the clash of ideas between dictators and democrats from the point of view of believers in the ultimate value of the full and free development of each individual citizen. The first half of the programme was concerned with the essentials of democracy; the second with the formation of public opinion, including the schools, the universities, the Press and adult education. Such a conference can scarcely fail to have a powerful effect in stimulating clear thinking on everyday affairs, and the vision and moral determination essential as preludes to the action and perpetual vigilance in defence of democracy, which alone can preserve for us in these threatening days mankind's rich intellectual heritage and freedom of thought and speech.

An Inquiry into "Marvels"

A Book of Marvels
By Lieut.-Comdr. Rupert T. Gould. (The Fountain Library.) Pp. ix+180. (London: Methuen and Co., Ltd., 1937.) 2*s*. 6*d*. net.

THIS book is mainly a survey of records of certain phenomena occurring between 20 B.C. and A.D. 1890 which, after sifting and weighing the available evidence, the author deems worthy of the designation "marvels". Some, however, may think the book scarcely bears out its title; indeed, the author himself, in the majority of his collected cases, carefully refrains from divulging his own views—if any were held—concerning the real significance of his "marvels". These may be summarized as follows:

(1) A line of foot-prints in the snow seen in Devon in 1855 which passed through—so it was said—locked gardens and over very high walls, haystacks, and roofs of houses, as though such things constituted no impedimenta. The impressions, which were in single file, were variously ascribed to a kangaroo, an otter, a badger, a donkey, a swan, and the Devil. Sir Richard Owen's opinion that the marks were made by a badger is discounted by Commander Gould on the score that, though Owen was an eminent palæontologist, he was given to "making dogmatic assertions,

in defiance of fact, which proved him to be possessed of a singular and not entirely scientific type of mind". For example, he insisted that the hippocampus major is the exclusive prerogative of the human brain whereas, as proved by Sir W. Flower and Huxley, it is a structure man shares with the apes; moreover, did not Owen also—and this is where the gallant Commander's sea-boot pinches—in "his utterly childish 'explanation' of the sea-serpent seen by H.M.S. *Daedalus* in 1848" postulate that the naval officers who saw it "were, one and all, half-witted"!

(2) Movements, by unknown agents, of coffins in sealed-up vaults. Floods admittedly entered some of these vaults, robbers broke into others, while yet others were in an area of occasional seismic disturbances. In 1899 Alfred Russel Wallace quoted Dale Owen's account of the coffin movements at Arensberg as "the best evidence as to occurrences which were, and are, wholly inexplicable". The value of this particular evidence may be gauged from the fact that the account was given to Dale Owen in 1859 (fifteen years after the alleged movements) by people who had only troubled to visit the vaults some considerable time after they had heard that certain individuals reported "groans" coming from the cemetery. Commander Gould admits that the evidence in this case was at third hand, and even so by a person with very little capacity for assessing its value; yet in the same breath he maintains that in the case of certain other coffin movements the disturbing agent "was neither human nor natural".

(3) The next "marvel" is an alleged power to sense (*nauscopie*) the approach of ships far below the horizon—sometimes three or four days' run distant. As the principal 'wizard' in these feats attributed his successes—there were also misfires—to careful observations of high-level atmospheric changes induced by the presence of the vessels beneath, further comments are needless.

(4) We are then reminded of the giants with which hearsay has peopled the earth since the days of the tales of Titan and Typhon, but whose outward and visible signs have invariably turned out to be either the skeletal remains of mammoth or other large lower animals or, where actually seen in the flesh, victims of ill-balanced endocrine glands.

(5) Acoustic mysteries, such as the ringing of bells in houses by undiscovered agents, and the hammer-like sounds alleged to have been emitted by Memnon at Thebes and heard by various celebrities between 20 B.C. and A.D. 190, since which date there has been silence. In the author's opinion, unequal expansion of the materials of the Colossus was the probable cause of the sounds.

(6) The most interesting part of the book is undoubtedly the account of some experiments carried out by Captain W. E. Parry in 1822 to determine the velocity of sound. At Winter's Island, with thermometer showing $-25°$ F., and the barometer 28·84 inches, fifteen rounds were fired from a six-pounder gun at an angle of elevation of 10°, the times of flash and report being recorded by observers 5,645 ft. distant. The mean of these gave a velocity of 1,023 ft. per sec. What perplexed Parry, however, was that the order 'Fire!' sometimes reached the observer about half a second *after* the gun's report. Commander Gould endorses an explanation of this anomaly which was sent him by a correspondent, namely, that as the velocity of sound increases with increase of temperature, the word 'Fire!', travelling over a slightly colder route nearer the ice, reached the observers after the report of the gun which, in consequence of the 10° elevation, passed through a higher and slightly warmer air route. This explanation, in view of what must have been a very slight difference of temperature (t) of the two converging sound paths, seems to the reviewer far-fetched, especially in the light of the formula $v=1093\sqrt{1+0{\cdot}00366\,t}$. It has been shown by many experiments that the velocity of the compression wave of sound increases with its intensity, a violent noise actually travelling faster than a gentle one. Jacques, for example, found that the sound emitted by the explosion of half a pound of gunpowder travelled at 1,032 ft. per sec., while that from 1½ pounds had a velocity of 1,187 ft. per sec. Surely this principle better explains the anomaly referred to by Gould. Other acoustic mysteries alluded to are distant cannon-like rumblings occasionally heard in mountainous regions. Colonel Godwin Austen, whose name is immortalized in the 28,265 feet high Himalayan peak, heard them when surveying in 1865. Similar sounds are also heard off the Belgian coast where, says Gould, they are locally known as 'fog-hiccups'.

The book concludes with *pro* and *con* arguments concerning the presence of canals in Mars.

These chapters, which must have involved a considerable amount of diligent delving into ancient records, savour in the majority of cases of much ado about nothing. We are surrounded by marvels; they make contact with us every day of our lives. How do radiation waves, from the fifteen-mile-long Hertzian, to the twenty million millionth of an inch cosmic waves, make their way through a *vacuum*? What is the secret of 'action at a distance', and how does an apple fall to the ground? What are 'energy' and 'matter', how are they mutually convertible, and how does the brain, as a synthesized aggregation

of their fundamentals—photons, electrons and protons—feel, think, and—marvel ? Here, indeed, are matters worthy of wonder, real marvels which put the mysterious pullings of bell-wires and movements of coffins in their proper perspective. Hearsay statements concerning events the causes of which were not ascertained, especially when made by credulous people with a mystical bent, though not necessarily devoid of truth, are always suspect. Science has carried all before it in virtue of two golden rules, the one, to "take no man's word for it", the other to be economical in assumptions in accordance with the Law of Parsimony that causes are not to be multiplied beyond mental necessity—*Entia non sunt multiplicanda praeter necessitatem.*

CHARLES M. BEADNELL.

A Compilation on Migrations

The Wandering Spirit :
a Study of Human Migration. By Dr. Ragnar Numelin. Pp. xvi + 375. (London : Macmillan and Co., Ltd., 1937.) 20*s*. net.

IN his attempt to analyse the conditions and stimuli underlying human migrations, Dr. Numelin has cast his net over the entire world, and has considered human movements from Palæolithic times down to the present day. But, although his many citations show that the physical and social conditions promoting migration are very complex, his methods and criteria are too vague to yield satisfactory results.

Despite his strictures on their loose use by others, the author uses terms like migration, wandering and nomadism without clear distinction, and he often fails to discriminate between seasonal movements of all or part of a community within its territory and group migration from one territory to another. Much of the movement among food-gathering peoples, of which he cites many examples, is in its seasonal and cyclic character to be distinguished clearly from large-scale displacements under pressure of food shortage or human enemies, and the author does not seem to have considered the evidence for territorial fixation among these peoples. This confusion of seasonal movements and journeying with migration in the sense of permanent displacement also leads him to regard fishing peoples as more migratory than primitive collecting and hunting groups. There is much evidence from western North America and north-eastern Asia, not mentioned by Dr. Numelin, which suggests that the contrary is more generally true.

Although a great deal of material is brought together in this volume, the use of sources is often very uncritical. The author frequently omits to mention or consider much recent work on peoples discussed, while general statements and assumptions of earlier writers are accepted as definitive. Assuming that remote linguistic relationships imply tribal migration between particular areas, he reaches improbable conclusions which are supported by no real evidence. The Iroquois, for example, are described as having migrated as coherent tribal groups from country west of the Mississippi, and the Navajo are brought to New Mexico from Alaska !

Dr. Numelin accepts creation myths as evidence of the origin and course of migrations of particular peoples, citing with approval for the Pueblo area the conclusions of Fewkes which, as later workers have shown, reduced the theory of historical migrations to absurdity. On the other hand, he does not refer to the more recent studies of Pueblo society by Kroeber, Parsons, and others, in which observed processes of fission and migration have been analysed. He gives numerous references to pilgrimages, trade journeys, and shifting of house and village site after death or pestilence, but does not discuss either the cumulative effects of such practices or their relation to group migration.

Although the discussion of "subsistence—geographical" conditions of migration, that is, the relation between the economy and the physical conditions at a particular place and time, is in general more satisfactory, and there are useful summaries of material on transhumance and other forms of seasonal migration in Europe, the evaluation of social and physiographical factors is rarely adequate. The author occasionally lapses into crude determinism. He refers frequently to mental qualities and uses the misleading term 'instinct', but does not present either a clear statement or cogent evidence concerning the part played by psychological factors.

This laborious piece of work has unfortunately been undertaken without either a clear formulation of the problems to be investigated or an adequate knowledge of recent methods and results in social anthropology. Dr. Numelin has not been very happily guided by those who revised his English text, for the writing is often unidiomatic, and his meaning is sometimes quite obscure.

DARYLL FORDE.

Epilogue to the Mendeléeff Centenary in Russia

Travaux du Congrès Jubilaire Mendeléev
Vol. 1. Pp. v+666+16 plates. Vol. 2. Pp. iv+471+10 plates. (Moscow et Leningrad: Académie des Sciences de l'URSS, 1936 and 1937.) 32+17 roubles.

THE Mendeléeff centenary congress held in Leningrad during September 1934 was described directly afterwards in NATURE (134, 799; 1934). The official report has just appeared.

The first volume contains the speeches of the Russian organizers and foreign guests, and all the lectures delivered in Leningrad. It is obviously intended for readers both in Russia and abroad; all the official Russian speeches are here followed by French versions, Russian lectures by translations into French or German, while lectures given in either of these languages—English was not used at the congress—are rendered into Russian also. There is no need to give a list of the speakers and their subjects, as these are already mentioned in the article in NATURE referred to above. Those lectures dealing with modern scientific questions have lost something of their topical interest through the long delay, though the various historical contributions are scarcely affected by the two years' procrastination.

Most of the foreign delegates to the congress were unable to follow the Russian speeches. While probably they were all impressed by the picturesque welcome offered by the delegation of Moscow chemical workmen, only now can they realize that the address spoken by their representative was one of the most significant delivered at the opening meeting, giving an account of the development of the Russian chemical industry; and that Prof. Nametkin's lecture traces in a most interesting manner Mendeléeff's endeavour to promote the petroleum industry in Russia. Those of Mendeléeff's admirers who had so far venerated him only as an investigator will be glad to learn how energetically he used his influence to direct this industry in the way he thought best for the benefit of his country.

The lectures delivered during the less formal continuation of the celebrations in Moscow; a few more already held in February 1934 at a meeting of the Russian Academy; and several papers which were only presented in manuscript and not read, form the subject of the second volume. The contributions by the Russian men of science frequently throw illuminating sidelights on Mendeléeff's rich and unconventional personality; Prof. S. I. Vavilov, in a paper on the importance of physics in Mendeléeff's scientific activities, incidentally mentions that his various interests, and their simultaneity, are reflected in his private library: it contains many books, bound by himself, which unite in the same volume novels with chemical and mathematical papers.

Some of the authors have taken the opportunity of extending their addresses. Prof. Wilh. Palmaer (Stockholm) presents in no less than fifty pages a survey of his own and his co-workers researches on the corrosion of metals; two excellent plates in colour illustrate his descriptions. In a few other cases one may be inclined to regret that the authors have strictly confined themselves to their spoken addresses; if, for example, Prof. W. Noddack (Freiburg) in his remarks on the Periodic System criticizes the evidence brought forward by some investigators for the existence of the elements 61, 85 and 87, readers may ask whether the proof which he himself offered so early as 1925 for the discovery of element 43 (masurium) is any more valid; as no confirmation has been forthcoming, it might be advisable to extend his well-founded scepticism also to this place of the Periodic System.

The delay in publication is probably due to an endeavour to produce a technically faultless book, and it must be acknowledged that the two stately volumes show none of those shortcomings in paper or print so frequently met with in Russian publications. This excellent typographic achievement and the great care devoted to the German and French texts and translations deserve high praise; although they may not always be linguistically quite correct, it is very remarkable that the Russian printers and proof-readers are able to produce such long and difficult treatises practically free from misprints in foreign languages.

At the end of the second part the names of the ten honorary presidents—the list being headed by J. V. Stalin—34 presidents, 34 members of the Organizing Committee, 28 foreign and 253 Soviet delegates, and additional official details are given. Many good reproductions of pictures adorn the volumes, amongst them portraits of Mendeléeff's father and mother, which are probably little known outside Russia.

The efforts made in 1934 by the Russian authorities and scientific workers to celebrate one of their greatest compatriots are now put on record in an appropriate manner by these two fine volumes.

F. A. P.

The Plant Diseases of Great Britain :

a Bibliography. Compiled and annotated by Dr. G. C. Ainsworth. Pp. xii+273. (London : Chapman and Hall, Ltd., 1937.) 15*s*. net.

THIS book, to which Dr. E. J. Butler has contributed a foreword, is a successful attempt to provide the plant pathologist—at rather a high price—with the key references to the literature on the principal plant diseases of Great Britain. The 183 host plants are conveniently arranged in groups as in the Ministry of Agriculture's reports on the annual occurrence of plant diseases, from which most of the nine hundred diseases included were taken. Under each host there is a list of diseases that may affect the plant and, where possible, the common names applied to these diseases are those recommended by the Plant Pathology Committee of the British Mycological Society. The attempt to name viruses and virus diseases will be particularly welcomed by plant pathologists. A selected list of literature references, mainly English but with a sprinkling of foreign papers, is given for the majority of the diseases, and each reference is briefly annotated to indicate the contents of the paper. Where a paper is abstracted in the *Review of Applied Mycology* a reference to this is given. Two indexes are provided, one of authors and one of hosts and parasites.

The selection of the English literature has been extremely well made, but many quite uncommon or doubtfully parasitic diseases are included without comment. Indeed, the value of the book to economic workers, both in Great Britain and Overseas, would have been greatly increased if the author had attempted to assess the relative importance of the diseases, for the number of articles published about a particular disease is apt to give a very misleading impression of its economic significance. The references have evidently been carefully checked, but elsewhere misprints are frequent. W. C. M.

Commercial A.C. Measurements

By G. W. Stubbings. Second edition, revised. Pp. xvi+348. (London : Chapman and Hall, Ltd., 1937.) 15*s*. net.

THIS book has been written primarily for testing engineers. For students reading for engineering examinations it will not be so useful, as there are no examples given to illustrate the application of the theory given to practical work. The author has reduced the mathematical theory to a minimum, and so does not discuss the cases where three vectors cannot be represented by three lines lying in one plane, or stated the full conditions that must be satisfied in order that the power factor of a circuit may be unity.

The author's descriptions are easy to follow and he is thoroughly familiar with the methods used in the testing departments of power stations. Apparently it is customary to express the errors of watt-hour meters as a percentage of the true registration, the number being + (positive) if the meter is fast and − (negative) if it is slow. The average consumer would probably understand the meter card more easily if fast were written for + and slow for −. It is quite unnecessary to burden the memory in this case.

Handbook of Engineering Fundamentals

Prepared by a Staff of Specialists under the Editorship of Ovid W. Eshbach. (Wiley Engineering Handbook Series, Vol. 1.) Pp. xii+1036+50. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1936.) 25*s*. net.

THIS book is divided into thirteen sections beginning with mathematical and physical tables and proceeding through such other subjects as mathematics, mechanics, flow of fluids, thermodynamics, electricity and magnetism, radiation, light, acoustics and meteorology, chemistry, metallic and non-metallic materials, to a final section on contracts, and certainly deals with the fundamental subjects required by the engineer.

The forty authors responsible for this work have been selected in equal numbers from the academic and industrial fields, so that, whilst the theoretical aspects of the various subjects are not overlooked, the practical applications of the theories receive due attention.

Intended as an introduction to the two volumes comprising Kent's "Engineering Handbook", and the two volumes constituting the "Handbook for Electrical Engineers", all of which are of uniform size, it possesses much useful information, but the English reader must always remember that it treats of American practice. Although containing nearly eleven hundred pages, the book is of convenient size, clearly printed, well illustrated, and firmly bound in flexible covers ; it should prove a useful addition to the library of the engineer.

The Metabolism of Living Tissues

By Dr. Eric Holmes. Pp. xi+235. (Cambridge : At the University Press, 1937.) 7*s*. 6*d*. net.

SIR F. GOWLAND HOPKINS has written a foreword in which he calls this a highly original book. Its chief claim to originality probably lies in its popular style, which strays from the narrow vocabulary generally used in scientific works in a way that is likely to shock the purists. The book is meant to be read straight through by students of biochemistry at the beginning of their course, and is likely to appeal to such readers. Advantage has been taken of the fact that the contemplation of structural formulæ brings æsthetic satisfaction to many who do not really understand them. Such contemplation is encouraged by an invitation to compare the formula of the lactoflavin in vitamin B_2 with the prosthetic group of Warburg's yellow pigment. The two substances are identical, but it takes the beginner some time to discover this fact because the two versions of the formula are written differently.

After some general remarks about enzymes, oxidations and redox potentials, the metabolism of the liver, kidney, muscles and nervous system are discussed in separate chapters, with particular emphasis on carbohydrate metabolism. This is probably the best part of the book. Hormones and vitamins are mentioned in later chapters, and their formulæ given. The book is intended as an introduction. There is a danger that it will come to be regarded by students as a complete account of all that they need to know.

Chemistry of Indian Opium

By Dr. H. B. Dunnicliff, Chemical Adviser, Central Board of Revenue, Government of India

OPIUM is the spontaneously coagulated latex which exudes when the partly ripened capsules of *Papaver somniferum* L. are lanced on the living plant. On exposure to air, the white, pale-yellow or pink latex turns darkish brown and, increasing progressively in viscosity, finally becomes quite hard. The product, called 'raw opium', is brown and soft inside, and has a characteristic smell and bitter taste. As marketed, raw opium contains about 15 per cent of water, some sugar, salts, albuminous substances and colouring matter. Its most valuable constituents are varying amounts of the meconates of some twenty-five alkaloids, the chief of which is morphine. At the time of collection, the content of morphine in Indian opium is not less than 8 per cent, though 16–20 per cent has been recorded when only latex from first lancings were taken. Narcotine (5–7 per cent); codeine (1–2 per cent), papaverine (0·4–1 per cent), thebaine (0·2–0·5 per cent) and narceine (0·5–1 per cent) are also present.

Opium waste products and contraband opium are used for the manufacture of morphine and other opium alkaloids. Excise opium is used in medicine, but in India much is chewed in harmless quantities.

The Hague Convention and the Dangerous Drugs Convention of 1925 have given international definitions to the two other varieties of the commercial drug, "prepared opium" and "medicinal opium". For the latter, selected chalâns of raw opium containing 9·5–10·5 per cent of morphine are employed.

In 1926, the Government of India discontinued the auctioning of "provision" opium for export and undertook the sales direct, the policy for many years having been to deal only with Governments. Also the supplies to Far Eastern countries for purposes other than medical and scientific were reduced by 10 per cent annually so as to extinguish exports by December 1935. This decision has involved great financial sacrifice to India, the sales in 1926–27 having yielded 3·36 crores of rupees (a crore is ten million rupees, approximately £750,000), while, in 1936–37, no revenue was collected under this head.

Experts have been frequently employed to report on the preparation of standard opium for sale and, for nearly thirty years, the technical side of the factory has been under the control of a chemist. W. A. Davis[1], indigo research chemist to the Government of India, deputed to report on the manufacture of medical opium and opium alkaloids at Ghazipur, recommended the installation of modern factory and laboratory research equipment, and showed how the Ghazipur Factory could produce a standard opium in sufficient quantity completely to replace that from Turkey and Persia in the English and American markets. Indian medical opium, the manufacture of which at Ghazipur was first undertaken during the Great War to replace the supplies no longer available from Turkey owing to international hostilities, is a better standardized product than that from Turkey. Indian opium also contains more codeine (2–4 per cent) than the Turkish variety (less than 1 per cent).

H. E. Annett and his co-workers[2] have made valuable contributions to the chemistry of opium and its alkaloids. With Bose, he showed that the observed increase in the percentage ash of the latex of the opium poppy at each successive lancing up to the fourth is accompanied by a decrease in the total alkaloid content of the latex. The principal loss was in morphine, while the codeine–morphine ratio rapidly increased at successive lancings. They failed to establish any relationship between the nature of the soil and the morphine content of the opium grown on it, though there was clearly some local factor influencing the power of a plant to produce the alkaloids. Different races of poppy possibly produced opium of varying morphine content and special strains could be produced by selective manuring. Organic manures caused an increased yield of opium of higher morphine content. Similar results with superphosphate linked the beneficial effect with the phosphoric acid in the manure.

Indian opium was, and still is, inferior to Turkish opium in morphine content. This can be ascribed to such factors as faulty methods of harvesting, defective lancing and collecting, the deterioration of opium on storage and environmental conditions in India, which are unfavourable when compared with those of Turkey, where the latex is collected in a moist atmosphere with a falling temperature, while the reverse conditions, favourable to bacterial deterioration, prevail in India.

In cloudy or moist weather a brown, watery substance called 'pasewa' exudes from opium. It used to be employed as 'lewa', a mixture of pasewa and inferior opium, in pasting poppy petals as a protective layer round the balls of provision

opium. Opium mixed with excess of pasewa is termed 'pasewa amez', but little is known of the genesis, chemistry or properties of pasewa and its peculiar sensitiveness to climatic conditions.

Considerable controversy arose over the assays of opium and its alkaloids submitted to the English market for sale. These differences between results of the English chemists and the Indian factory analysis were traced to different methods being employed for the evaluation of the opium and the purity of morphine hydrochloride, and the interpretation of the results.

In 1915, the chemical work of the Ghazipur Laboratory was done by the assistant opium examiner, W. W. Todrick. His staff was augmented in 1915 by a chemical assistant, J. N. Rakshit (Rai Sahib, 1926), who eventually succeeded Todrick. Later he was designated factory chemist, but in 1929 he was appointed to the newly created post of opium chemist to the Government of India.

In 1917, Rakshit[3] showed that opium yields about 2·5 per cent ammonia, and, a year later, isolated a complex substance he called "opium wax"[4]. Its composition varies widely from different sources, giving saponification values, 113–126, acid values, 41–45, and iodine values 130–170. The presence of hydrocarbons is also indicated, and from two other components ; J. N. Ray (Lahore, unpublished work) has separated acids melting at 76° and 178° respectively, the latter being most probably a resin acid. Hence Ray suggests that opium wax is probably a resin, since destructive distillation yields an oily product resembling the higher terpenes.

Rakshit[5] isolated porphyroxine from opium and reported it to be a crystalline compound with a sharp melting point different from the mixtures examined by Merck (1837), Dey (1883) and Hesse (1894). Rakshit's proposed structure for this compound has been the subject of criticism in view of the development of the chemistry of morphine.

The determination of the morphine content is a most important but controversial question, leading to modifications of standard procedure from time to time.

The Indian Opium Factory sales of medical opium of standard strength for supply to medical men and hospitals have increased from 511 lb. in 1922 to 1,800 lb. of medical opium powder and medical opium cake of B.P. 1932 strength in 1936. During the year ending September 30, 1936, 1578 lb. of crude morphine, 130 lb. of morphine hydrochloride, 14 lb. of morphine sulphate and 284 lb. of codeine were sold from the Factory. Cotarnine prepared by the oxidation of narcotine has been made to supply special orders.

Literature on the problem of the loss of morphine from opium on storage has been summarized in an article by Dunnicliff, Ray and Singh[6]. Their investigations show that the morphine content of Indian opium does not fall if it is stored under anærobic conditions in a moist condition but that, if dried at 60° and stored in contact with air, it suffers a rapid loss of the alkaloid. When dried at 98°–100° and stored out of contact with air, the fall in morphine content is small. Simple trituration of opium with lime shows that there are ammonium salts present, but it is claimed that their formation is not due to the degradation of morphine as hitherto believed.

The consumption of excise opium in India has decreased steadily for the last six or seven years, the issues from the Ghazipur Factory having fallen from 12,767 maunds in 1919 to 5,665 maunds in 1936. This decline is to be attributed partly to the economic depression of recent years and partly to the steady increase in the duty on opium. To a large extent, opium-eating in India is quasi-medical, being used by the poor as a very common and highly valued household remedy. Its physiological importance depends not only on its morphine content but also on the presence of alkaloids like codeine, papaverine, etc., which assist in the relief of many ailments.

The conclusion that opium may have an anti-malarial action was based on the low incidence of malaria in certain districts where opium was regularly consumed. Gordon affirmed the prophylactic value of narcotine against malaria, but Chopra and Knowles[7] have shown that it has neither curative nor prophylactic value in malaria, even in large doses.

Ahluwalia, Kochhar and Ray[8] oxidized narcotine to cotarnine in good yield and prepared a number of derivatives of cotarnine. One of these formed from resorcinol was found, like quinine, to be an antipyretic and toxic to Paramecia. Its acetyl derivative may possibly find some application in gynæcology, while cotarnine phthalate is a stypic.

The opium habit, the physiological results of smoking opium, the effect of opium and morphine on the human system and morphine addiction in India have all received the attention of scientific workers and official commissions[9], from the reports of which valuable information on these important sociological problems may be found.

[1] Report on the Opium Factory, Ghazipur, by W. A. Davis (Government Press, U.P., India, 1918.)

[2] *Bull. Agric. Research Inst. Pusa*, **116** (1921) ; *Mem. Dep. Agric. India*, **6**, 1, 2 (1921) ; **8**, 2, 3, 4 (1925) ; *Agric. J. Ind.*, **6** (1922).

[3] *Pharm. J.*, **98**, 255 (1917).

[4] *Analyst*, **43**, 321 (1918).

[5] *J. Chem. Soc.*, 455 (1919) ; *Ber.*, 2473 (1926).

[6] *Proc. Nat. Inst. Sci. India*, **1**, 107 (1935).

[7] *Indian J. Med. Res.*, **18**, 5 (1930).

[8] *J. Indian Chem. Soc.*, **9**, 215 (1932).

[9] "A.B.C. of Narcotic Drugs", by O. Anselmino. (League of Nations. Permanent Central Opium Board. Geneva, 1931.) Report of the Royal Commission on Opium, 1895. Report of the International Opium Commission, Shanghai 1909 (*North China and Daily News Herald Ltd.*, Shanghai 1909). "Indian Opium", *Bull. Imp. Inst.*, 1915, "The Truth about Opium", by W. Brereton (1882).

Recent Caterpillar Plagues in Great Britain

THE epidemic occurrence of the caterpillars of the Antler moth (*Charœas graminis* L.) in the north of England and Scotland, and of the Willow 'Small Ermine' moth (*Hyponomeuta rorella* Hb.) in Suffolk, have been the subject of considerable comment, not to say confusion, in the daily Press, and since the two outbreaks are of a very different type a brief account of their essential features may be of interest.

The species first mentioned is widely distributed throughout Great Britain, haunting chiefly moor or downland, and the poorer types of pasture, where the larvæ feed on *Festuca ovina*, *Nardus stricta*, and grasses of a similar type. In lowland regions, the Antler moth appears never to increase to such numbers as to do appreciable harm ; but in hill districts from South Wales and Derbyshire northwards, moorland pastures, usually at a considerable elevation, may suffer very severely, the grasses being largely destroyed and only a brown 'mat' of dead grass left. The caterpillars then occur in such numbers as to be driven by starvation to migrate in vast hordes, blocking streams and water courses, or collecting in heaps at the base of walls or other obstacles. This migratory stage, if that term be applicable, is reached when the caterpillars have nearly completed their feeding, and although a certain proportion crawl downhill towards the lowland meadows, the latter never seem to be damaged. Antler moth outbreaks occur relatively infrequently, as the following records show, although there may have been others on a smaller scale of which records have been overlooked, notably between 1827 and 1881 :

1827 Skiddaw[1].
1881 Lancashire (Clitheroe)[2], Derbyshire[6].
1884 Glamorgan[3].
1885 Selkirk[4].
1894–95 Selkirk and south-west Scotland[5].
1910 Glamorgan[6].
1917 Derbyshire[6].
1935 Wales (Brecon).
1936 Brecon Beacons and Cader Idris, north-west England.
1937 Cader Idris (slight compared with 1936), north-west England, Scotland.

It is evident, therefore, that outbreaks seldom occur for more than two years in succession in the same area, and often they are confined to single years with long intervals in between. The factors that lead to these enormous increases in numbers are at present unknown. The outbreak in Derbyshire in 1917 was investigated by Imms and Cole[6], and they suggested that these factors were possibly climatic, and the fact that the hills were snow-covered in 1916–17 might have given the species greater protection during that winter. Since, however, the insect spends this season in the egg stage (a fact not then known) this explanation is not very likely to be correct. An alternative suggestion discussed by Imms and Cole was that the failure to burn hill pastures during the Great War had favoured the outbreak, but again this explanation can scarcely apply generally, and it is more probable that the causes of an outbreak are complex and due to the interaction of both climatic factors and the varying incidence of the natural enemies of the moth.

The matter clearly needs investigation; but owing to the considerable period of years that may elapse between outbreaks and the necessity for intensive field and laboratory work every year, regardless of outbreaks, the problem would seem to be more appropriate to a university department with a succession of students than to a research worker in economic entomology, who would not be able to give annually so large an amount of time required to a problem that, taken over an average of years, is not of great economic importance. So far as direct control measures are concerned, nothing of a practical nature is yet known, since the value per acre of moorland grazing is so small that it will not carry any appreciable expenditure on caterpillar control.

The Antler moth outbreaks are thus typical of a resident species that normally occurs in small numbers, but is occasionally released from the factors that exercise a natural control.

The outbreak of the other species attracting attention, the Willow Small Ermine moth (*Hyponomeuta rorella*) is of a different character. This moth, until 1936, was regarded as a very rare species in Great Britain, having been noted only in Sussex and Dorset, and even in these counties there seems to be no record of any permanent colony. In 1936, however, the marshland willow trees in the neighbourhood of Beccles in Suffolk were found to be heavily infested by the larvæ, and specimens were also received from Barnby, farther down the Waveney valley, while a single specimen was taken at Rockland Broad in the valley of the Yare in Norfolk, some twelve miles from Beccles[7].

According to Goldsmith, who first recorded the Suffolk outbreak[8], larvæ had been noted at Beccles some five years before his attention was directed to them. It is thus possible that there may have been a small nuclear colony of the species in Suffolk for many years. This, however, is not very likely, since the Beccles neighbourhood has been fairly well worked in respect of the Lepidoptera, and the 'nests' of the larvæ are so conspicuous that they could scarcely be overlooked. On the whole, it is more probable that the species is a recent arrival in Suffolk, having either flown or been carried by boat from the Continent.

If this suggestion is correct, the conditions favouring an epidemic increase might easily have been fulfilled, since the moth would arrive without its natural parasites, and feeding upon willows in a marshland district, where other members of the genus are not abundant, it would gain some years' start before being found by any indigenous parasites. In 1936, the rate of parasitism was certainly very low. Mr. Stringer, of the British Museum (Natural History), reared from Beccles larvæ the species *Herpestomus brunneicornis* Grav., an ichneumonid that frequently attacks the allied *Hyponomeuta padella;* but the writer obtained no parasites whatever either from Beccles or from Barnby material.

Provisionally, then, *H. rorella* may be regarded as an invader (in contradistinction to the indigenous *C. graminis*), and although it is very unsafe to prophesy, it is at least possible that it will be increasingly parasitized, and even perhaps brought completely under control as soon as it is discovered by the parasites of our native species of *Hyponomeuta*—a process that might be hastened artificially if it were considered worth while.

As to the economic importance of the insect, it is not possible as yet to give any definite opinion. If cricket bat willow or basket willow were attacked, the species might prove a serious menace, notably to the former, since the spraying of large trees is seldom commercially worth while. Fortunately, there is some hope that neither will be affected. In Suffolk, the trees that are suffering appear to be *Salix alba* (although the writer claims no expert knowledge in this respect). However this may be, larvæ of the *rorella* brought from Beccles, and also others reared in captivity from the egg, have been given the foliage of the true cricket bat willow, but neither in 1936 nor 1937 were they able to survive on it. Similarly, they refused to feed on *Salix caprea* or other 'sallows', or on one of the basket willows that was given them. The experiments were not sufficiently extensive to justify any final conclusion in respect of the cricket bat willow, but they are at least suggestive and show that *H. rorella* is very specific in its tastes.

A note on the outbreak in 1936 was published in the *Entomologist*[7], to which readers may be referred for a description of the larvæ and the damage they do. J. C. F. F.

[1] Curtis, "Farm Insects", 507 (1883).
[2] Ormerod, "Report on Injurious Insects", 21 (1881).
[3] *ibid.*, 16 (1884).
[4] *ibid.*, 12 (1885).
[5] *ibid.*, 12, (1894); 18 (1895).
[6] Imms and Cole, *J. Board Agric.*, **24**, 516 (1917-18).
[7] Fryer, *Entomologist*, **69**, 269 (1936).
[8] Goldsmith, *Entomologist*, **69**, 217 (1936).

Nottingham Meeting of the British Association

AS has already been announced, the annual meeting of the British Association will this year be held in Nottingham on September 1–8, under the presidency of Sir Edward Poulton. Twice previously the Association has held its annual meeting in Nottingham. In 1866, before the foundation of University College, Nottingham, Mr. Justice Grove, Q.C., the inventor of the Grove cell, was president. It was at this meeting that Wheatstone was president of Section A (Mathematics and Physics), before which Joule read a short paper on the heating effect of an electric current in a wire, and one wonders if this paper was an abridged version of that which Wheatstone is reputed to have rejected in his capacity as a referee for Royal Society publications. At the same meeting, Sir William Huggins gave an evening discourse on the applications of spectroscopy to the problems of stellar constitution. Among the more distinguished members present in 1866 were Frank Buckland, T. H. Huxley, A. R. Wallace, W. Crookes and H. E. Roscoe, while Dean Farrar contributed to discussions on the teaching of science in public schools, and C. F. Varley reported on the Atlantic cable successfully completed a month before the meeting. Among the visits paid to local industrial undertakings was one to Messrs. Taylor's bell foundry in Loughborough, and it is pleasant to think that members will again have an opportunity of visiting the works this September.

In 1881 the University College, Nottingham, buildings in Shakespeare Street, near the centre of the city, were opened, and these were the headquarters of the Association at its annual meeting

in 1893. Dr. J. S. Burdon Sanderson was president, and Sir Richard Glazebrook was president of Section A, which was remarkably active, and at which a committee presented a report on the foundation of a National Physical Laboratory.

This year the Association will hold all its sectional meetings in the University College buildings in University Park, provided by the munificence of the late Lord Trent and opened by H.M. King George V in July 1928. Here the members will be able to enjoy extremely pleasant surroundings, and, if they wish, refresh themselves in an open-air swimming pool.

Nottingham is the centre of a large number of industries; its connexion with textiles is well known, and there are large chemical, mining, tobacco, bicycle and general engineering undertakings in the city and immediate vicinity. Since the last meeting here, interest in lace manufacture has declined, or, rather, been replaced by activity in hosiery manufacture. Visits to representative works have been arranged, including an excursion to a coal mine, and the Geography and Geology Sections of the Association are combining in a discussion on the potential resources of the area. Members visiting Nottingham for the first time will find much to interest them in the many excursions which have been arranged to the surrounding countryside.

A meeting in which local members should be considerably interested is an evening discussion arranged between six sections on the planning of the land of Britain. A joint meeting of the Education and Geology Sections to discuss the teaching of geology in schools is also likely to be keenly followed, and Mr. H. G. Wells's presidential address to the Education Section will naturally be of considerable interest. In addition to the evening discourses, one on "Illusions of Colour" to be given by Prof. H. Hartridge and another on "Grass and the National Food Supply" by Dr. R. E. Slade, a series of popular lectures for non-members has been arranged in the neighbouring towns. Dr. Alexander Wood will address a company of Nottingham children on "Noise", Sir Gilbert Walker will talk to a Derby audience on "The Science of Sports", Mr. R. Kay Gresswell will talk on "Rivers" at Lincoln, Dr. J. E. Constable on "Everyday Application of Physics" at Long Eaton, Prof. J. Walton on "Coal and its Origin" at Mansfield and Mr. T. M. Herbert on "Transport of Food" at Newark.

The Lord Mayor and members of the City Council will hold a civic reception at Nottingham Castle on Thursday evening, September 2, and the College Council will give a garden party on September 7. On these occasions members should find ample opportunity of meeting many of the local scientific workers and citizens who are interested in the aims and objects of the Association and who are working to make the Nottingham meeting a successful one in every way.

Obituary Notices

Prof. Thomas Mather, F.R.S.

THOMAS MATHER was a man who worked his way up to an important and honourable position from a starting condition devoid of all advantages due to financial or personal support. His early training was that of a carpenter. By strenuous evening study he won a Whitworth Scholarship at a time when these scholarships were few in number and of greater money value than is nowadays the case. With the aid of this scholarship, he supported himself at college throughout a fairly complete course of full-time study. His early education was not such as to make it possible for him to meet all the academic conditions at that time needed in order to qualify for a science degree. He could not get a degree but he could, and did, work hard at physical, mathematical, and engineering subjects, so as to leave college with a thorough grip of them. He next became an assistant to Prof. W. E. Ayrton at the start of the technical teaching work financed by the City and Guilds of London Institute. He followed Prof. Ayrton from the college at Finsbury to the one at South Kensington which is now part of the Imperial College. On the death of Prof. Ayrton he succeeded him as professor of electrical engineering. When he died on June 23, he had lived more than eighty-one years, and during half that period he was a fellow of the Royal Society.

Mather joined Prof. Ayrton's staff at Finsbury in 1881 before the College was actually built, and while the City-Guilds classes were carried on in a boys' school, part of the playground of which was afterwards used as the site for the College. The classes at the school and later on at the College were held mainly in the evening, and were thronged with adult students all engaged in the new industry of electrical engineering. At that time, trained men were not to be found, and electrical engineering departments did not exist. There was a new and sudden demand for large laboratory classes to train men in the use of apparatus utilizing electrical currents of a magnitude previously unknown. The development of suitable training courses with corresponding testing appliances called for much ability and initiative. Prof. Ayrton

at first directed this work, but later on was content to leave it almost entirely in the capable hands of his assistant. The work grew in volume and altered in character with the change from the Finsbury to the South Kensington College, with the establishment of three-year College day-courses, and with the rapid development of electrical engineering. As years passed, the laboratories had to be enlarged and their equipment increased, and many new members of the staff had to be engaged. Mather throughout remained in control. The main work of Mather's life consisted in the development of these laboratories and in the constant assistance given by him to those who worked in them whether as ordinary course students or as exceptional ones, like Duddell, carrying out important original work.

For many years, Mather could not lecture since his speaking suffered from an impediment so serious that he often had to resort to paper to explain what he wished to say. He was quite unable to take part in the discussions at the Institution of Electrical Engineers, or at the Physical Society. Had he been able to do so, he would have been more adequately appreciated outside the College than was the case. His struggles to overcome his disability were at times pathetic, but during and after 1914, to the astonishment and delight of everyone who knew him, he was able to give lectures. These were highly esteemed by his students.

From the pure science point of view, Mather's most valuable work was an investigation concerning details in the improvement of the standard cell and involving an accurate determination of its electromotive force. This work formed the subject of papers to the Royal Society, and was probably the main factor determining his election to the fellowship of the Society.

Technical men will remember Mather best for a number of papers written, mostly in conjunction with Prof. Ayrton, dealing with improvements in the construction of electrical instruments of all kinds. An instance is a set of papers on galvanometers and accessories such as the well-known Ayrton-Mather shunt. Another consists of his work on electrostatic voltmeters, which involved most skilful and careful design. These instruments were widely used in practice, since at the time they were first produced they were much wanted and were the best available instruments of their kind. The precision wattmeter of Mather and Duddell is another instance of the excellence and care in detail of Mather's work. First-rate instruments and appliances suitable for college or industrial testing are now commonplace articles of commerce, but such a result could only be reached after much previous work had been done in laboratories established for technical teaching. Mather was one of the earliest and ablest pioneers in this work.

In nature, Prof. Mather was most modest and retiring. He was always kindly and willing to help in either simple or advanced work, and never wished to have such help acknowledged in public. He was personally much liked and was held in honour by all who knew him. It would be hard to value too highly the influence of a man who spent so many years guiding the laboratory training of ordinary students and in helping in the research work of others, many of whom have become highly distinguished men.

Prof. Albert Griffiths

PROF. ALBERT GRIFFITHS was born at Chester on October 8, 1867, and after the removal of his family to Manchester was educated at the Manchester Central School, the Royal College of Science, London, and in 1887 won the Dalton entrance scholarship to the Owens College, Manchester, then one of the constituent colleges of the Victoria University. He was one of the first students to read for the honours degree in physics of the University, and at the end of his first year was awarded the Heginbottom Scholarship. He obtained the degree of B.Sc. with first-class honours in 1890, and went to Germany to continue his studies at Freiburg.

In 1893 Griffiths was elected to a Bishop Berkley fellowship at the Owens College, and commenced a series of electrical researches, an account of which he published in the *Philosophical Magazine*, vol. 39, in 1895. He was appointed demonstrator in physics on the termination of his fellowship in 1895 and lecturer in physics at University College, Sheffield, in 1898.

Griffiths obtained his D.Sc. degree in 1899 and in the following year, after acting as head of one of the students' hostels at Sheffield, was appointed head of the physics department of Birkbeck College, London, and ultimately professor of physics. He held this position until his retirement in 1933, and founded a school of research which concerned itself mainly with problems of diffusion of salts in solutions and improvements in the methods of determining coefficients of diffusion. Heart trouble set in during the summer of 1935 and became rapidly worse early in 1937; he died on May 24. He leaves a widow and one son.

WE regret to announce the following deaths:

Prof. H. E. Armstrong, F.R.S., emeritus professor of chemistry in the Imperial College of Science and Technology, City and Guilds (Engineering) College, on July 13, aged eighty-nine years.

Dr. A. A. Bialinycki-Birula, formerly director of the Zoological Museum of the Russian Academy of Sciences, known for his zoological work in the Arctic and for systematic work on scorpions and Solifugidæ, aged seventy-three years.

The Right Hon. Lord Ernle, M.V.O., president of the Board of Agriculture and Fisheries in 1916–19, who received the Gold Medal for 1935 of the Royal Agricultural Society "for distinguished service to the farming industry", on July 1, aged eighty-five years.

Prof. A. W. Gibb, emeritus professor of geology in the University of Aberdeen, on July 12, aged seventy-three years.

News and Views

H.M. the Queen and the University of Edinburgh

AT a special graduation ceremonial on July 8, the Senatus Academicus of the University of Edinburgh conferred on Her Majesty the Queen the honorary degree of doctor of laws. The degree was conferred by the vice-chancellor, Sir Thomas Holland, who expressed to Her Majesty the thanks of the University. In her reply, Her Majesty said, "I thank you, Mr. Vice-Chancellor, for the very kind words with which you have admitted me to-day to your Roll of Honour, and I assure you that I deeply appreciate the distinction which the University of Edinburgh has conferred upon me. As a Scotswoman I know the high value which my fellow-countrymen set upon education, and the important part which a university such as this plays in the civic and national life. It is very gratifying, therefore, to me to feel that as a member of this great University I am connected with so important a centre of Scottish life and thought. It is my earnest hope that this ancient foundation will long continue to prosper, and I can assure you that its interest will always lie very close to my heart." Among those present were the Right Hon. Ramsay MacDonald, and Prof. J. Graham Kerr, two of the members of Parliament for the Scottish Universities.

Sir David Prain, C.M.G., C.I.E., F.R.S.

SCIENTIFIC workers in general and botanists in particular will join in congratulations and good wishes to Sir David Prain on the occasion of his eightieth birthday, which he celebrated on July 11. Sir David Prain's career as a botanist began with his appointment as curator to the Calcutta Herbarium some fifty years ago. After twenty-one years' distinguished service to the cause of botany, both pure and applied, in India, Sir David was appointed to the directorship of the Royal Botanic Gardens, Kew, a post which he occupied no less successfully for seventeen years. On the present occasion, however, we think not merely of his many services to the welfare of science but also of his personality that has gained for him both the esteem and the affection of his colleagues. It was this personality and his wise council that rendered Sir David so eminently successful during his presidency of the Linnean Society and of the Imperial Botanical Congress, and caused him to be in so great demand as a chairman. That his kindly charm and valued advice may be long spared to us will be the wish of all his colleagues.

Prof. R. M. Gordon

PROF. R. M. GORDON, professor of tropical diseases of Africa in the University of Liverpool, has been awarded the Chalmers Medal of the Royal Society of Tropical Medicine and Hygiene, which is given annually for research of outstanding merit in tropical medicine or hygiene. It is one of the conditions of the award that the recipient should be less than forty-five years of age. Prof. Gordon's first experience of medical research in the tropics was in Brazil, where he worked for several years on the Amazon, in the laboratory at Manaos directed by the late Dr. Wolferstan Thomas. After this, he was transferred to the staff of the Sir Alfred Jones research laboratory in Sierra Leone, West Africa, where he has since remained. In 1929 he became director of that laboratory, and in 1930 the University of Liverpool elected him to the chair of tropical diseases of Africa. Prof. Gordon has not been in the fortunate position of being able to select a subject and settle down for a long period of years of quiet research, in a specially equipped laboratory, aided by well-trained laboratory assistants, and free from administrative and financial worries. On the contrary, he has at all times had to carry out many routine duties and has had distracting difficulties and responsibilities with which to contend. When it is remembered also that the whole of his research has been conducted in the trying climate of the worst parts of the tropics, it is a great testimony to his initiative and perseverance that he has succeeded in maintaining a standard of work which compares so well with that of colleagues working in much more favourable circumstances.

DR. GORDON'S first publication was from South America, in the year 1921, and dealt with an experimental investigation into the feeding habits of *Stegomyia calopus*. In 1922 he published a record of the ancylostomes collected at sixty-seven autopsies; it was this early interest in the subject which led soon after to the publication from Sierra Leone in 1925 of a very important paper "On the effect of *Ancylostome*, *Ascaris* and *Trichuris* infection on the health of the West African natives". In bilharziasis, which constitutes a serious menace in large areas of Sierra Leone, as in many other parts of the tropics and sub-tropics, he has made notable advances by the discovery of a focus of *Bilharzia mansoni* infection, and by a very complete experimental study of the mode of transmission, and of the much debated question of the anatomy of the cercariæ. His contribution to the study of malaria in many of its aspects, especially as it affects pregnant women in endemic areas, and to the subject of metazoan immunity, assume the greater value the more research on these subjects advances. His latest paper records the discovery of typhus fever in West Africa, a discovery which is clearly destined to have far-reaching results. His investigations into the distribution and bionomics of anopheline mosquitoes in the Freetown area, carried on steadily now for many years, have yielded and will yield valuable data applicable to similar regions throughout the tropics.

General Hertzog and the South African Protectorates

GENERAL HERTZOG, Prime Minister of the Union of South Africa, on his return to South Africa from attending the recent Imperial Conference in London, once more raised publicly the question of the transfer of the administration of the native Protectorates in South Africa from the Imperial Government to the Government of the Union. According to a message, which appeared in *The Times* of July 7, he alleged that the British Government has failed to carry out pledges of early transfer, which were not only conveyed to him personally by the responsible minister on several occasions, but also were embodied in the agreement which formed the substance of the *aide-mémoire* framed and made public in 1935. He went on to assert that instructions issued by the British Government to its administrative officials in the Protectorates have failed to carry out an undertaking to direct those officials to bring their influence to bear on the natives in such a manner as to induce in them an attitude favourable to the transfer to the Union.

MR. MALCOLM MACDONALD, Secretary of State for Dominion Affairs, lost no time in his reply to General Hertzog's criticisms. In a statement to the House of Commons on July 9, he made it clear that not only was there no agreement that transfer would take place within a specified time, but also that when General Hertzog had urged upon him in a personal interview that transfer should begin in the near future, he had pointed out in his reply that the situation described in the *aide-mémoire* had not greatly altered. Further, he went on to indicate that General Hertzog has been kept fully advised of developments in the matter of the Protectorates, not least of the terms of the instructions issued to officials, in which he has fully concurred. Not only did Mr. MacDonald's action meet with the full approval of the House, but also his further reiteration of the pledge that no action in the matter of transfer would be taken without previous consultation of the inhabitants of the Protectorates received its full endorsement.

Grassland Management in Great Britain

IN his presidential address delivered on July 14 to the Fourth International Grassland Congress held at Aberystwyth, Prof. R. G. Stapledon gave an interesting summary of his views concerning the approach to grassland problems in general and also in relation to the special circumstances of grassland management in Great Britain. The most hopeful line of attack on the general problem, Prof. Stapledon believes, is by employment of the regional survey method, as developed by the Aberystwyth workers in their treatment of the grasslands of Wales. The procedure is to map, classify and plan on the basis of natural regions; adapting to each the correct type of implements, fertilizers and especially the correct strains of seeds. The breeding of herbage plants should be carried out in the area for which they are intended, and interchange of genes between different countries is more likely to be fruitful than interchange of seeds. Of the many factors concerned in the making of useful grassland, the animal is by far the most important; next comes the leguminous plant. Improvement in many instances consists in setting up such soil conditions that a suitable legume will grow, and then adopting a system of management to favour the legume as well as the grazing animal. Then follows the possibility of growing superior herbage plants that had never succeeded before in that area.

TURNING now to some of the special problems of grassland farming in Great Britain, Prof. Stapledon made a strong case for the use of the plough on grassland wherever possible. The method should be to graze hard before breaking up with the view of laying up a store of organic manure or 'stock nitrogen' in the soil. After ploughing a dressing of lime is given, and the accumulated fertility is then in shape to be cashed in the form of some arable crop or immediately put back into still better pasture. Another point of the greatest importance is the production of out-of-season keep. Much has been done lately to conserve summer grass in dried form for winter feeding, but some progress has been made in growing good quality fresh grass for use between December and March. It is a case of species and management. Choosing winter green strains of plants, the grass is heavily manured through the growing stock, further assisted by a little mineral nitrogen, and rested from the end of summer onwards. Working in this way, the Aberystwyth workers have secured on occasions as much as 1½ tons of dry matter per acre with 14–20 per cent of crude protein between Christmas and the end of March. Here again young leys offer more possibilities than permanent pasture.

Archæological Excavations at Tell Duweir, 1936–37

AN exhibition of antiquities from Tell Duweir, the ancient Lachish, in Palestine, opened at the Wellcome Research Institution, Euston Road, London, N.W.1, on July 12. These antiquities, with an extensive series of photographs of the site and of the work of excavation in progress, represent the results obtained by the Wellcome-Marston Archæological Research Expedition to the Near East in the season 1936–37. The excavations were again under the direction of Mr. J. L. Starkey. The operations of the season were directed mainly to the investigation of three areas—the north-east corner of the mound on ground rising from the valley to the level of the moat of the Hyksos period; the great rock-cut excavation of shaft discovered in 1935, now ascertained to measure eighty-five feet long by seventy feet broad, with a depth of ninety feet; and the area lying behind the south-west gate, with the rising ground to the east reaching up to the walls of the Jewish palace. In the last-named area, water-borne deposits on the ancient roadway as it descends sharply on approaching the threshold of the inner gate, which had been due to the blocking of the

drainage by the fall of the gateway before assault and conflagration, afforded the first tangible archæological evidence differentiating the two Babylonian attacks of 597 B.C. and 588 B.C., hitherto not clearly to be distinguished. Tunnels cut in the contents of the great shaft—water-borne deposits, overlying the stones of the collapsed walls of the Jewish city—have as yet afforded no evidence of exits or means of access, nor can the purpose of the shaft yet be determined. Work on this rock-cut shaft, it can be seen, was still incomplete, when it was abandoned, possibly as a result of frontier troubles before the fall of the Jewish kingdom.

A NOTEWORTHY feature among the exhibits is the collection of scarabs, which with the character of the amulets found at Tell Duweir in Sixth and Seventh Century tomb-groups illustrate the persistent influence of Egyptian beliefs and ways of thought among the peoples of southern Palestine. In one of the numerous rock tombs of the north-east corner of the Tell nearly two hundred scarabs of the Eighteenth and Nineteenth Dynasties were found. A continuous series of scarabs with the Royal name now covers the whole period of Egyptian occupation, with the exception of a gap of some fifteen years under Akhenaten and Tutankhamen. One of the most interesting objects in the exhibition, however, is a copper dagger, found in the excavations of 1934, but recently cleaned by the Palestine Museum of Antiquities and on loan by the Palestine Government. It belongs to the Hykos period and is certainly not later than 1600 B.C. Its interest lies in the fact that it is now seen to bear on one side characters in a pictographic script, affording proof of the development of a script independently of both Egypt and Mesopotamia. With the evidence of these pictographs of the now famous inscribed ewers and of the no less remarkable Lachish letters of the pre-exilic period, of which a detailed study by Dr. Harry Torczyner is now in the press, it is now possible to piece together something of the history of the development of writing in Palestine. The exhibition will remain open until August 7, a cinematograph film of the work of the expedition being shown twice daily; and on July 16 at 5.30, and July 28 at 6 p.m. lectures on the new discoveries will be delivered by Mr. Starkey at the Wellcome Research Institution.

Gold Mining with the Aid of Aeroplanes

MESSRS FRASER AND CHALMERS, of Erith, Kent, have recently equipped a gold mine at Progresso in Peru, which is at a height of 12,800 feet above sea-level in an almost inaccessible district about ninety miles south-west of the city of Cuzco. A description of this mine and of some of the difficulties that had to be overcome in transporting the whole of the mine equipment, weighing 150 tons, and the buildings, weighing about 1,000 tons, to the site of the mine is given in the *G.E.C. Journal* (General Electric Co.) for May by W. Bullock. A railway line runs to within about seventy miles of the mine; the connexion between them is a mountain track, which can only be traversed by mules and llamas, and the journey takes fourteen days to complete. As the track over the mountains is often merely a narrow ledge on the side of a steep hill, it is impossible to carry by animals pieces of machinery or equipment more than 10 feet long. Sectionalizing the plant to this extent rendered this mode of transport impracticable. The engineers therefore chartered and equipped two aeroplanes, each capable of carrying a load of two tons. In this way it was found possible to transport reasonable loads by air. The actual time taken by air was about one hour and that taken by a llama was 14 days. The cost of the latter method, if it had been practicable, would have been one third the cost of transport by air. The ore, after being mined, is reduced in a 'breaker' and brought into the mill on a belt conveyor. It is crushed to pieces of about 2 in. cube size and distributed into a 450-ton crushed ore bin situated behind the stamp mill, which is provided with 24 stamps each having a falling weight of 2,100 lb.

Pollution of Sea and Shore by Oil

FOR several years, persistent complaints have been made about the damage caused to organisms upon the sea-shore and particularly to birds which frequent the surface by oil discharged from ships. The number of birds whose feathers become so coated with the discharge that they are unable to fly or to dive for food, and in consequence die a slow death from starvation, has been reported to be very great in some years and in some places. From preliminary investigations into the whole subject of oil pollution at sea, Prof. N. K. Adam has written a report, submitted to the Council of the Royal Society, and printed for private circulation, the general effect of which is to allay some of the fears aroused by the earlier records and surmises. In the seas about the British Isles, the principal sources of oil are wrecks, fuel oil accidentally discharged, usually from ballast tanks, and sludge from the cleaning of oil tanks on tankers or oil-burning ships. But the nuisance due to the oil appears to have diminished in recent years, owing partly to the regulations which now prohibit the discharge of oil or oily water near the coast, and partly to the increased use of separators on board ships. A reassuring statement is that fuel oil entirely loses its tendency to spread after a few weeks at ordinary temperatures on a water surface in contact with gravel. On the surface of the sea also it seems to disappear, for it is rare to see an oily film, and it has been found that no appreciable amount is present as an invisible film.

As regards damage caused by oil to marine plant and animal life, the evidence is inadequate and often contradictory. Prof. Adam's impression is that the moderate amount of pollution round our coasts appears to be doing little damage to life, other than birds, either between tide-marks or below low tide level; and that in other places, if there is very heavy and continuous oil pollution, life between tide-marks is seriously affected, but there is not much

evidence of damage below low tide. The impression of the present writer, however, for what it is worth, is that in a limited area where pollution may be high, animals not exposed between tide-marks suffer and may be exterminated, and the supposition was that even if adult sessile forms may be able to withstand pollution, the delicate free-swimming ciliated larvæ, by which most sessile forms propagate, succumbed, and multiplication accordingly ceased. But that and several other matters referred to in the report await the test of experiment.

Economic Value of an Experiment in Transplanting

FOR some seventy years before 1917, the State of Pennsylvania possessed no beavers, and in that year two, imported from Wisconsin, were set free. Between 1917 and 1924, 94 beavers were imported and liberated at a cost of about 50 dollars each. So rapidly did the creatures multiply that it soon became necessary to transfer some to other parts of the State. A survey by the Board of Game Commissioners gives an idea of what the increase meant: in 1931 there were 899 beaver dams with an estimated population of 4,377; in 1934, the population had risen to 15,000. During the trapping season of 1934 the number of beavers taken was 6,455, and the pelts brought the trappers a sum total of 22,610 dollars. Wherever beavers are doing damage, as in farming communities or in irrigation areas, the policy of the U.S. Bureau of Biological Survey has been to encourage and aid in the transference of the animals to carefully selected sites where their dam building may aid in the cause of conservation. To further this policy, the Bureau has published a *Farmers Bulletin* (No. 1768) on "Trapping and Transplanting Live Beavers", in which live-beaver traps are described and trapping methods and transport are discussed for the help of farmers, stockmen, foresters and others interested in beaver control.

An Air-Conditioning Unit

AN air-conditioning unit is usually a small cabinet, the only external evidence of its purpose being two small grilles. In *Engineering* of July 9, a description is given of one meant to stand on the room floor and placed near a window as the air inlet can then be readily arranged. It is about 40 in. high, 30 in. wide and 18 in. deep. It is electrically operated, and the supply cable can be plugged into any existing power point such as one used for a radio cabinet. With the air-cooled type this is all that is required, but with the water-cooled type connexions are needed with the water supply. In both summer and winter, the incoming air is first filtered; the inlet is a permanent fixture and does not interfere with opening the window for cleaning. Otherwise the window is kept closed to keep out the noise of street traffic. The fan is driven by a motor independent of the fans used for cooling and so can provide ventilation without either heating or cooling, if the outside air is in the desired condition. The cooling of the air and the removal of excess moisture by condensation is effected by a special refrigerator. The condensate is then re-evaporated and carried outside, so no drain-pipe is required in the air-cooled unit. For increasing the moisture in the air, the water in the humidifier tank is vaporized by an electric immersion heater. The relative humidity is settled by a hygrostat which automatically controls the heater. A small neon light indicates when the heating elements are working, and reminds the occupant to consider whether it is advisable to turn off the heat at night when leaving the conditioning plant running.

Atmospheric Pollution

THE twenty-second report on atmospheric pollution contains an account of observations for the year ending March 31, 1936 (London: H.M. Stationery Office, 1937. 6*s*. net). Reviewing the last twenty years, it is concluded that the effort and propaganda of the period have brought about an appreciable reduction in air contamination. This now seems to have ceased, or even changed to a slight rise, probably on account of the increased industrial activity. Again the figures for some London stations are very high, especially for sulphur. Westminster shows some of the highest figures, and compares very unfavourably with some of the industrial areas. In some cases, remarkable improvements have been rendered over a period of years, and the causes deserve scrutiny. The report is cautious in its interpretation, as the difficulty of sampling is obvious. At Burnley a fifty per cent fall has been recorded in ten years—attributed to the removal of a factory. Attention is directed to the high drop at Wakefield in total deposit, from 613 tons per square mile in 1924 to 227 tons in 1935. This may be associated with the persistent efforts made by the authorities there, and shows what is possible when those who wield political power treat seriously the problem of cleaner air. Unfortunately, it is only too rare that in local authorities the will and wish to improve the atmosphere are combined. The most important development recorded is the initiation of an intensive survey in and around Leicester—selected because it is relatively isolated from other industrial areas likely to prove disturbing factors.

Empire Conference on Tuberculosis

THE Minister of Health, Sir Kingsley Wood, delivered the inaugural address on May 3 at the Empire Conference on the "Care and After-care of the Tuberculous" at Overseas House, St. James's, London. He first reviewed tuberculosis as a cause of mortality in England and Wales. The standardized death-rate from this disease has fallen from 3,638 per million of population in 1851–55 to 687 in 1935; nevertheless, tuberculosis in this country still comes next to cancer in the list of killing diseases. Sir Kingsley next dealt with the public provision for the treatment of tuberculosis—29,000 beds in approved institutions—and the amount of expenditure thereon. He commended particularly the value of village settlements for treatment and after-care, and emphasized the importance of the after-care of patients who did not enter a village settlement.

Tuberculosis (Attested Herds) Scheme

THE Minister of Agriculture and Fisheries has amended the Tuberculosis (Attested Herds) Scheme (England and Wales) dated January, 1935, by the issue of a revised scheme, which came into force on June 1. The purpose of the new scheme, which adheres to the principles of the earlier one, is to encourage the addition of herds to the register of herds officially certified to be tuberculosis-free, by the offer of additional financial inducements to owners of cattle herds to qualify for a certificate of attestation. Further information in regard to the scheme may be obtained from the Secretary of the Ministry, Whitehall Place, London, S.W.1.

International Population Congress at Paris

UNDER the patronage of the International Union for the Scientific Investigation of Population Problems, a congress will be held in Paris for the discussion of these problems on July 29–August 1. The congress is organized by the French National Committee of the Union, under the presidency of M. Adolphe Landry, a former Cabinet Minister. Among the members of the organizing committee may be mentioned, MM. P. Rivet, J. Alquier, H. Bunle, A. Demangeon, M. Huber, R. Legendre, A. Siegfried and other distinguished workers in the field of demography. It is expected that there will be many representative delegations from a large number of countries. From Great Britain there will be members of the British Population Society, presided over by Prof. C. B. Fawcett, and of the Population Investigation Committee, presided over by Prof. A. M. Carr-Saunders, and others. America will send Prof. P. K. Whelpton, Dr. Warren S. Thompson and others. Delegations are also expected from Belgium, Czechoslovakia, Denmark, Germany, Holland, Hungary, Italy, Rumania, Sweden, and perhaps India and Japan.

THE subject-matter of the congress is divided into two main groups: quantitative problems, namely, historical demography, contemporary demography, including existing statistics, movements and international migrations, mortality, fertility and so on, and the resulting economic and social problems; and qualitative problems, namely, biometry, ethnology, transmission of characters, eugenics. Two questions are specially put forward for discussion, namely, (1) "De la meilleure méthode pour dégager et mesurer la tendance du mouvement naturel de la population"; and, (2) "La biométrie différentielle et la biotypologie, comme méthodes pour la classification des individus et des groupes". It is clear that the congress has plenty of work before it. It has been announced that the opening session will be honoured by the presence of the President of the French Republic, M. Albert Lebrun, and will take place at the Maison de la Chimie, 28 rue Saint-Dominique. All inquiries should be addressed to the Congrès International de la Population, 16 rue de l'Estrapade, Paris, V.

Leverhulme Research Fellowships

AMONG the list of Leverhulme Research Fellowships and Grants for 1937 are the following, who will carry out their researches at the places indicated:

RESEARCH FELLOWSHIPS: Prof. D. H. Bangham, professor of inorganic chemistry, Egyptian University, Cairo, the wetting of solid surfaces and the phenomena of spreading liquids thereon (Great Britain); Dr. D. Enid Charles, research fellow, Department of Social Biology, London, the mechanism of population decline with special reference to Scottish population problems (University of Aberdeen); Dr. C. W. Davies, senior lecturer in chemistry, Battersea Polytechnic, adsorption at liquid surfaces (University College, London); O. V. S. Heath, research worker, Institute of Plant Physiology, London, carbon assimilation by the green plant (Imperial College, London); Dr. J. de Graaff Hunter, late director, Survey of India, planning and execution of geodetic triangulation of great extent (renewal of present fellowship) (England); G. W. B. Huntingford, farmer, Kenya Colony, member, Nandi Land Trust Board, Government examiner in Nandi language, sociology of the Dorobo, a forest people of Kenya (Kenya); Dr. J. W. H. Lugg, biochemist, Imperial College, London, preparation and amino acid analysis of pasture plant proteins (Imperial College, London); J. P. M. Prentice, solicitor, meteors and meteor streams (England and North Africa); Dr. H. Scott, assistant keeper, Department of Entomology, British Museum, biogeographical research on the fauna of the highlands of South Western Arabia (Arabia); G. Seligman, chairman, British Group, International Commission of Snow, the transition of firn snow into glacier ice (Switzerland); Dr. H. W. Thompson, departmental demonstrator, Old Chemistry Department, University Museum, Oxford, correlation of data derivable from the spectra of polyatomic molecules with chemical problems (Pasadena).

RESEARCH GRANTS: Dr. D. Elliot Dickson, colliery surgeon, Lochgelly, Fife, occupational morbidity in coal miners (Scotland); Dr. E. M. Lind Hendricks, research worker, Imperial College, London, geological research in Cornwall (Cornwall); G. Manley, senior lecturer in geography, University of Durham, the helm wind of the Northern Pennines (England); Dr. R. E. Mortimer Wheeler, keeper, London Museum, origins in northern France of later prehistoric civilizations of Britain (France); Dr. M. Wilson, reader in botany, University of Edinburgh, a comparative study of the diseases of the Douglas fir in Europe and North America (Canada).

Beit Memorial Fellowships

THE following elections have been made by the trustees of the Beit Memorial Fellowships for Medical Research:

FOURTH YEAR FELLOWSHIPS (value £500 a year): Dr. R. P. Cook, to continue his research on cholesterol metabolism in reference to the cause of atheroma in blood vessels (at the Institute of Biochemistry, Cambridge); S. L. Cowan, to continue his research on the neuro-muscular transmission of nervous

excitation (at the Department of Pharmacology, University College, London); Dr. D. E. Green, to continue his studies on intracellular enzymes and on the influence of vitamin B on oxidation processes (at the Institute of Biochemistry, Cambridge); Dr. M. Jowett, to continue his study of the action of narcotic drugs on the metabolism of the central nervous system (at the Biochemical Laboratory, Cardiff City Mental Hospital).

JUNIOR FELLOWSHIPS (normal value £400 a year): I. A. Anderson, for research on iron analyses of diets of women of the poorer classes at Aberdeen, and studies on the treatment of anæmia (at the Metabolic Research Laboratory, Aberdeen Royal Infirmary); Dr. D. Beall, for work on sterol metabolism, with special reference to sex hormones (at the Department of Pathology, British Postgraduate Medical School, London); J. G. Chalmers, for work on the role of polycyclic hydrocarbons in experimental tumour production (at the Glasgow Royal Cancer Hospital); Dr. F. C. Courtice, to study the influence of insulin and endocrine secretions on the metabolism of prolonged muscular exercise (at the Physiology Laboratory, Oxford); H. Davson, to study the cause of primary chronic glaucoma of the eye) at the Department of Physiology and Biochemistry, University College, London; Dr. T. R. R. Mann, for research on intracellular compounds of blood pigment and the metabolism of oxalic acid in mammalian tissue (at the Molteno Institute, Cambridge); Dr. Antoinette Pirie, to study the metabolism of filterable organisms by analysis of their enzyme systems (at the Institute of Biochemistry, Cambridge); Dr. D. Richter, for work on the action of adrenaline and related substances on the metabolism of individual organs (at the Institute of Biochemistry, Cambridge).

Travelling Fellowships in Tuberculosis

THE Medical Research Council has awarded Dorothy Temple Cross research fellowships to the following, who intend to study problems of tuberculosis at centres abroad, during the academic year 1937–38: Dr. B. C. Thompson, formerly assistant tuberculosis officer, Durham County Council (renewal of present fellowship for three months); R. H. R. Belsey, resident surgical officer, Hospital for Consumption and Diseases of the Chest, Brompton, London; Dr. B. M. Maxwell, senior assistant medical officer, Cheshire Joint Sanatorium, Market Drayton; O. S. Tubbs, chief assistant to a Surgical Unit, St. Bartholomew's Hospital, London; Dr. Enid M. Williams, assistant lecturer in tuberculosis, Welsh National School of Medicine, Cardiff.

British Empire Cancer Campaign

THE quarterly meeting of the Grand Council of the British Empire Cancer Campaign was held on July 12. On the recommendation of the Scientific Advisory Committee, the following grants were approved: £500 to Dr. P. M. F. Bishop, at Guy's Hospital, for the expenses for one year of certain investigations in regard to endocrine therapy in relation to cancer; £250 to Prof. G. I. Finch, at the Imperial College of Science and Technology, for the expenses of an investigation, on behalf of the Scientific Advisory Committee, into the nature and structure of carcinogenic compounds; and £160 to Dr. P. R. Peacock, at the Glasgow Royal Cancer Hospital, for the purchase of special apparatus for the continuation of his cancer research. On the recommendation of the Joint Committee of the Campaign and of Mount Vernon Hospital, Dr. G. Cranston Fairchild was reappointed the William Morris research fellow in radiology at that Hospital for a further period of one year. The William Morris research fellowship was established five years ago by a generous donation of a capital sum of £25,000 by Lord Nuffield.

Occultations of Mars and Venus

IF the evening sky is clear on July 17, an interesting observation can be made without a telescope (though, preferably, slight optical aid is desirable) of the occultation of the planet Mars by the moon. The disappearance of Mars, as seen from a station near Greenwich, takes place at the moon's dark limb (the age of the moon being 9·7 days) at position angle 53° from the north point of the disk, measured eastwards, at $21^h\ 13^m$ U.T. ($22^h\ 13^m$ Summer Time). The reappearance of Mars at the moon's bright limb is at position angle 326° at $22^h\ 10^m$ U.T. or $23^h\ 10^m$ Summer Time. The apparent diameter of Mars is about 14″ and its stellar magnitude − 0·8. A map in the B.A.A. Handbook for 1937 gives the limits on the earth's surface of the visibility of this occultation. The occultation of Venus by the moon on August 3 takes place in full daylight and cannot, in any event, be seen from southern England. The southern limit of visibility of partial occultation, as given in *J. Brit. Ast. Assoc.*, March, p. 187, runs approximately between Hull, Bradford and a little north of Blackpool; the southern limit of total occultation runs from just south of Bridlington, to Borough Bridge and just north of Carnforth. At Edinburgh, the disappearance of Venus is due at $8^h\ 26^m$ U.T. at position angle 159° from the north point of the moon's disk, and the reappearance at position angle 212° at $9^h\ 1^m$ (add 1^h to convert to Summer Time). The phenomenon will require telescopic aid generally, though Venus can on occasions be 'picked up' in daylight by keen-sighted observers. The moon's age is 26·2 days, so that the crescent is a very narrow one. Venus is in its gibbous phase, the ratio of the illuminated area of the disk to that of the entire apparent disk (17″ in diameter) being 0·67. Its stellar magnitude is − 3·6. The position of Venus on August 3 at 9^h is R.A. $5^h\ 53^m{\cdot}0$; Dec. + 21° 20′.

A New Comet (1937 f)

A NEW comet was discovered on July 4 not far from the star, β Persei (Algol), by Mr. Finsler at Zurich. At discovery, the comet was diffuse without a central condensation of nucleus, but two days later, according to an observation made at Barcelona, a nucleus was observed as well as a short tail somewhat more than 1° in length. The *International*

Astronomical Union Circular No. 664 from Copenhagen gives elements of the comet derived from observations made at several observatories from July 4 to July 7. Independent elements of the comet's orbit are derived by Möller (Copenhagen), Kwiek (Poznań) and Cunningham (Harvard). These elements give the time of perihelion passage, respectively, as August 12·435, 11·139 and 14·52 U.T. The ephemeris derived from Möller's elements gives the position of the comet at 0^h U.T. on July 14, 18 and 22 as follows :

	R.A.	N Decl.
July 14	3^h 17·5^m	45° 43′
18	3^h 25·6^m	49° 59′
22	3^h 39·1^m	55° 31′

Dr. Steavenson has already observed this comet, which promises to be an interesting object. Its present magnitude is 7, but the decrease in its present heliocentric and geocentric distances, 1·05 and 1·25 units respectively, will probably cause a considerable increase in brightness.

Announcements

THE first award of the Johannes Schmidt Medal has been made to Mr. Henry G. Maurice, fisheries secretary of the Ministry of Agriculture and Fisheries, and president of the International Council for the Exploration of the Sea, in recognition of his great services to international oceanographical and fisheries research. Most appropriately the presentation, by H.R.H. Prince Waldemar of Denmark, was made in the new offices of the Council in Charlottenlund Slot, on the occasion of the thirteenth annual meeting of the Council, which was held on July 5–10.

IN connexion with the centenary celebrations of the University of Athens (see NATURE, May 1, p. 749), the honorary degree of doctor of science was conferred upon Sir Napier Shaw, formerly director of the Meteorological Office and honorary president of the Commission for the Exploration of the Upper Air.

THE following officers have been elected to the Council for the year 1937–38 of the Institution of Electrical Engineers : *President*, Sir George Lee ; *Vice-Presidents*, Sir Noel Ashbridge, Mr. J. R. Beard ; *Hon. Treasurer*, Mr. W. McClelland.

THE following, among others, were granted Civil List pensions during the year ended March 31, 1937 : Mrs. Jessie Bennett, in recognition of the services rendered by her husband, the late Mr. Arthur Bennett, to botanical science (£60) ; Dr. Maurice Copisarow, in recognition of his services to science, and in particular to chemical research (£130) ; Mrs. Elizabeth MacKenzie, in recognition of the services rendered by her husband, the late Mr. Donald MacKenzie, to the study of anthropology, mythology and folk-lore (£70).

THE following appointments have recently been made in the Colonial Service : R. A. Wright, veterinary officer, Malaya ; R. J. A. W. Lever (entomologist, British Solomon Islands Protectorate), entomologist, Fiji ; C. Swabey (assistant conservator of forests, Trinidad), forestry officer, Jamaica ; K. J. Johnston (superintendent of surveys), assistant surveyor general, Ceylon ; A. V. Lawes (surveyor, Tanganyika), surveyor, Gold Coast ; H. M. W. Nicholson (assistant pharmacist), pharmacist, medical department, Tanganyika ; H. F. Rainsford (staff surveyor, Tanganyika), computer, survey department, Uganda ; W. F. Wegener (assistant chief mechanical engineer), chief mechanical engineer, Federated Malay States Railways ; W. W. Williams (assistant superintendent), superintendent of surveys, Ceylon ; L. G. O. Woodhouse (assistant surveyor general), deputy surveyor general, Ceylon.

PROF. PAUL MONTEL, professor of the theory of functions and theory of variability at the Sorbonne, has been elected a member of the Section of Geometry of the Paris Academy of Sciences, in succession to the late Prof. E. Goursat.

M. LÉON GUILLET, director of the École Centrale des Arts et Manufactures, and professor at the Conservatoire des Arts et Métiers, Paris, has been nominated an honorary vice-president of the Iron and Steel Institute.

PROFS. JULES BORDET, director of the Pasteur Institute of Brussels, and Pierre Nolf, president of the Red Cross, have been awarded the Grand Cross of the Order of Leopold.

DR. RUFUS COLE, director of the Hospital of the Rockefeller Institute for Medical Research since 1909, has retired. His successor is Dr. Thomas Milton Rivers, who has been a member of the board of scientific directors of the International Health Division of the Rockefeller Foundation since 1927.

THE Paul Appel Prize and Gold Medal of the Renaissance française, for the best contribution in recent years to the campaign against social scourges, has been awarded to the French League against Cancer for the "Index Analyticus Cancerologicus", commenced eleven years ago under the scientific direction of MM. Forgue, de Nobile, Hartmann, Rogard and Roussy. The recipients of the prize are MM. Lacassagne and Lavedan, general secretaries of the League.

A "Catalogue of Books and Journals on Zoology, Biology and Geology" (No. 507) for sale by W. Heffer and Sons, Ltd., Cambridge, contains 1,886 items. General works and scientific journals are well represented, as also are the groups dealing with entomology, ornithology and geology.

IN connexion with the notes on national and international standardization in NATURE of July 3, p. 19, we are asked to state the Survey to which they refer can be obtained from the Central Office of the World Power Conference, 36 Kingsway, London, W.C.2, price 3*s*. 6*d*., or 3*s*. 8*d*. post paid ; copies may also be ordered through any bookseller.

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 114.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Production of Positron and Electron Pairs by Bombardment of Mercury with β-Particles of Low Energy

SKOBELZYN and Stepanowa[1] have reported the production of positrons when β-particles of energy 1–3 MV. impinge on solid lead. In order to conserve electric charge, the phenomenon must have involved the production of a pair of positive and negative electrons. Examination of about a thousand photographs of the tracks of β-particles from radium E in a mixture of 5 per cent mercury dimethyl vapour and 95 per cent nitrogen, in a Wilson chamber, has rather surprisingly yielded two definite cases of the production of pairs of positrons and electrons by β-particles of energy just greater than 1 MV. It is quite clear that phenomena of this kind would be very difficult to detect unless the bombarded element was in gaseous form. Measurement of the best pair gave the following result, where E_β is the kinetic energy of the incident β-particle:

	MV.				
E_β	E_+	E_-	ψ_+	θ_-	$(\psi_+ + \theta_-)$
1·10	~0·15	0·013	48°	77°	125°

The energy of the electron was determined from its range, that of the positron from its radius of curvature. The latter could not be determined with great accuracy owing to the shortness of the illuminated portion of the track, but energy appears to be approximately conserved. The absence of a second negative electron track at the point of creation of the pair is of considerable interest. Its energy, after escape from the nucleus, may have been less than 2,000 volts, rendering the track of the particle undetectable; but the possibility of absorption by the nucleus must not be left out of account.

The total length of track of β-particles between 1 MV. and 1·3 MV. was about 40 metres and the effective cross-section of the mercury nucleus would accordingly be about 10^{-22} cm.^{2}. Statistical fluctuations would prevent any great reliance being placed upon this figure, but it is in approximate agreement with that deduced by Skobelzyn and Stepanowa. Previous results[2] have shown that not one pair is produced in 200 metres of similar track in nitrogen. It would therefore appear that the probability of pair production by β-particles of low energy (*a*) increases rapidly with the atomic number, (*b*) is large in the region $E_\beta \sim 2mc^2$. Unfortunately, there does not seem to be as yet any theoretical treatment of the production of pairs by a β-particle which has itself a kinetic energy just greater than $2mc^2$.

It is plausible that there may be also an 'internal production' of pairs by the nuclear β-particles. Possibly a part of the γ-radiation from radium E, found by G. H. Aston[3], may arise from the annihilation of the positrons formed by the internal conversion of the β-rays of energy greater than $2mc^2$. If this effect is at all appreciable, it will have to be taken into account in interpreting experimental data on the energy distribution in continuous β-ray spectra, since it would lead to a preferential weakening above 1 MV. and a corresponding increase in the region of low energies.

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June 14.

[1] *J. de Phys. et le Radium*, **6**, 1 (1935).
[2] Champion, *Roy. Soc. Proc.*, A, **153**, 353 (1936).
[3] *Camb. Phil. Soc. Proc.*, **23**, 935 (1927).

Porphyrins of the I and III Series in Congenital Porphyrinuria

As the result of a detailed chemical examination carried out *post mortem* upon a bovine suffering from congenital porphyrinuria[1], and my paper appearing in the *Onderstepoort Journal of Veterinary Science* (vol. 7, No. 2), I have been able to isolate porphyrins similar to those found by Fischer[2] and his collaborators in the human porphyrinuric 'Petry', but in addition have also obtained coproporphyrin, ester m.p. 243–44°, from the *blood plasma* and of m.p. 241° from the washed *erythrocytes*; both uroporphyrin, ester m.p. 276–77°, and coproporphyrin, ester m.p. 244–45°, from the *bone marrow*; uroporphyrin, ester m.p. 278°, from the *spleen* and uroporphyrin together with its copper complex, ester m.p. 313°, from the *liver*.

The isolation of coproporphyrin I from the blood is important as supplying a basis of explanation for the photosensitivity exhibited by the animal.

The melting points of the uroporphyrin esters, including those from the bones and urine, approximated to 278°, whilst Fischer reported 293° for pure uroporphyrin I, thus suggesting that a mixture of isomers might be present. This suspicion was enhanced by the isolation from the mother liquors of the crystallization of the bone product of a uroporphyrin ester with m.p. 253–55°. A scheme of chromatographic separation of the I and III series porphyrin isomers has been worked out using a column of alumina and dioxan as the solvent. A note upon the separation of uroporphyrins from urine and bones in these cases into I and III series isomers is attached as an appendix to my publication, already referred to, which is in the press. The bile coproporphyrin (m.p. 237°), after similar treatment melted at 246–48°, whilst a trace of pigment remaining in the column was found also to have a coproporphyrin spectrum; the quantity was insufficient for crystallization.

Whilst this work was in progress, Fischer, in a note appended to a paper by Fischer and Libowitzky[3], claimed that such a separation of uroporphyrin (m.p. 286°) from the Petry case into uroporphyrin I and uroporphyrin III had been effected in his laboratory by a chromatographic technique which was not described. No coproporphyrin specimens were examined. A paper by Fischer and Hofmann[4] has now appeared in which their technique is described, using talcum and chloroform-methyl alcohol.

It would appear highly probable that small quantities of series III pigments accompany those of series I excreted by congenital porphyrinurics. The uroporphyrin of acute idiopathic porphyrinuria has recently been shown to be uroporphyrin III by Waldenström[5] and by Mertens[6] (m.p. 255–58°). Any theory seeking to explain these diseases must now take cognizance of these facts.

The various forms of porphyry are probably brought about by failure of, or interference with, a particular aspect of the hæmoglobin synthetic mechanism, as is suggested in my forthcoming paper. The *site* of interference serves to determine which isomer is excreted in quantities above the normal.

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[1] NATURE, **139**, 68 (1937).
[2] Fischer, Hilmer, Lindner and Putzer, *Z. physiol. Chem.*, **150**, 44 (1925).
[3] Fischer and Libowitzky, *Z. physiol. Chem.*, **241**, 220 (1936).
[4] Fischer and Hofmann, *Z. physiol. Chem.*, **246**. 15 (1937).
[5] Waldenström, *Deut. Archiv. klin. Med.*, **178**, 38 (1935).
[6] Mertens, *Z. physiol. Chem.*, **239**, 1 (1936).

Retention of Radioactive Substances in the Body of Rats and the Lethal Dose

THERAPY by radioactive substances introduced directly into the organism is limited only to a small number of elements, as the use of radioactive salts deposited permanently in the bones proved to be dangerous[1]. For this reason only two elements have been studied, namely, radon and polonium, with regard to their retention in the organism and quick elimination by means of various vehicles. Experiments were carried out with rats, the weight of which varied from 66 gm. to 290 gm. The present communication deals with the results obtained with radon only. A physiological solution, namely, a 10 per cent solution of glucose or emulsion of tungsten in olive oil, is used as vehicle. The rats received an injection of a maximum dose of 1 c.c. of these substances either subcutaneously or intermuscularly. The solutions were activated with radon in such a manner that the activity of one injection was 0·5–14 millicuries. The rate of elimination of radon from the body of the rats was measured electrometrically by the method of gamma rays of the active deposit of radon.

The results were as follows:

(1) In the case of physiological solution and glucose, radon is eliminated from the body of rats at the same rate, irrespective of the method of injection (intermuscular or subcutaneous), in a period of 30 minutes, which coincides with the period of elimination of radon ascertained in drinking and inhalation cures.

(2) In the tungsten emulsion radon is bound more permanently, 67 per cent of the initial dose injected remaining after two hours, whereupon it is eliminated in a period of 100 minutes.

(3) The elimination of radon with each of the vehicles is effected mainly by breathing.

(4) Even a dose of 14 millicuries is not capable of killing, and does not even disturb any of the basic vital functions.

(5) In the case of tungsten emulsion, an approximate calculation of energy of alpha rays absorbed in the organism, which constitute almost entirely the physiological effect of the injected radon, was carried out. The maximum dose of 14 millicuries gives about 17×10^6 ergs of energy absorbed, which, compared with gamma rays, would correspond to irradiation with the quantity of one gram of radium (with soft gamma rays absorbed) attached directly to the body of the animal for a period of about 30 minutes.

(6) In the case of polonium injections, on which a separate report will be made, the lethal dose was reached at an average absorbed energy of about 6×10^6 ergs. This energy was absorbed at a much lower rate than the maximum energy supplied by radon, which proves that the effect of equal doses of radioactive radiation grows with the period of its duration.

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[1] Summarized report: Evans, R. D., *Amer. J. Public Health*, 23, 1017 (1933); Laborde, S., *Presse méd.*, Nr. 95 (1936).

Nature of the Diffusion Process in Rubber

IT is known[1,2], that silica-gas diffusion systems exemplify a type of non-specific activated diffusion process, as opposed to the specific type of diffusion

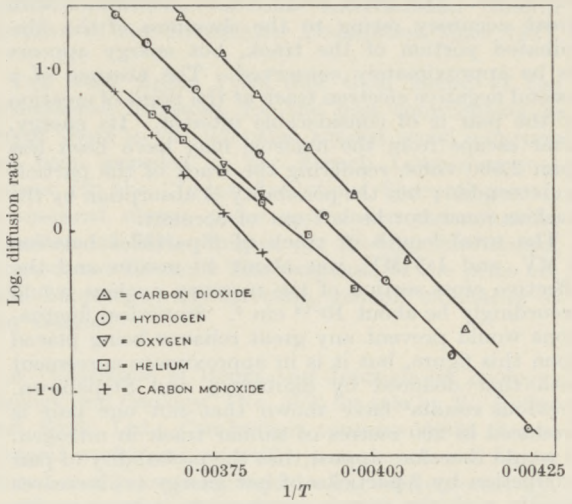

Fig. 1.

DIFFUSION THROUGH PURE PARA-RUBBER (DEWAR'S DATA). DIFFUSION RATE IN C.C./DAY/CM.^{2}/ATMOSPHERE; THICKNESS OF MEMBRANE, APPROXIMATELY 1 MM.; T = ABSOLUTE TEMPERATURE.

system such as hydrogen-palladium. It seemed that the diffusion of gases through other 'glass-like' materials such as some organic membranes, for example, rubber, might offer further examples of

non-specific activated diffusion. The data needed to test this hypothesis were available in papers by Edwards and Pickering[3], and by Dewar[4]. Graham[5] first noted the large temperature coefficient of the diffusion process through rubber, and that the diffusion velocities had no connexion with the molecular weights.

Edwards and Pickering's data for the diffusion of hydrogen, helium and carbon dioxide through vulcanized rubber, and Taylor, Hermann and Kemp's data[6] for the diffusion of water through vulcanized rubber, give good straight lines when log (diffusion rate) is plotted against the reciprocal of the absolute temperature (T), with the exception of the data for carbon dioxide at temperatures of 80° and 100° C. Similarly Dewar's data (Fig. 1) for diffusion of hydrogen, helium, carbon monoxide, carbon dioxide and oxygen through pure para-rubber, give linear log (diffusion rate) *vs* $1/T$ curves. Energies of activation calculated from these curves for vulcanized and for para-rubber are given in the accompany table. They are very much larger for the pure para-rubber than for the vulcanized rubber.

Vulcanized Rubber			Para Rubber		
Gas	Energy (cal./mol.)	Author	Gas	Energy (cal./mol.)	Author
He	6,300	Edwards and Pickering	He	15,400	Dewar
H_2	6,470	,,	H_2	19,000	,,
	5,900	Daynes[7]			
CO_2	7,580	Edwards and Pickering	CO_2	19,100	,,
H_2O	2,780	Taylor, Hermann and Kemp			
			O_2	16,300	,,
			CO	19,000	,,

The solubility of these gases in rubber varies only slightly with temperature[8], so that no explanation save one involving activated diffusion can account for the velocity *increasing* exponentially with temperature.

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[1] Alty, *Phil. Mag.*, **15**. 1035 (1933).
[2] Barrer, *J. Chem. Soc.*, 378 (1934).
[3] Edwards and Pickering, *Sci. Papers. Bureau of Stds.*, **16**, 327 (1920).
[4] Dewar, *Proc. Roy. Inst.*, **21**, 813 (1914-16).
[5] Graham, *Phil. Mag.*, **32**, 401 (1866).
[6] Taylor, Hermann and Kemp, *Ind.-Eng. Chem.*, **28**, 1255 (1936).
[7] Daynes, *Proc. Roy. Soc.*, A, **97**, 286 (1920).
[8] Wroblewski, *Wied. Ann.*, **8**, (1879).

Nitric Oxide and Alkyl Ethers

THE reaction of dimethyl ether and nitric oxide has been investigated in some detail by Dr. P. F. Gay and myself[1], and whatever the mechanism of the secondary reaction which follows the suppression of the main decomposition process may be, it seems to be quite clear that it cannot be the one represented by the equation,

$$NO + CH_3 \rightarrow CO + NH_3,$$

since the ratio, $(CO + CO_2)/CH_4$, in the product is the same as when nitric oxide is absent from the system. What does happen is that the ratio CO_2/CO is greater when nitric oxide is present than when it is absent, and in the presence of nitric oxide the product contains very little free hydrogen. It seems likely, therefore, that the mechanism suggested by Dr. Gay and myself[2] explains the effect of the nitric oxide better than that put forward by Messrs. Thompson and Meissner in NATURE[3] of June 12.

I may point out that nitrous oxide is also certainly a product of the process, and it is interesting to note that ammonia, or an amine, is also formed. However, the significance of this observation will only be arrived at by quantitative study of an exacting character, which will be difficult.

As Dr. Gay and I have pointed out, the interaction of nitric oxide and the ethers is a particular instance of a common phenomenon involving the retardation or suppression of one process and the acceleration or initiation of another. Similar reactions have been studied in this laboratory.

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[1] *J. Faraday Soc.*, **33**, 768 (1937).
[2] NATURE, **138**, 546 (1936).
[3] NATURE, **139**, 1018 (1937).

Structure and Resistance of Thin Metal Films

IT was proposed by Kramer[1] that a film below a certain 'transition temperature' is mainly amorphous, though containing some regions of normal metal, and that at the transition temperature the film is converted completely into the normal crystalline metal. The transition temperature was given by an empirical formula in terms of atomic volume, conductivity, and the number of free electrons per atom (N) in the normal metal. Structural changes have been shown to occur by different investigators[2], and have been discussed by them and others[3]. It has not always been observed that the structural changes occur at a sharply defined critical temperature, and theories alternative to that of Kramer have been proposed.

It does not appear to have been remarked that the resistance-temperature curve shown by Cosslett[4] indicates a transition temperature at about 10° C. for indium. If we take for indium $N = 3$, then Kramer's formula indicates a transition temperature of 282° K., which is in excellent agreement with Cosslett's curve. Kramer takes $N = 3$ for aluminium, which would justify the use of $N = 3$ for indium, although Hume-Rothery prefers $N = 1$ in each case[5]. The transition temperature of 282° K. would not agree with the recent proposal of Fukuroi[6] that the 'recrystallisation' temperature is 0·4 multiplied by the melting point, since the melting point of indium is 428° K., and the zero-thickness transition temperature would be higher than 282° K.

On the other hand, this agreement with Kramer's theory may be fortuitous, since, setting $N = 1$ in his formula, we obtain for rubidium and cæsium transition temperatures of 80° K. and 117° K. respectively. The work of Lovell[7] on rubidium covered the range 64°–90° K., and showed not only no transition point but a resistance-temperature curve with a positive slope, while cæsium[8] showed similarly a positive slope, which would not be expected below the transition temperature.

It seems possible that the existence of a sharp transition temperature may be associated with the desorption of gas from a film originally formed under poor vacuum conditions, or on a substrate not free from gas, owing either to the existence of a critical temperature for gas desorption or to a delay of recrystallization owing to the presence of gas. That gas may be important under high vacuum conditions (10^{-7} mm.) has been shown here in work on the high-frequency resistance of thin molybdenum films deposited on glass. High-frequency resistance is insensitive to large-scale structural changes, for example, to formation of cracks and fissures, and even to the formation of 'windows'[9]. Nevertheless, there is an increase in film resistance with time unless the glass has been thoroughly degassed by prolonged baking.

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[1] Kramer, *Ann. Phys.*, **19**, 37 (1934).
[2] Gen. Zelmanoff and Schalnikoff, *Phys. Z. d. Sowjetunion*, **4**, 825 (1933). Perucca, *Z. Phys.*, **91**, 660 (1934). Suhrmann and Barth, *Z. Phys.*, **103**, 133 (1936). Cosslett, *Proc. Phys. Soc.*, (2), **49**, 121 (1936).
[3] Tamman, *Ann. Phys.*, **22**, 73 (1935). Vand, *Z. Phys.*, **104**, 48 (1936).
[4] Cosslett, *Proc. Phys. Soc.*, (2) **49**, 121 (1936).
[5] Hume-Rothery, "Metallic State", p. 326 (Oxford, 1931).
[6] Fukuroi, NATURE, **139**, 884 (1937).
[7] Lovell, *Proc. Roy. Soc.*, A, **157**, 311 (1936).
[8] Appleyard and Lovell, *Proc. Roy. Soc.*, A, **158**, 718 (1937).
[9] Andrade, *Phil. Trans. Roy. Soc.*, A, 235, 69 (1935).

Principle of the Cartesian Diver applied to Gasometric Technique

IF for some reason or other the quantity of gas in a Cartesian diver decreases or increases, the pressure necessary to bring the diver to a standstill at a fixed level will change correspondingly, that is, the pressure change will be a measure of the change in quantity of gas. If, therefore, within the diver processes take place involving liberation or absorption of gas, the rate of these processes may be estimated quantitatively by measuring at different times the pressures at which the diver is in (unstable) equilibrium at a fixed level.

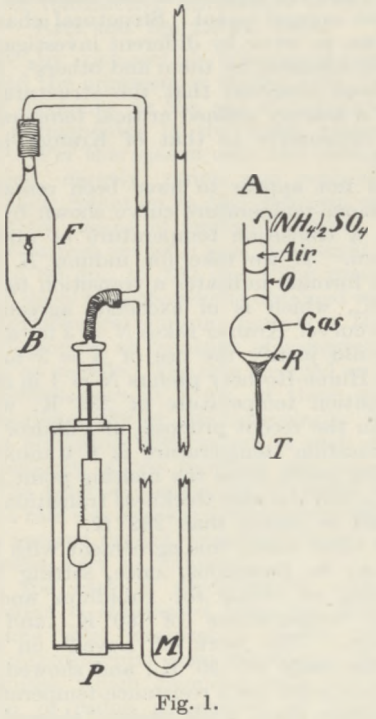

Fig. 1.

Fig. 1 shows how this may be done on an ultra-micro scale. *A* is a diver of the simplest type and with a gas volume of approximately 10 c.mm. In the bottom of the bulb 1 c.mm. of reaction mixture (*R*) is placed, and in the neck there is a small stopper of paraffin oil (*O*). *T* is a glass tail which serves as a weight to maintain the diver in a vertical position and to regulate its equilibrium pressure at a value close to that of the atmosphere. The diver is placed in a vessel *B* filled with saturated ammonium sulphate (to reduce gas exchange to a minimum without increasing viscosity). *B* is submerged in a well-regulated thermostat ($\pm$ 0·02°) and connected with the manometer *M* and pressure adjuster *P*. The latter consists of a syringe the piston of which is moved by means of a rack. The manometer and the syringe are filled with water. By pressing the piston up and down it is possible to bring the diver to a temporary standstill at the mark *F*, and the corresponding pressure observed on the manometer is reproducible within 0·2 cm. water. Since this uncertainty is 0·02 per cent of the total pressure (about 1 atm.), any variation of the quantity of gas within the diver may be measured with an accuracy of $\frac{10 \times 0{\cdot}02}{100}$ c.mm.

Furthermore, the equilibrium pressures of two different divers kept in two different vessels for a period of 24 hours will not change mutually by more than 0·2 cm. water.

The principle has been successfully applied to the study of choline esterase activity using the Warburg technique (change of carbon dioxide tension over bicarbonate buffered reaction mixtures). But it is also applicable to the study of respiration and generally in many cases where gasometric analysis is used.

Details and applications will be described in subsequent papers.

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On Bremsstrahlung

THE method previously used[1] to calculate the cross-section for pair production by a beam of γ-rays has been extended to deal with transitions of a Dirac electron between two states of positive energy in a Coulomb field. It is thus theoretically possible to obtain an exact evaluation of the differential cross-section for energy loss by radiation of an electron incident on an atomic field (neglecting screening, which is justifiable for the energy values used). Actually, owing to difficulties of computation, the calculation is only practicable for fairly slow electrons losing more than half their kinetic energy in the field of a heavy nucleus. This is the case in which the values calculated by the use of Born's approximation[2] may be expected to be least reliable. The numerical work involved in the exact solution is too heavy to

allow a full survey of the low energy region, so in order to check the Born values in this region the differential cross-section (per unit energy range of the final state) has been calculated in two particular cases, for lead ($Z = 82$) for an incident electron of total energy $E_0 = 3mc^2$, losing energy $h\nu = 1{\cdot}5mc^2$ and $1{\cdot}95mc^2$.

The cross-sections Φ are given for these two cases and for comparison the values obtained using the Born approximation are inserted (Bethe and Heitler, *loc. cit.*, eqn. (15)).

Energy loss	$1{\cdot}5mc^2$	$1{\cdot}95mc^2$
$\Phi \times 10^{24}$	13	8
$\Phi \times 10^{24}$ (Born)	9·9	1·8

The values given should be correct to about 10 per cent. It appears that in this case the Born approximation gives fairly good results, except towards the short wave limit, $h\nu \to E_0 - mc^2$, where it is much too low. This is to be expected, as the wave function of the electron in the final state can no longer be regarded as an approximately plane wave.

As suggested by Heitler[3], it can also be shown that for the Dirac electron, as in the non-relativistic theory of Sommerfeld, the cross-section approaches a finite value at the short wave limit. We may expect that, as in the analogous case of pair production by a beam of γ-rays[4], the error of the Born values will decrease rapidly with increasing E_0 and decreasing atomic number, except near the short wave limit.

Comparison with experiment is as yet impossible, but it may be noted that Klarmann and Bothe[5], using electrons of mean total energy about $3{\cdot}5mc^2$ scattered in xenon and krypton, have obtained results indicating energy losses about 3–5 times those given by the Born approximation.

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[1] Jaeger and Hulme, *Proc. Roy. Soc.*, A, **153**, 443 (1936).
[2] Bethe and Heitler, *Proc. Roy. Soc.*, A, **146**, 83 (1934).
[3] "Theory of Radiation", p. 171.
[4] NATURE, **137**, 781 (1936).
[5] *Z. Phys.*, **101**, 489 (1936).

Absorption Spectra Evidence of the Decomposition of the Ground Term of Nd^{+++} Ion due to Crystalline Fields

PARAMAGNETIC ions in crystals are subject to electrostatic crystalline potentials the symmetry properties of which depend mainly on the local arrangement of other atoms around the ion. For example, six oxygen atoms grouped octahedrally around the ion, as in $NdCl_3.6H_2O$ and $Nd_2(SO_4)_3.8H_2O$, give rise to a field of cubic symmetry of the type $D(x^4 + y^4 + z^4)$. A general method for determining the decomposition of the energy levels of the ion in such a field has been worked out by Bethe[1], and Van Vleck[2] has utilized this theory to account for the broad features of the temperature variation of the magnetic susceptibility of crystals. Penney and Schlapp[3] have considered the rare earth salts in detail. From the temperature variation of the mean susceptibility, as measured by Gorter and de Haas, they find that the level $^4I_{9/2}$ of the free ion is split into three groups of levels at 0, 244 and 610 cm.$^{-1}$. Spedding[4], by direct spectroscopic measurements of the absorption spectra of this crystal, finds levels at 0, 77 and 260 cm.$^{-1}$. From these results the conclusion is drawn that the levels predicted by Schlapp and Penney are not found, but the levels actually observed have the same relative, but only one third overall, separation. Determining the value of the constants in Penney and Schlapp's equations, Spedding finds that his results are in better agreement with the susceptibility measurements of Zernicke and James, and of Selwood.

I wish to report on the result of certain investigations carried out in my laboratory by Mr. P. C. Mukherji on the absorption spectra of crystals of $NdCl_3.6H_2O$, which are in good agreement with the predictions of Penney and Schlapp's theory. The detailed results are being published in the *Indian Journal of Physics*. It has been found that in the region of 5000 A., there is an absorption band consisting of seven intense lines, and accompanied on the longer wave-length side by a similar group of six faint absorption lines.

Strong lines	Weak lines	Interval
19,144 cm.$^{-1}$	18,897 cm.$^{-1}$	247 cm.$^{-1}$
19,095	18,852	243
19,082	18,820	262
19,035	18,788	247
19,001	18,752	249
18,972	—	—
18,940	18,691	249
	Mean	249 cm.$^{-1}$

On reducing the temperature of the crystal to that of liquid oxygen, it is found that while the sharpness of the faint components increases, their intensities diminish, so that they can be observed at the low temperature with a comparatively thick crystal only ($t = 2{\cdot}5$ mm.). The weak lines seem, therefore, to be due to transitions from a lower excited level of the ground term of the Nd^{+++} ion, and the observed frequency difference of 249 cm.$^{-1}$ seems to be in good agreement with the calculated value of 244 cm.$^{-1}$ found by Penney and Schlapp. This result appears to be a definite optical verification of the splitting up of a term in a crystalline field as calculated from purely magnetic data.

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[1] *Ann. Phys.*, **3**, 133 (1929).
[2] "Theory of Electric and Magnetic Susceptibilities" (Oxford, 1932).
[3] *Phys. Rev.*, **41**, 194 (1932).
[4] *J. Chem. Phys.*, **5**, 160 (1937).

THE interpretation of the absorption spectra of rate earth crystals, as given by Spedding and his collaborators[1], and by Prof. Bose in the above letter, to us seems too simple to be true. Spedding claims that his measurements on the absorption spectrum of crystals of the type $X_2(SO_4)_3.8H_2O$, where X is a rare earth element, can be quantitatively explained on the basis of a crystalline potential $D(x^4 + y^4 + z^4)$. In the case of Pr^{+++}, for example, this potential by no means removes all the degeneracy of the lowest state, $^3H_4$, of the free ion, but gives a pattern consisting of a single, a doubly-degenerate, and two triply-degenerate levels. Spedding actually finds four low-lying levels, and identifies them with this pattern. As he points out, any terms in the potential function not of cubic symmetry will remove the degeneracy of the triple levels in first approximation, and the fact that no trace of such doubling or tripling can be detected, he takes to mean that terms other than those of cubic symmetry are practically absent.

The validity of the assumption of a crystalline field of almost perfect cubic symmetry can be tested with considerable accuracy by an appeal to magnetic data, since any deviation from cubic symmetry causes anisotropy in the paramagnetic susceptibility. At room temperatures, for the rare earths (anisotropy/mean susceptibility) must be of the same order as (splitting caused by non-cubic terms in a triply degenerate cubic level/overall splitting due to cubic field). Prof. K. S. Krishnan has kindly informed us that $Pr_2(SO_4)_3.8H_2O$ at room temperatures has an anisotropy roughly 10 per cent of the mean susceptibility[2]. Hence, separations of at least 50 cm.$^{-1}$ must be assumed between the various components of either of the two triply degenerate cubic levels of Pr^{+++} in order to account for the magnetic measurements. All nine levels of $J=4$ should show up in absorption spectra, and the failure of Spedding to locate more than four may simply mean that at room temperatures these are the only ones with any appreciable population. Again, the explanation may very well lie in peculiar intensity rules, at present not understood.

We have made further calculations on the mean susceptibility and anisotropy of $Pr_2(SO_4)_3.8H_2O$, and the corresponding salts of neodymium and ytterbium. Roughly the same cubic fields, together with small rhombic terms give satisfactory agreement for Pr^{+++} and Yb^{+++}, and for Nd^{+++} at all but very low temperatures. At these temperatures, as pointed out by Van Vleck[3], small departures from cubic symmetry can only have the effect of *increasing* the susceptibility of Nd^{+++}, whereas the experimental results are considerably *lower* than those predicted by a field of cubic symmetry. We find that if the rhombic field is made sufficiently large to lower the mean susceptibility of Nd^{+++} to the observed value, all resemblance of the energy diagram to the cubic field pattern is lost.

Details will be published elsewhere.

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June 2.

[1] Spedding, Hankin and Nutting, *J. Chem. Phys.*, **5**. 191 (1937), and earlier papers.
[2] Krishnan and Mookherji, to appear shortly in *Phil. Trans.*
[3] *J. Chem. Phys.*, **5**. 198 (1937).

Band Spectrum of Chromium Hydride, CrH.

CONTINUING our investigations of the spectra of the hydrides of the transition elements, we have now observed a band in the region 3600–3700 A. when running a high-tension arc between chromium electrodes in a flame of hydrogen burning in air.

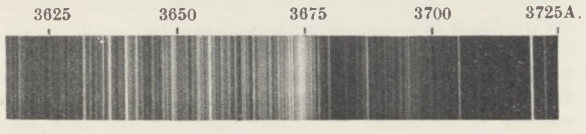

Fig. 1.

The method of production of this band is similar to that used by us to obtain the spectra of nickel hydride[1], NiH, and manganese hydride[2], MnH, and we attribute the new band to CrH. A spectrogram taken in the first order of a 20 ft. concave grating is reproduced in Fig. 1. The band is degraded to shorter wave-lengths, and the rotational structure is only partially resolved under this dispersion.

The chromium oxide, CrO, bands in the orange region of the spectrum were not observed under the conditions most favourable for the production of the new band, and it seems very unlikely, for experimental reasons, that the band can be due to anything except the hydride. The chromium atom has a ^7S level as its lowest state, and a high multiplicity, probably six, is therefore to be expected for the hydride; this would account for the complexity of the rotational structure of the band.

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[1] *Proc. Roy. Soc.*, A, **143**. 312 (1935).
[2] NATURE, **139**, 590 (1937).

Nuclear Moments of Aluminium

THE hyperfine structure of the lines $3\ ^2P_{1/2} - 4\ S_{1/2}$ (3944 A.), $3\ ^2P_{3/2} - 4\ S_{1/2}$ (3961 A.), $3\ ^2P_{1/2} - 3\ ^2D_{3/2}$ (3082 A.) and $3\ ^2P_{3/2} - 3\ ^2D_{5/2}$ (3093 A.) was investigated by means of the absorption in an atomic beam of aluminium. The structure of the lines $3\ ^2P_{3/2} - 4\ S_{1/2}$ and $3\ ^2P_{3/2} - 3\ ^2D_{5/2}$ could not be resolved. The line $3\ ^2P_{1/2} - 4\ S_{1/2}$ was found to possess three components at $-0{\cdot}048$, $0{\cdot}000$ and $+0{\cdot}048$ cm.$^{-1}$ of approximately equal intensity. The line $3\ ^2P_{1/2} - 3\ ^2D_{3/2}$ possessed two components, their separation being $0{\cdot}062$ cm.$^{-1}$; the intensity ratio of these two components was measured to a high degree of accuracy; the mean of eighty measurements gave the value $1{\cdot}21$, the component of longer wave-length being the stronger.

From the observed structure of the line $3\ ^2P_{1/2} - 4\ S_{1/2}$, it follows that the levels $3\ ^2P_{1/2}$ and $4\ S_{1/2}$ are both split into two levels, of separation $0{\cdot}048$ cm.$^{-1}$ (the greater splitting of the line $3\ ^2P_{1/2} - 3\ ^2D_{3/2}$ is due to a small unresolvable inverted structure of the level $3\ ^2D_{3/2}$ which is probably caused by perturbation by the term $3s\,3p^2\ ^2D_{3/2}$). The observed intensity ratio of the components of 3082 A. gives a value 9/2 for the nuclear spin, the theoretical value for a spin 9/2 being $1{\cdot}22$. The magnetic moment, calculated from Goudsmit's formula, is $4{\cdot}1$ nuclear magnetons according to the splitting of the level $4\ S_{1/2}$, and $3{\cdot}6$ nuclear magnetons according to the splitting of the level $3\ ^2P_{1/2}$. The agreement between these two values is the more satisfactory as the formula for p-terms gives, according to Goudsmit, rather too low values for light elements.

The lines $4\ S_{1/2} - 5\ ^2P_{3/2}$ (6696 A.) and $4\ S_{1/2} - 5\ ^2P_{1/2}$ (6699 A.) were observed in emission; they were both doublets, only just resolvable on account of the Doppler width, of separation about $0{\cdot}05$ cm.$^{-1}$; the intensity ratio, when corrected for overlapping, was found to be about $1{\cdot}23$, the long wave component being the stronger. These observations are in agreement with the above conclusions.

This result is in disagreement with the contents of a preliminary note by Ritschl[1]; from an observed doublet hyperfine structure in the lines 3057 and 3050 of the arc spectrum and 2669 of the spark spectrum, he suggested a nuclear spin of 1/2; but he made no intensity measurements, and the observed doublet structures can be explained by incomplete resolution.

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[1] Ritschl, R., NATURE, **131**, 58 (1933).

Aggregation of Virus Particles

EVIDENCE confirming the description[1] by Bawden *et al.* of the shape of the tobacco mosaic virus particle appears in Best's recent photograph[2] of virus protein forming long threads after it has been precipitated from solution. Further evidence that virus particles, even in dilute solutions, may form chain aggregates is obtained from experiments on the relation between dilution of virus and number of infections caused.

Certain carefully purified preparations of virus[3] gave, on dilution, infection series which agreed closely with an equation of the form $y = N(1 - e^{-pn_1x})$, where y is the number of infections produced by an inoculum of relative concentration x, N is the asymptotic number, n_1 is the number of virus particles in the undiluted preparation, and p is the small probability of any one particle entering one of the N points in the plant tissue to cause an infection.

In the example given of a dilution series for a purified sample of tobacco mosaic virus (ref. 3, Table 1) there was a significant divergence from the values calculated from the equation; and the results since published by Stanley[4,5] for crystalline tobacco mosaic and aucuba mosaic proteins are widely divergent from calculated values. The number of infections increases less rapidly with concentration of virus than would be expected. In attempting to explain such divergences, we assumed that the virus particle was capable of combining reversibly with a particle of impurity to give an inactive complex. The relation between the concentration of effective virus particles, n_1x, and the total concentration, v_1x, is given by

$$(n_1x)^2 + n_1x\{k - v_1x(1 - q)\} - v_1xk = 0,$$

where q is the ratio of the number of particles of impurity to the number of virus particles and k is the dissociation constant of the complex. The special form of the equation which fitted the results was that when $q = 1$. This seemed to be a highly unlikely state of affairs. Search for a more likely hypothesis revealed the fact that the same equation is obtained if it is assumed that virus particles can join end-to-end to form chains, single particles or aggregates being infective units. If r is the number of junctions between particles, then using the above nomenclature,

$$r = v_1x - n_1x;$$

and if k_1 and k_2 are independent of chain length

$$k_1(n_1x)^2 = k_2r = k_2(v_1x - n_1x)$$
$$(n_1x)^2 + kn_1x - kv_1x = 0.$$

The infection-dilution data for a number of experiments with viruses of the tobacco mosaic group and Stanley's results with purified virus proteins[4,5] have been tested by applying this modifying equation. The former were obtained with virus preparations at various stages of purification, but in all cases the agreement between observation and calculation is sufficiently accurate to render it likely that end-to-end aggregation is the main cause of the divergence of the results from expectations based on the simpler picture of separate virus particles.

It may be expected that the modified picture will apply only to the tobacco mosaic group of viruses, which are thought to consist of rod-shaped particles[6], and this has so far been borne out by experiment.

These results are described more fully in a paper to be published in the *Australian Journal of Experimental Biology and Medical Science*.

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[1] Bawden, F. C., *et al.*, NATURE, **138**, 1051 (1936).
[2] Best, R. J., NATURE, **139**, 628 (1937).
[3] Bald, J. G., *Ann. Appl. Biol.*, **24**, 33 and 56 (1937).
[4] Stanley, W. M., *J. Biol. Chem.*, **117**, 325 (1937).
[5] Stanley, W. M., *Amer. J. Bot.*, **24**, 59 (1937).
[6] Bawden, F. C., and Pirie, N. W., NATURE, **139**, 546 (1937).

Production of Mutations by Neutrons

IN experiments to determine the possibility of producing mutations by treatment with neutrons, adult males of *Drosophila melanogaster* were subjected to a neutron bombardment derived from a 485 gm. block of beryllium exposed to the γ-rays from 4 gm. of radium. It is known that beryllium thus exposed produces neutrons of two velocities, the fast ones having an energy of 0·60 million electron-volts and the slow of 0·16 million electron-volts. Fast neutrons were used in one series of experiments, the very slow ones being excluded by means of a cadmium plate. In a second series, the fast neutrons were slowed down by passage through paraffin, so that only slow neutrons were used. In a third series, serving as a control, paraffin was substituted for the beryllium block, so that the flies received no neutrons but did receive the same gamma radiation and secondary radiation from the radium source as in the first two series. In these three series, a thick lead block was used to remove most of the radium γ-radiation. Finally, in a fourth series, serving as a second kind of control, the flies were not irradiated artificially in any way.

The ClB method of breeding was used, and the occurrence of all sex-linked lethals was noted. The table below gives the summarized results of the examination of the F_2 groups of flies (15,352 fertile cultures in all).

Series	No. of Groups of F_2	No. of lethals	Observed frequency of lethals
1. Fast neutrons plus escaping radium radiation	4312	44	1 in 98
2. Slow neutrons plus escaping radium radiation	1504	5	1 in 301
3. Escaping radium radiation without neutrons	4764	19	1 in 250
4. No irradiation	4772	12	1 in 398

It will be seen that although the radiation escaping from the radium source may have caused a few mutations, this by no means accounts for all the mutations arising in the flies treated with fast neutrons. On the other hand, the slow neutron series did not have an appreciable number of mutations produced in it, although, from a theoretical point of view, some production of mutations by this means also is to be expected.

The mutations produced by the fast neutrons probably result from the action of the recoil protons and other atomic nuclei, in producing ionization along their tracts. This effect then falls in line with that of gamma and X-rays, of fast electrons, of ultra-violet and of alpha rays, in producing mutations, being most nearly akin to that of the last-named agent.

A more detailed account of the physical arrangements and of the results obtained is in course of preparation. We wish to express our thanks to Prof. Edgar Altenburg, under whose encouragement and guidance on the genetic side the work was carried out. We wish also to thank the American Oncologic Hospital of Philadelphia for the use of its 4 gm. radium bomb.

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A Short Periodic Growth Cycle and a Secular Variation in *Lemna minor*

THE rate of frond production in *Lemna*, when grown under constant conditions in which light, temperature and culture solution were all controlled, was found to be only approximately exponential and certain deviations from the ordinary compound interest law have been established. First, there is a secular variation which takes the form of a wave with a 25–35 day cycle and, secondly, superimposed on the long variation is a short periodic cycle of 4–6 days. The short wave has been followed through 15 successive cycles in one experiment. The length of the cycle of the short, and possible also of the long wave, appears to be correlated with the mean rate of increase in frond number, in that when grown under conditions which give rise to a rapid rate of division the cycle is short, and vice versa.

Successive measurements of dry weight show a secular 'wave' as in the case of the rate of increase in frond number. The waves in both cases are of approximately equal lengths in any one experiment, but are opposite in phase. The presence of a *short* periodic cycle in dry weight determinations has not been definitely established, but the data available indicate its probability.

The experiments show that, while there is neither constancy in the dry weight per frond nor in the relative rate of increase in frond number, yet the rate of increase of total mass appears to be strictly exponential.

Little is known of the factors influencing the rhythmic increase in frond number and variation in dry weight, but they may be related to the fact that the growth data are those of colonies of numerous individuals, that is, that there is a social biological effect. This aspect of the matter is now undergoing investigation.

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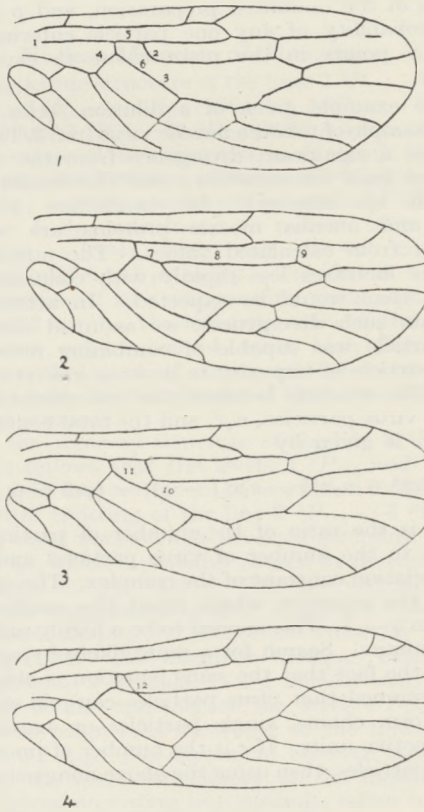
Graded Mutations in Wings of a Stonefly

MORE than two hundred definable variants have been recognized in the wings of the variable stonefly, *Allocapnia pygmæa* Burmeister. Some of them were mentioned in a former paper[1]. The three following deviations are new and merit special reference. Figs. 1 and 2 are left and right forewings of the same female, the former nearly normal, the latter highly exceptional; Fig. 3 is the left forewing of another and Fig. 4 that of a third. Left wings are seen from below. In a typical plecopterous forewing (Fig. 1), the radial sector (2) arises directly from the radius (1) by its own radicle; it is separated from the arculus or basal anastomosis (4) by a radial internode (5) and from the median stem (3) by the basimedian



passage (6). The hindwing is characterized, typically but not invariably, by a partial fusion of radial sector and median vein, which leave the arculus by a common mediosectoral pedicel. In *A. pygmæa* these veins issue separately from the arculus on an average of 8 per cent in five hundred hindwings.

In two forewings from a sample of five hundred, there is a perfect mediosectoral pedicel (7) in the right forewing of one (Fig. 2), in the left of the other, so that there is no basimedian passage, no sectoral radicle, and the interracial cell (8) extends throughout the length of the discal area from the upper division of the arculus to the interradial crossvein (9). In several instances an adventitious mediosectoral basal crossvein (10) passes from the angle of the sectoral radicle across the intervening space to the median vein (Fig. 3), closing off a basimedian cell (11) from the median basin. This crossvein appears in three states: strong, weak and rudimentary.

In another rare instance (Fig. 4), the sectoral radicle has attained direct nodal fusion with the median radicle (12) and has thus been drawn definitely into the mediosectoral linkage group. If the sectoral radicle faded out of existence or became merged with the arculus, the result would be that shown in Fig. 2.

In conclusion it may be remarked that while these phases are consecutive in form, they are contemporary in incidence, occurring as individual variations.

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The Neutrino Theory of Light

SOME time ago I directed attention[1] to some serious difficulties connected with the neutrino theory of light as developed by Jordan and Kronig, namely, (1) the contradiction with the superposition principle especially in the three-dimensional case, and (2) the impossibility of expressing the Bose amplitudes $b(\nu)$ in terms of Fermi amplitudes $\gamma(\nu)$. This criticism has met with objections[2,3]. It has been pointed out that in Jordan's theory the introduction of neutrino-holes is essential and that operators satisfying the Bose commutation rules *can* be constructed if Dirac's theory of holes is used.

My present purpose is to elucidate some points connected with the operators considered, and to point out that (1) the problem of constructing Bose amplitudes remains unsolved, and (2) new difficulties arise in the theory when the neutrino-holes are introduced.

In a theory working with an indefinite number of particles, the following boundary condition for the wave functional is necessary. *The probability of finding more than N physical particles must tend to zero if* $N \to \infty$. The boundary conditions in the ordinary theory (physical particles are neutrinos) are thus different from those in the theory of holes (physical particles are neutrino-holes and neutrinos with positive energy). In the ordinary theory, if we put

$$L(\nu) = \int_{-\infty}^{+\infty} \gamma^{+}(\alpha)\gamma(\nu+\alpha)\,d\alpha, \qquad (1)$$

we obtain [1]

$$L(\nu)L^{+}(\mu) - L^{+}(\mu)L(\nu) = 0. \qquad (2)$$

In the hole theory, we must introduce a new quantized wave function, $\varphi(\alpha,\varepsilon)$, with $\alpha \geqslant 0$, $\varepsilon = \pm 1$, by means of the equations

$$\varphi(\alpha, 1) = \gamma(\alpha);\ \varphi(\alpha, -1) = \gamma^{+}(-\alpha);\ (\alpha \geqslant 0). \quad (3)$$

The operator (1) transforms[4] into

$$K(\nu) = \sum_{\varepsilon} \int_{0}^{\infty} \varphi^{+}(\alpha,\varepsilon)\,\varepsilon\,\varphi(\alpha+\nu,\varepsilon)d\alpha +$$

$$+ \int_{0}^{\nu} \varphi(\nu-\alpha,-1)\ \varphi(\alpha,1)d\alpha \quad (\nu \geqslant 0), \qquad (4)$$

and satisfies the Jordan-Kronig commutation rules

$$K(\nu)K^{+}(\mu) - K^{+}(\mu)K(\nu) = \mu\delta(\mu-\nu). \qquad (5)$$

Jordan and Kronig put $\sqrt{\nu}\,b(\nu) = K(\nu)$. But the Bose amplitudes $b(\nu)$ are defined by their commutation rules only if $b(\nu)$ and $b^{+}(\nu)$ form a *complete set* of operators, in the sense that any operator commuting with them must be a *c*-number. This can only be the case if the parameter ν in $b(\nu)$ includes all the degrees of freedom contained in the arguments of the quantized wave function φ and of the corresponding wave functionals.

This is *not* the case in Jordan's theory, since $\varphi(\nu, \varepsilon)$ contains, besides ν, a new degree of freedom ε, corresponding to a replacement of a neutrino by an antineutrino.

From this it follows that: (1) in Jordan's theory the operators $b(\nu)$ do not form a complete set and are not uniquely determined (we might take for example $\sqrt{\nu}\,b(\nu) = K(\nu) - K(0)$ as well); and (2) all the probabilities and mean values referring to light quanta depend essentially on the values taken by the ε variable.

But a neutrino cannot be distinguished by any physical means from an antineutrino, since according to the very neutrino theory their charge, their mass and their spin are the same and they possess no other physical characteristics. Thus the dependence of the above probabilities on the circumstance whether a particle is a neutrino ($\varepsilon = +1$) or an antineutrino ($\varepsilon = -1$) constitutes a very serious objection to the neutrino theory. If one remembers that the superposition principle is also violated in this theory and that only neutrinos having strictly parallel momentum —the probability of which is zero—are supposed to contribute to the formation of a light quantum, it is difficult to avoid the conclusion that a consistent neutrino theory of light is impossible.

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[1] Fock, V., *O.R.* (*Doklady*). *Acad. Sci. U.R.S.S.*, **4** (**13**), No. 5 (109), 229 (1936); NATURE, **138**, 1011 (1936).
[2] Stueckelberg, E., NATURE, **139**, 198 (1937).
[3] Nath, Nagendra, NATURE, **139**, 331 (1937).
[4] cf. Sokolow, A., NATURE, **139**, 1071 (1937), where a similar formula is given.

Number of Fragments of the Pułtusk Meteorite

IT is generally stated that the remarkable meteorite fall near Pułtusk, Poland, on January 30, 1868, consisted of 100,000 stones. Thus Charles P. Olivier in his monograph "Meteors"[1] states that "the famous fall at Pułtusk . . . consisted of perhaps 100,000 fragments". Also F. Heide cites in his book[2] the same number, and places this fall as the highest with regard to number of fragments (in the second place comes the shower at Holbrook, Arizona, on July 19, 1912, with 14,000 fragments). The same number is quoted by various works on astronomy and cosmography.

In 1936 I visited the Mineral Department of the British Museum (Natural History) in London, which contains a beautiful collection of fifty-nine Pułtusk meteorites; and in the note placed on the collection I found again the total number "estimated at 100,000". The same value is given also in the guide to the collection of meteorites by Dr. G. T. Prior[3].

In spite of this remarkable agreement of data, the high number of 100,000 fragments does not seem to correspond with the facts. Indeed, in the original report on the Pułtusk meteorite, published in 1868 by the University of Warsaw[4], we find that only 400 fragments had been collected, although the total number of stones which reached the ground at the time was greater. On the other hand, the Polish "Cosmography" by J. Jędrzejewicz[5] estimates the amount of the Pułtusk shower at about 1,000 stones,

and the Polish edition of the "History of the Earth" by M. Neumayr[6] at 3,000 stones.

What is the source of this discrepancy? The original paper of 1868 contains the figure 100,000; this, however, does not refer to the number of fragments of the shower, but only to the result of chemical analysis, which is as follows:

Silicates soluble in HCl	47·014
Silicates insoluble	52·986
	100·000

Therefore it seems to be probable that this total (100 per cent) was erroneously read by someone as hundred thousand and cited as the number of meteoric fragments.

This explanation would account for the enormous figure quoted for the number of fragments stated to have fallen on January 30, 1868, near Pułtusk. As to the real number, I believe that 3,000 stones, as given by Neumayr, may be adopted as the most probable number of fragments.

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[1] "Meteors" (Baltimore, 1925).
[2] "Kleine Meteoritenkunde" (Berlin, 1934).
[3] "Guide to the Collection of Meteorites" (Brit. Mus. (Nat. Hist.), 1926).
[4] "Notice sur la météorite tombée le 30 Janvier 1868 aux environs de la ville de Pułtusk" (Haute École de Varsovie).
[5] "Kosmografja", 2nd edition, by M. Ernst (Warsaw, 1907).
[6] "Dzieje Ziemi", vol. 1 (Warsaw, 1912).

Points from Foregoing Letters

FROM measurements of the energy of an electron-positron pair, produced by a beta particle of energy 1·1 MV. in a mixture of nitrogen and mercury dimethyl vapour (5 per cent), Dr. F. C. Champion and A. Barber find that there is approximate agreement with the values obtained by Skobelzyn and Stepanowa when beta particles impinged on lead. It appears that the probability of pair production by beta particles of low energy increases rapidly with the atomic number and is large when the energy of the beta particle is of the order $2mc^2$.

The rate of elimination of 0·5–14 millicuries of radon injected into rats is found by Dr. F. Běhounek and F. V. Novák to be half an hour when glucose solution is used as vehicle, and several hours when tungsten emulsion is used as vehicle.

By plotting the logarithm of the rate of diffusion (through rubber) for various gases, against the inverse absolute temperature, R. M. Barrer finds straight line relations. He also gives a table for the energies of activation, calculated from the linear diffusion curves in the case of vulcanized and para rubber, and concludes that only an explanation involving activated diffusion can account for the diffusion increasing approximately with the temperature.

A method for measuring small amounts of gas liberated during certain chemical reactions, using a modified 'Cartesian diver' technique, is described by Dr. K. Linderstrøm-Lang.

D. A. Wright points out that the resistance-temperature curve obtained by Cosslett for thin films of indium indicates a transition temperature at about 10° C., in agreement with Kramer's formula. Thin films of rubidium and cæsium, on the other hand, do not behave in accordance with deductions based on Kramer's theory.

The differential cross-section for transition of a Dirac electron between two states of positive energy in a Coulomb field has been calculated by J. C. Jaeger for lead in the case of an incident electron of total energy $3mc^2$ losing energy equivalent to 1·5 and $1·95mc^2$. The theoretical values obtained by Jaeger agree fairly well with the theoretical values calculated by means of Born's approximation except near the short wave limit.

Prof. D. M. Bose reports measurements of the absorption spectra of crystals of neodymium chloride ($NdCl_3.6H_2O$), which, he considers, illustrate the six oxygen atoms grouped octahedrally around a (paramagnetic) neodymium ion. Dr. W. G. Penney and G. J. Kynch point out that the agreement claimed by Spedding and others, between the spacings of the low-lying levels of various rare earth ions, as deduced from absorption spectra measurements and from theoretical considerations of the temperature variation of the magnetic susceptibilities, is probably fortuitous. The magnetic data is not sufficiently detailed to permit accurate determinations of the levels.

A spectrum band in the region 3600–3700 A. observed when running a high-tension arc between chromium electrodes in a flame of hydrogen burning in air, is attributed by A. G. Gaydon and Dr. R. W. B. Pearse to chromium hydride.

From the intensity of the components in the hyperfine structure of the lines 3944, 3961 and 3093 A. (observed by absorption) and 6696 and 6699 A. (observed in emission), D. A. Jackson and Dr. H. Kuhn calculate for aluminium a nuclear spin of 9/2, which does not agree with the previous value of $\frac{1}{2}$, suggested by Ritschl. The magnetic moment, calculated from Goudsmit's formula, is approximately 4 nuclear magnetons.

The results of investigations on the relation between dilution of virus preparations and number of infections caused suggest, according to J. G. Bald and G. E. Briggs, that in the tobacco mosaic group there is an end-to-end aggregation of the virus particles comparable with the 'crystal' structure recently described.

Fruit flies (*Drosophila melanogaster*) treated with fast neutrons from a radium-beryllium source, show, according to Mary Nagai and G. L. Locher, a larger proportion of mutations than untreated flies, as indicated by the sex-linked lethals, which increased $2\frac{1}{2}$ times.

Certain deviations from the ordinary compound interest law of frond increase which have been established for *Lemna minor* grown under constant conditions are described by H. Dickson. These involve a secular variation which takes the form of a wave with a 25–35 day cycle, and superimposed on this a short periodic cycle of 4–6 days. Successive measurements of dry weight also show a secular wave. It is suggested that a social biological effect may be responsible for these growth cycles.

Research Items

Natives of Mount Hagen, Papua

MR. F. E. WILLIAMS, Government anthropologist, Papua, in *Man* of June, records some results of a short visit by aeroplane to the natives of Mount Hagen, the previously unknown tribes first described by Mr. E. W. P. Chinnery in 1934. Information going beyond externals was obtained from Fr. Ross of the Mission of the Society of the Divine Word, who has now resided among them for two years. He estimates that there are now 25,000 natives speaking various dialects of the Mount Hagen language, divided into some twenty tribes, who are again divided into numerous local groups. One of the most remarkable features of the life of these peoples, as well as of the Papuans recently patrolled by Hides and O'Malley, is that they have no villages, but live in scattered homesteads, to some extent grouped together as settlements, something like primitive garden cities. Descent is patrilineal, and marriage patrilocal. Girls marry young, and there is a ceremonial payment. Many households are polygamous. The natives are of strong build and fleshy with somewhat heavy, decided features and a darkish skin. The men mostly wear fine black beards, and the women roll their eyes. Altogether they are a good-looking people, of a caste that is Papuan rather than Melanesian. The main item of dress of the men is an apron of fine netting, black, greasy and soft, which is suspended from the belt, and reaches below the knees. Behind they wear numerous twigs of *Dracæna* tucked into the belt. The belt is of stiff bark, up to eight inches and more in width. It is usually plain, but sometimes is decorated with incised geometrical patterns. Thongs of stiff cane may be bound round the belt near the upper and lower margins. To some extent, the belt may have served the purpose of armour. The hair is worn short by boys and youths, but nearly all adults cultivate a fairly long growth, which is tightly encased in bark cloth, bound round the forehead and occiput with a band of the same material. This gives the effect of a well-stuffed globular cushion.

Serbian Gypsy Feast-Days

DR. ALEXANDER PETROVIĆ continues his studies of Serbian gypsies with an account of the feast days they observe (*J. Gypsy Lore Soc.*, Ser. 3, 16, Pt. 3). While the Serbs belong to three religions, Orthodox, Catholic and Mohammedan, the Gypsies are Orthodox and Mohammedan only. As, however, the only mosque is at Nish, the Gypsies of other localities perform for themselves the rites of baptism, marriage and burial. In Bosnia, the Mohammedan clergy hold that the Gypsies were never true Mohammedans. On the other hand, neither are the Orthodox priests pleased with their Gypsy parishioners; but scarcely more satisfactory in his home was the Serbian peasant of the illiterate class up to the beginning of the present century, for he preserved his ancient pre-Christian customs and beliefs. While the Serbs could not carry out a feast without the services of the Gypsies in some capacity or other, the Gypsies, though thus made familiar with them, on conversion adopted only some of the beliefs and customs of their Orthodox fellow villagers. They considered the feast of Bibi as their greatest religious holy day. Bibi is a disease—cholera. In order to protect their children from being strangled by Bibi, they founded the cult, and propitiate her by celebrating her feast day. She then protects their children from her wrath. This basic idea of a strangler going from house to house is borrowed from the Serbs, who think that the cause of every illness is some living thing that enters a man. Plague and cholera are women dressed entirely in black, who always carry an infant in their arms. It is evident that the Gypsies are beginning to forget the origin of their belief in Bibi. She is for them a Gypsy woman who has babies and likes Gypsies, protecting their children, while she strangles those of the Serbs. Many Gypsies believe that Bibi has appeared to them in their dreams, and this is to them the strongest proof that Bibi really exists. Until some years ago, Bibi's day was celebrated only by a few colonies between Belgrade and Krusevač. Now it is becoming widespread, though confined to Orthodox Gypsies speaking Romani.

Embryonic Monkeys and Man

No complete account of the intra-uterine development of any species of monkey appears to have been published, and therefore the description of the prenatal development of the grey langur, *Semnopithecus priam thersites*, by Prof. W. C. Osman Hill, is of unusual interest (*Spolia Zeylanica*, 20, Pt. 2, 211; 1937). The embryos differ from human embryos very early in showing, as a rule, a double placenta instead of a single one, in possessing 43 instead of 38 body somites, a more slender body form, a longer tail, which persists and grows after the tenth week, and slightly different feet and hands, in which the thumb is rudimentary at the 24·5 mm. stage. On the other hand, resemblances between the development of the monkey and corresponding human stages are shown in the peculiar twist on the long axis of the 9 mm. embryo, the form of the neural tube and cerebral vesicles, the mode of formation of the face and branchial arches, the slight advance in development of fore limb over hind limb, the presence of an umbilical hernia, the disproportionately large head, and large cranium relative to face, the projection of the upper jaw beyond the lower in about one third term embryos, and the presence of a lobule on the pinna. The last character seems to be confined to the family of monkeys to which the genus belongs and to man, for it is not found in the apes, nor in macaques or their relatives. It has, in fact, usually been regarded as a peculiarly human characteristic.

Effect of Pasteurization on the Nutritive Qualities of Milk

THE annual report for 1936 of the National Institute for Research in Dairying, University of Reading, recently issued, contains summaries of two researches carried out at the Institute upon the effect of pasteurization upon the nutritive qualities of milk. In one experiment, shorthorn bull calves when 4–5 days old were grouped in pairs of similar age and

weight, and one of each pair, chosen by lot, received raw, and the other pasteurized, milk until the completion of the experiment twenty-six weeks later. The milk diet was supplemented from the ninth week onwards with a little hay, and from the seventeenth week with a small allowance of crushed oats and flaked maize. Records were kept of the food consumed, the live weight gains, general appearance of the animals and other relevant matters. Eleven pairs completed the experiment, and no material difference could be detected between the two groups. The average daily live-weight gain per head for the calves receiving raw milk were 1·967 lb., for those receiving pasteurized milk 1·969 lb. Another study was on the effect of commercial pasteurization upon the nutritive value of milk. The raw and pasteurized milks were from the same bulk, the experiments being carried out on rats. No marked loss in the value of milk as food which could be attributed to commercial pasteurization could be detected. One fifth of the vitamin C content of raw milk is lost in the course of commercial pasteurization, but this is partly due to exposure to light. Milk exposed in a bottle in the sun for half an hour loses half its original anti-scorbutic properties.

Fossil Insects from Kansas Rocks

CONTRIBUTION No. 16, on Kansas Permian insects, by the late Dr. R. J. Tillyard, appeared in the December issue of the *American Journal of Science* (32, 435–453; 1936). In addition to describing new fossil mayflies, the author discusses the affinities of his group Protohymenoptera. The eminent Russian worker on fossil insects, A. Martynov, and also F. M. Carpenter, of Harvard University, claim that this group is not a separate order apparently ancestral to the Hymenoptera but a subdivision of the fossil order Megasecoptera. Carpenter claimed that Tillyard had misinterpreted the venation, and concluded that any affinities with the Hymenoptera were extremely remote. Tillyard re-examined the subject in this paper and accepted Carpenter's revision of the venation, but reaffirmed his opinion that the Protohymenoptera are ancestral to the Hymenoptera. The fact that a large and complete ovipositor is present in *Asthenohymen*, it is claimed, strengthens this argument. This character, furthermore, argues against Carpenter's contention that the Protohymenoptera are specialized members of the Megasecoptera since none of the latter possessed an ovipositor. The presence of three-segmented tarsi seems to preclude Tillyard's Protohymenoptera being on the direct line of descent of the Hymenoptera, which have five-segmented tarsi. Tillyard argued that since *Asthenohymen* is the most advanced member of the Protohymenoptera, more archaic forms may have possessed tarsi of five segments.

Scottish Copepods

DR. S. G. GIBBONS, who has already studied certain copepods of Scottish seas in some detail, now reports on collections made by the R.R.S. *Explorer* in February–November 1933 on eight cruises covering a large area and including the southern North Sea, the Hebrides and Faroes and round to the Moray Firth ("*Calanus finmarchicus* and other Copepods in Scottish Waters in 1933". Fishery Board for Scotland. Scientific Investigations 1936, No. II). Except for two large isolated patches at the surface in May and June, the bulk of the *Calanus* population (later copepodid and adult stages only being considered) were taken in the mid-water and bottom nets and few were in the surface layer. From February until July they were mostly in mid-water; from August onwards they were in the deepest layer. This indicates a general sinking towards the end of the year. There is conspicuous vertical movement, and the figures show a maximum diurnal migration which takes place at those seasons when the hours of darkness are longest, whilst in July when the light is strong the difference is less marked. As in previous years, *Calanus* proved the dominant plankton organism throughout the year, their greatest abundance occurring in June in the Faroe Shetland Channel region, and the least in the North Sea in November. Among the other copepods mentioned is *Anomalocera pattersoni*, the 'blue feed', well known as important herring food, which occurs in numbers in certain areas in May and June. It is noteworthy that, in the chart showing its abundance together with *Calanus*, it should be usually more abundant than that species when it occurs. Although nothing is said to this effect, it is probably because *Anomalocera* is eating *Calanus*, for it is a voracious copepod feeder.

Feeding Habits in Pleuronectidæ

THE relationship between the structure of the brain and the feeding habits of the Pleuronectidæ has been studied by H. Muir Evans (*Proc. Roy. Soc.*, B, May 1937). The same author has previously shown a relationship between the structure of the medulla oblongata and the feeding habits in cyprinoids, clupeids and gadoids. In the present work, the investigation is extended to include the fore-brain, mid-brain and infundibulum. Four groups can be recognized: (1) typified by the sole, a purely bottom, night feeder; (2) typified by the plaice, which is also a bottom feeder but utilizes sight, taste and smell; (3) typified by the turbot, which is predatory and feeds by sight; and (4) typified by the halibut, also predatory and feeding by sight. The fourth group is distinguished from the third by the deep dorso-ventral extension of the olfactory lobes and by a different arrangement of the tubules of the pituitary gland.

A Disease of Hawthorn

A SHORT paper by Messrs. W. J. Dowson and W A. R. Dillon Weston (*Gard. Chron.*, 426, June 19, 1937) directs the attention of plant pathologists to a brown rot of the hawthorn. The malady, which is fairly widely distributed in East Anglia, is caused by the fungus *Sclerotinia cratægi*. The conidial stage only has yet been found in Great Britain, but the ascigerous condition has been known for many years in Germany and the United States. Similar diseases appear on the medlar and quince, but are caused by different species of *Sclerotinia* from that which attacks the hawthorn. Symptoms are a browning of the young shoots, the dead leaves of which often bear a sweetly-scented powdery grey mould of conidia. The disease may be more widespread than is reported by the present paper, and appears to be sufficiently destructive to mar the beauty of a quick-thorn hedge.

Gold Deposits of the Canadian Shield

A REVIEW of the geological relations of some of the chief gold deposits of the Canadian Shield is presented by E. L. Bruce in a paper read at the New York Meeting of the American Institute of Mining

and Metallurgical Engineers (*Technical Publication* No. 807; 1937). Summaries are given of the Beattie and Sisco mines of Quebec, of the mines of the Porcupine and Kirkland Lake area, and of the Howey and other mines of north-west Ontario. It is shown that there are few places in which a genetic relationship between ore-bearing solutions and neighbouring igneous rocks can be satisfactorily established. In some places where such relationships have been assumed, later investigation has shown that the igneous rocks are very much older. In deposits like those of Porcupine and Kirkland Lake, it seems likely that the solutions that formed the veins were derived from a magma far below the present surface and that the veins are localized by structural factors. The fact that contacts between igneous rocks and the rocks invaded are structurally favourable for the development of zones of fracturing, in some deposits at least, explains the occurrence of gold-bearing veins near intrusive bodies.

Formation of Submarine Canyons

IN recent years, there has been much discussion of the various hypotheses suggested to explain the formation of submarine canyons and gorges. The only hypothesis to which there are no serious objections is that proposed by Daly. During the low sea-levels of the Pleistocene glaciations, mud was stirred up by wave action on the shallowing continental shelves. In this way, a suspension was formed with a higher specific gravity than that of clear sea-water. The 'heavy' liquid flowed down the continental slope, as submarine currents which developed ruts in the soft bottom deposits and gradually deepened them into gorges. This theory, though superficially seeming to be improbable, has been greatly strengthened by experiments carried out at Leyden by Ph. H. Kuenen (*Leidsche Geol. Med.*, (2), 8, 327–351; 1937). The results prove that a suspension will flow down a slope without being much diluted by mixing with the adjacent clear water, and that such a flow will concentrate in slight depressions in the surface. Quantitative data and comparison with natural slopes show that the velocity of the actual submarine currents should be somewhat lower than that of large rivers, but increasing as it proceeds and picks up more sediment. At the lower end the suspension gains six times the effective density with which it began and two or three times the velocity, and at this stage the load of sediment being carried is that of the most muddy major rivers. Though the data are rough, they show that no preposterous assumptions are involved in accounting for such submarine canyons as those of the Georges Bank. It is of special interest to note that an 8 mm. film of about 20 metres length, illustrating the experiments, can be obtained at the price of 8 guilders from the Rijksmuseum van Geologie at Leyden.

A New Type of Threaded Connexion for Oil Well Casing

AT a meeting of the Institution of Petroleum Technologists on May 4, Mr. W. M. Frame described a new type of threaded connexion for use on oil well casing. Casing having such connexions is known as 'extreme line casing' and is being used successfully in a number of the United States oil fields. The joint consists simply of an upset, threaded pin end and an upset, threaded box end without any coupling. A shoulder is provided on the pin end to avoid any abrupt change of contour, and the outer surface is turned and the inner bored to give more accurate joint dimensions than are normally obtainable. The advantages claimed for this type of joint over the normal V-threaded type are that it is stronger and has a higher resistance to leakage and accidental drainage, that the external joint diameter is smaller and has a stream-lined contour both inside and out. Experience has shown that a great saving of time in running and pulling can be effected with this 'extreme line casing' as compared with collared casing.

A West Indian Hurricane

AN account was given by Mr. C. S. Durst, at the meeting of the Royal Meteorological Society on May 26, of a case that occurred in September 1936 of a West Indian hurricane which recurved into middle latitudes towards the far side of the Atlantic and crossed over almost to the Irish coast without losing its tropical character of a mass of revolving tropical air. The recurve took place at about lat. 30° N., long. 61° W., and the track of the storm was then an almost straight one to the south-west of Ireland. As the storm approached the polar front, which lay at about lat. 45° N., a new depression developed on that front and became intense, and to this development is attributed a great increase in the speed of travel of the tropical storm. When centred at about lat. 43° N. and long. 39° W., its continued tropical character was well shown by the existence of a northerly wind of nearly gale force of which the temperature was 74° a short distance behind the centre. The author was unable to find any previous case of this kind of a persistent revolving tropical vortex within the warm sector of another depression farther to the north. He attributed the abnormal features in this case to the fact that the encounter between the tropical storm and the polar front took place in mid-ocean, and to the fact that a very shallow disturbance already existed on the polar front at that point. It is more usual for tropical storms to reach the coast of America and to have greatly diminished in intensity by the time that they encounter the polar front, and for their tropical characteristics to be lost in the temperate depression which results.

Passivity of Iron

EXPERIMENTS by W. H. Cone and H. V. Tartar (*J. Amer. Chem. Soc.*, 59, 937; 1937) show that iron is passive in solutions of chromic acid at all concentrations. If the solution also contains sulphuric acid or other activating electrolytes such as phosphoric acid and sodium sulphate, the iron under reduced pressure becomes active, but in pure chromic acid solutions iron does not become activated by reduction of pressure. An atmosphere of hydrogen causes iron to be active in a chromic acid–electrolyte solution. Oxides of iron were found to be soluble in chromic acid solutions, and oxide-covered wires could be made active by a reduction of pressure. This makes it doubtful whether an oxide layer is an essential factor for passivation, as has been asserted, and an adsorbed film of oxygen or a "two dimensional compound" of iron and oxygen as the primary cause of passivity is suggested. Definite oxides may be formed afterwards, particularly in the case of anodic passivation, but such oxides are readily soluble in the acidic solutions used by the authors.

Transmission of Excitation in Living Material

ON Thursday, June 3, at the Royal Society, Dr. C. F. A. Pantin opened a discussion organized by Prof. A. V. Hill on "The Transmission of Excitation in Living Material", which was largely devoted to the consideration of the rival merits of electrical and chemical theories of conduction.

The electrical theory, which has been worked out mainly in connexion with the nerves of vertebrates, is briefly as follows. We know that conducting tissues may be excited at the cathode by an applied electric current, and we also know that the propagated wave is invariably associated with an electric disturbance which is in such a sense that the current flowing between the active and the inactive regions of the tissue has the cathode on the inactive part, and is hence in the direction which tends to excite it. Thus it is clear that if the disturbance is intense enough, the inactive region in front of the wave must be raised to activity, thereby achieving propagation. Whether in fact this is the mechanism therefore rests upon the measurement of the adequacy of the electrical disturbance to excite the region in front of the wave.

This study was presented by A. L. Hodgkin (Cambridge), working on frog's nerve in which the propagation was blocked by the application of pressure or by freezing. Though the impulse is not able to traverse the block, yet the electrical current spreads out into the inactive region and produces there a considerable exciting effect, for, when the shock setting up the impulse is followed by a second shock applied this time to the inactive region just beyond the block, and so timed that it coincides with the electrical disturbance due to the blocked impulse, it is found that the second shock can be effective at only 10 per cent of the intensity necessary when applied alone. The excitability thus measured is found to follow a time course nearly identical with that of the electrical wave from the blocked impulse. It is clear that if at some distance from the disturbance the excitability is raised to 90 per cent threshold, at the active region itself the current will be fully adequate. Thus the electrical theory is established for conduction in frog's nerve.

But the adequacy thus shown for a full-grown impulse will not apply to the very small impulse arising from the area under the cathode of an external stimulating circuit. It is clear that a stimulus, to be effective, must not only excite the tissue at a point, but also must nurse the new-born impulse until it has reached a size adequate to propagate on its own.

The results of a mathematical development of this aspect were presented by W. A. H. Rushton (Cambridge), who pointed out that, in spite of shortcomings due to over-simplification, it is possible to describe quantitatively the whole range of excitability measurements both spacial and temporal, including some observations hitherto unexplained, with only two arbitrary constants.

Now in the intact organism, nerve-muscle activity is carried out by impulses following each other in rapid succession, hence the electrical generation of repetitive impulses from continuous currents is of interest. A. Monnier (Paris) has found that excised nerves and muscles in solutions of low calcium ion content respond to prolonged continuous currents with prolonged rhythmic discharges. The bearing of this upon the mode of origin of central nervous rhythms was strongly indicated by B. H. C. Matthews (Cambridge) from oscillograph records of single motoneurones. When these cells are provoked to reflex activity by sensory stimulation, in addition to the quick potential change associated with each impulse there are slowly developed changes localized somewhere in the spinal cord, apparently produced by the cumulative effect of the sensory impulses, and acting like the prolonged currents in Monnier's experiments. This similarity has been further confirmed by passing a prolonged current in at the nerve and out at the cord, which, even in the absence of sensory stimulation, produced repetitive impulses of reflex character.

Though these experiments suggest that electrical considerations are sufficient to explain the passage of an impulse from one cell to another, there is quite other evidence, primarily pharmacological, which shows that the liberation of a specific chemical substance in relation to the cell junction may be of great importance.

Adrenalin has long been known to produce, when injected, the same general effects as widespread sympathetic stimulation, and it is now recognized that sympathetic nerves act by liberating adrenalin (or something very like it) in intimate relation to the cells of the organ supplied. Later, a similar state of affairs was found in connexion with the parasympathetic nerve endings, but the specific chemical, acetyl-choline is rapidly inactivated by an enzyme normally present and hence cannot be obtained unless the enzyme is inhibited by eserine. Chemical transmission was thus established in conduction between cells in two important classes, and the question arose as to whether some chemical was invariably necessary for such conduction. In particular, the cases of nerve-voluntary muscle, sympathetic ganglion and central nervous system are receiving consideration, but the possibility of a similar chemical counterpart of transmission down the nerve fibre itself is not overlooked.

A. von Muralt (Bern), realizing that any liberation of acetyl-choline during nerve transmission must be almost instantaneously reversible, adopted the following method to 'fix' the chemical liberated by a single impulse. The stimulated nerve together with an unstimulated control were shot instantaneously into liquid air, withdrawn, and ground to powder in solid carbon dioxide and then extracted and tested pharmacologically for acetyl-choline. It was found that the stimulated nerve contained about twice as much as did the control, but as was brought out in discussion with Prof. J. H. Gaddum, this was possibly due to the effect of the applied current (as in Gaddum's own experiments) for the results were more pronounced with prolonged currents, and the 'resting' control was probably excited by contact with the liquid air.

G. L. Brown (Hampstead), continuing the work of Dale and his other colleagues, showed that when an impulse passes from nerve to muscle, not only is acetyl-choline liberated in circumstances strictly

limited to the passage of the impulse, but also that the injection of it suddenly into an artery in close relation to the muscle gives rise to a twitch very similar both from mechanical and from electrical records to that produced on nerve stimulation.

F. Buchtal (Copenhagen) has made a more minute study of the structures involved in this transmission. Working with single muscle fibres from the lizard, he measured the resting and active potentials on the surface of the muscle and the nerve-muscle junction. There is a resting potential of some 50 mV. between junction and fibre, and this difference is reversibly reduced to zero by the drug curare, which simultaneously produces a reversible nerve-muscle paralysis.

Z. N. Bacq (Liège) treated from a much wider zoological aspect the question of chemical transmission, and showed that, though acetyl-choline may be regarded as transmitter over a great range, yet this substance is not present in the Protochordates, the Crustacea, or the Cœlenterates.

J. C. Eccles (Oxford) considered the application to ganglion and central nervous system. He presented evidence for two transmitters, one rapid, and apparently related to the electrical effect, the second slower and probably related to acetyl-choline.

This same duality was advocated by C. F. A. Pantin (Cambridge) in his opening communication. His own work on sea anemones and crabs shows that facilitation at the nerve-muscle junction depends upon both the number and the frequency of impulses arriving there. A chemical transmitter is suggested because the time relations of the decay of facilitation are much longer than those of electrical effects, and are not dependent upon ions as are the electrical phenomena. On the other hand, the accumulation of facilitating chemical is never sufficient to set up repetitive impulses on its own account, nor are the ionic changes which increase facilitation capable of allowing a first impulse to pass; it seems that in these systems it is necessary to have the electrical change associated with the present impulse as well as the chemical facilitation resulting from a previous impulse. He also pointed out that the study of comparative physiology is rich in examples of the same end being achieved by different means, and of the same means being employed to different ends, or to no end at all. The fact that a certain chemical has important function in one tissue and that it is also present in another tissue, cannot be used as indicating that it has any biological significance in the second case.

Prof. E. D. Adrian, starting the open discussion, was also of the opinion that both electrical and chemical conditions are involved in transmission. He pointed out, however, that the secretion of molecules so strongly polar as those of acetyl-choline may involve quite considerable potential changes, while on the other hand the diffusibility of acetyl-choline through lipoids makes this ion of importance in the passage of electricity through cell walls. It is therefore possible that some of the phenomena variously considered as electrical or chemical may in fact be merely two aspects of the same process.

W. A. H. RUSHTON.

The Individuality of Gliadin

By Prof. A. G. Kuhlmann, Research Institute of the Baking Industry, Moscow

THE principal proteins of wheat are, as is well known, glutenin and gliadin. These proteins, upon the interaction of wheat flour with water, form the so-called gluten, the quality and quantity of which is of such great significance in the baking of bread, in the manufacture of macaroni, noodles and similar products. In the numerous works devoted to the proteins of wheat, a great deal of attention is paid to the question of the individuality of glutenin and gliadin.

Considering gluten to be a natural high polymer, we must come to the conclusion that it represents a complex of proteins, forming micelles of various length. Such a conclusion has been fully confirmed by an investigation which I conducted in my laboratory, which showed as well that the longest and most stable micelles are those of glutenin. Gliadin consists of shorter micelles, which are less stably built and more flocculent than those of glutenin.

According to the literature, the gliadin of wheat is best extracted by a 70 per cent solution of ethyl alcohol. A study of the influence of the concentration of ethyl alcohol on the peptization of the proteins of gluten carried out in my laboratory gave the following picture (Fig. 1). In one series of experiments, samples of one and the same gluten were treated with alcohol-water solutions. The experiments were repeated, this time a given sample of gluten being treated with alcohol solutions of increasing concentration (alcohol of higher concentration being used only after complete extraction with alcohol of the preceding lower concentration).

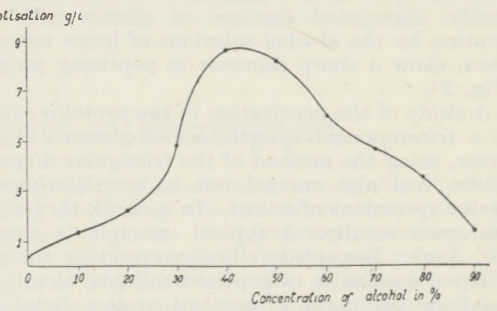

Fig. 1.

Results of these experiments are shown in Fig. 2. The data of both these series of experiments are in good agreement with each other and show that maximum peptization occurs with alcohol having a concentration of about 40 per cent. The

investigation of several kinds of gluten gave an analogous picture.

When gluten is treated with alcohol of low concentration (up to 30 per cent C_2H_5OH) it retains its cohesive properties and changes only slightly in its external appearance. Upon treatment with 40 per cent alcohol, it is greatly altered; it loses its cohesive properties and begins to disintegrate into separate particles. The supernatant liquid becomes turbid and viscous.

It is a striking fact that peptization of gluten by alcohol of various concentrations falls considerably more sharply after reaching a definite maximum, in the case illustrated by Fig. 2 than that by Fig. 1. This can be accounted for by the presence in gluten of a less highly aggregated and more easily peptizable fraction the solubility of which reaches a maximum with concentrations of alcohol of about 40 per cent. This fraction, through interaction with the more highly aggregated and less soluble fraction of gluten by means of absorption, acts as a peptizer of the latter. It also conditions the stability of the sol obtained. This fraction, when separate samples of gluten are extracted by different concentrations of alcohol (Fig. 1), asserts its action even at high

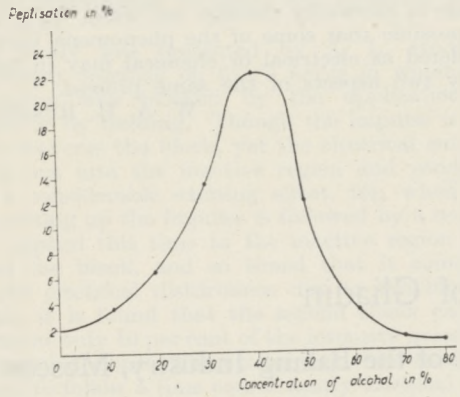

Fig. 2.

concentrations; while when one and the same sample is extracted by alcohol of different concentrations, the alcohol solutions containing more than 40 per cent C_2H_5OH, devoid of this less highly aggregated fraction of gluten due to its solution by the alcohol solutions of lesser concentrations, show a sharp decrease in peptizing properties (Fig. 2).

A study of the peptization of the proteins of gluten as a tricomponent system, sol of gluten – alcohol – water, using the method of the triangular diagram of Gibbs, was also carried out in my laboratory on twelve specimens of wheat. In general, they all gave analogous results. A typical example is shown in Fig. 3 (*a*). Isopeptides (lines connecting the points of equal quantities of peptized colloids) clearly show a definite maximum of peptization at a definite concentration of alcohol (40–50 per cent). If isoprotein sections (lines I, II, III) parallel to the side *BC* and connecting points of equal quantities of protein are drawn, then the above-mentioned maximum is seen still more clearly (Fig. 3 (*b*)).

If proteins are extracted with 40 and 70 per cent alcohol-water solutions from separate samples of a given specimen of gluten, then we obtain two products, different from each other with respect to their behaviour towards water (swelling and hydration). Thus the protein fraction extracted with 40 per cent alcohol from the gluten of the wheat Lutescens 0329 imbibes 1·63 gm. of water (calculated on the basis of 1 gm. of dry substance), while gliadin (that is, the fraction extracted from that same sample of gluten with 70 per cent alcohol) imbibes 1·83 gm. The corresponding fractions extracted from the gluten

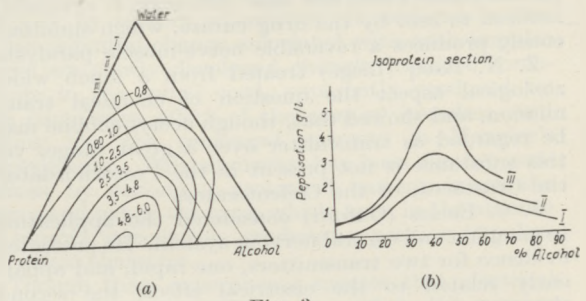

Fig. 3.

of the wheat Ferrugineum *H* 622 gave a still more distinct picture: here gliadin imbibed 1·08 gm. of water while the '40 per cent-fraction' imbibed 0·91 gm. The gliadin of that wheat increased its volume by 158 per cent on swelling, while the '40 per cent-fraction' increased by 135 per cent.

The above data, as well as other observations noted in my laboratory, give me reason to maintain that the gliadin of wheat is not a chemical individual. It represents an adsorption complex of at least two fractions, which I name α- and β-gliadin. In its properties (swelling, peptization, etc.) β-gliadin approaches glutenin. β-gliadin dissolves as a result of interaction by means of adsorption with the more easily peptizable fraction, α-gliadin, which forms the main mass of Osborne's gliadin.

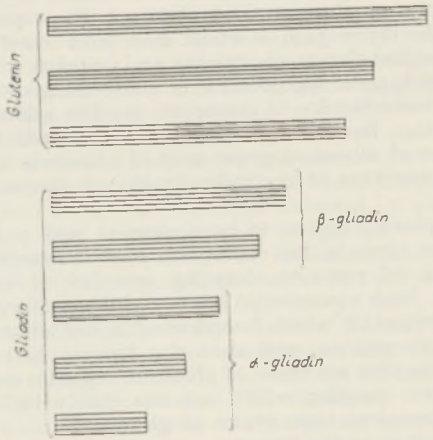

Fig. 4.

In the light of this work, the distribution of proteins of the various fractions of gluten according to the length of their micelles may be represented schematically as in Fig. 4.

Research in this field is being continued.

Intellectual Co-operation and International Science

A JOINT meeting of the Executive Committee of the International Council of Scientific Unions and of the Scientific Experts Committee of the International Organization of Intellectual Co-operation was held on July 9–10, at the International Institute of Intellectual Co-operation, in Paris.

Representing the Executive Committee of the Council were: Prof. C. Fabry, chairman of the Council; Prof. H. R. Kruyt, vice-president; Prof. D. B. Němec; Prof. F. J. M. Stratton, general secretary of the Council; E. Esclangon, representing the International Union of Astronomy; Jean Gérard, representing the International Union of Chemistry; General Perrier and Brigadier H. St. J. L. Winterbotham, representing the International Union of Geodesy and Geophysics; General Bourgeois and E. J. Voute, representing the International Union of Geography; Profs. Abraham and A. Cotton, representing the International Union of Physics; and Dr. M. J. Sirks, representing the International Union of Biological Sciences. The Committee of Scientific Experts included: Prof. Cabrera, chairman of the Committee and professor of theoretical physics at the University of Madrid; Prof. Białobrzeski, professor of theoretical physics in the University of Warsaw; Prof. F. A. E. Crew, director of the Institute of Genetics at the University of Edinburgh; Prof. P. Langevin, professor of experimental physics in the Collège de France; Prof. Ch. Maurain, dean of the Faculty of Sciences of the University of Paris; Prof. Harry M. Miller, professor of zoology in Saint Louis University; Prof. M. Plancherel, professor of mathematics in the Polytechnic Federal School of Zurich; Prof. A. A. J. de Sigmond, professor of agricultural chemistry in the Palatin Joseph University of Technical and Economical Sciences, Budapest; and Prof. E. Späth, rector of the University of Vienna.

This meeting is the result of several years negotiations between the International Council of Scientific Unions and the International Organization of Intellectual Co-operation, the outcome of which was the approval by the assemblies of the two organizations of the draft agreement prepared by a joint committee of representatives of the Council of Scientific Unions and of the International Committee on Intellectual Co-operation.

The agreement lays down in detail the manner in which the two institutions are to collaborate. The International Council of Scientific Unions will henceforward act as the advisory body to the Intellectual Co-operation Organization on questions of a scientific character, while the latter will be consulted by the Council on all international matters concerning the organization of scientific work. The executive organs of the Intellectual Co-operation Organization will provide the secretariat for the committees to be appointed by the Council, the president of which will *ex officio* attend plenary meetings of the Committee on Intellectual Co-operation at which the sciences are discussed; a representative of the Intellectual Co-operation Organization will take part in the meetings of the Executive Committee of the Council.

One of the aims of the meeting of July 9–10 was the signing of this agreement by the presidents of the two organizations, Prof. Gilbert Murray and Prof. C. Fabry. It also dealt with a number of other questions, among which are: the analysis of the scientific programme of the Organization of Intellectual Co-operation, that is, co-ordination in the matter of scientific research (financial aid, collaboration with the scientific unions for the preparation of small co-ordinating committees, publication of reports on the progress made in each branch of science); scientific bibliographies (transcription of the titles and the names of authors of scientific works written in a language that does not use Roman characters, and compilation of a bibliography of scientific works published in such languages); 'scientific conversations' the first of which will deal with "the general consequences of deep alterations that have taken place in physics concerning the principles of the explanation of the natural phenomena", etc. . . .

The Committee has also studied the programme and methods of the International Council of Scientific Unions and examined several new proposals received by the Organization of Intellectual Co-operation, among which are the publication of old scientific manuscripts and the question of the co-ordination of work in the study of physical constants.

It is necessary to emphasize the importance of the signing of the agreement by the presidents of the two organizations. It marks the beginning of a practical collaboration removing all possibility of overlapping, and having as a result the development of a definite programme.

New Chemistry Laboratories at Birmingham

THE new A. E. Hills Laboratories, which form a most valuable extension of the Department of Chemistry in the University of Birmingham, were formally opened by the donor (Mr. A. E. Hills) on July 7. The pro-chancellor (Mr. Walter Barrow) expressed the gratitude of the University to Mr. Hills for his generosity in giving £50,000 to build the laboratories, as well as a further gift of £25,000 for postgraduate scholarships. Benefactions by Birmingham donors have provided a further £7,700 for equipment (including £4,200 from Cadbury Bros. and £2,000 from W. Canning and Co.)

The opening address was given by Sir Frederick Gowland Hopkins, who remarked that every encouragement given to chemistry increases the possibility of discoveries of universal value. The thoughts of physicists and that of chemists, which have been separate, are coming nearer together, and the help which chemistry has given to physics in the past is to-day being handsomely repaid; though there is still an inherent distinction between the modes of thought of the chemist and physicist which is of mutual advantage in their collaboration.

Chemistry is also becoming more serviceable to medicine and all the biological sciences. The psychiatrist is now coming to the chemist for help. Many forms of mental disorder appear to arise from disturbances of metabolism which are revealed by chemical studies, and there is hope that methods of treatment may be found to correct the errors so discovered. If only some forms of insanity can be cured, it would be at least a partial solution of one of the most painful human problems. "Extending this idea, may we not believe that even the psychologist will have to pay attention to chemistry? So intimately interwoven are the activities of mind and body that no one can deny that the psychology of the individual is greatly affected by the hormonic balance which is part of his physical constitution; and hormones owe their specific influence in the body to particular aspects of their molecular structure". Chemistry in fact is ubiquitous, though it required the Great War to make Great Britain realize the truth of Disraeli's dictum that the prosperity of the chemical industry is the best index of the prosperity of the country as a whole.

The distinction between pure and applied science is becoming less real, and it is probable that never before has organic chemistry shown more possibility of continued development. How remarkable in *kind* the development of organic chemistry has been in its apparently static time. The product of a pictorial, or even artistic rather than mathematical type of intellect, the evolution of the idea of molecular structure was something new and distinct, and the verification by modern physical methods of the conclusions reached is indeed remarkable. Organic chemistry in approaching physics is becoming more dynamic and more subtle.

Biochemistry is a borderland subject (not a hybrid, because it is certainly not infertile), and borderland workers usually find work not found by the cultivators of either of the contiguous regions. Intellectual trust and sympathy between two departments may be very fertile. Biochemistry is the study of chemical dynamics as exhibited in life, and requires a knowledge of the physical properties and molecular structure of the substances which play an essential part in the constitution of living systems. Its special endeavour must be to follow so far as possible the function and fate of each significant constituent amid the multitudinous reactions which underlie the manifestations of life, and to explore the mechanisms which control those reactions. For this work, biochemistry is developing its own technique, and its progress though difficult is real. While immersed in problems so different in kind, it is almost impossible for the specialized biochemist to acquire the knowledge and experience, or the mode of thought and intuitions of the accomplished organic chemist, in determining molecular structure and in the difficult art of synthesis. Even the best biochemist must remain an amateur in organic chemistry. There never was a case in which progress could be better secured by a wise division of labour. Recently organic chemists have been examining the structure of natural products with marked success.

Sir Frederick concluded with a eulogy of the work of the Birmingham University School of Chemistry, referring in particular to the synthesis of vitamin C, the commercial manufacture of which means that no case of scurvy need in future remain uncured.

Standardization of Physical Units

IN a paper by Lyman J. Briggs, director of the National Bureau of Standards at Washington, which appeared in the January issue of the *Journal of the Franklin Institute*, some of the present-day problems in connexion with securing international uniformity in standards are discussed.

The British inch, derived directly from the imperial yard, is about four parts in a million shorter than the United States unit. But if we use the conversion factor so that one inch equals 25·4 millimetres exactly, then the new value of the inch would fall midway between the British and the United States inch. The Bureau of Standards has definitely proposed that this be done. The change would not affect industry in the slightest because it falls well within the tolerances in industrial measurements. This conversion factor, one inch equals 25·4 mm., has recently been adopted for industrial purposes by standardizing groups in fifteen countries including both England and the United States.

In the field of electricity, the tools of measurement now depend on national standardizing laboratories. The maintenance of units is made possible on a world-wide basis by the rise of the great national standardizing laboratories, especially in Germany, Great Britain and the United States. The revision of the units is under way at the present time. But as the present units are more than sufficiently accurate for industrial use, the changes made will only affect laboratories making very precise measurements. The change will become effective on January 1, 1940. The present 'international' units of the ampere, ohm and volt will be respectively 0·9999, 1·0005 and 1·0004 of the new (absolute) ampere, ohm and volt respectively.

The present standards for use in photometry are either flame standards or carbon filament lamps giving light of a yellowish colour, and there is no general agreement as to a method regarding a method of passing over to lamps giving 'whiter' light. The German-speaking countries also never accepted the old 'international candle' but use their own unit, the Hefner, which is only nine tenths of it. Now that the Bureau of Standards has determined the behaviour of the normal eye in terms of 'factors of luminosity' which have been internationally agreed, a basis has been fixed for measuring lights of any colour provided we have some kind of standard as a starting point. We have still to agree upon the photometric scale for the brightness of the primary standard. The Bureau of Standards has recently suggested that the old 'international candle' be abandoned and that a slightly different unit be fixed by taking the round value of 60 candles per sq. cm., instead of the old value of 58·9, as the brightness of the blackbody radiator at the platinum point.

Science News a Century Ago

The Engineering Branch of the Royal Navy

ON July 19, 1836, an Order in Council was promulgated which for the first time granted permanent rank to engineers serving in the Navy and laid down the regulations for the training and employment of engineers. The Order in Council began: "Having had under our serious consideration the situation of the Engineers of Your Majesty's steam vessels, and being of opinion that it is necessary to place this description of officers on a permanent footing, in the same manner as the Gunners Boatswains and Carpenters in Your Majesty's Navy, with such rank and pay as appears to be fitting for persons charged with the performance of such important and responsible duties, we beg leave most humbly to entrust for Your Majesty's most gracious consideration and approval the following regulations. . . ." The engineers were to be appointed in the same manner as other warrant officers; they were to rank next below carpenters; they were to be distributed into three classes and they were to be allowed to retire upon superannuation upon the scale laid down for warrant officers in 1826. The pay of a first-class engineer was to be £9 12*s*. a month, and sixpence a day for each apprentice or boy that may be placed under his instruction; the pay of a second class engineer was to be £6 16*s*. a month and that of a third class was to be £4 18*s*. a month. On entry into the service engineers had to pass an examination before the Chief Engineer and Inspector of Machinery or such other officer as might be appointed for that service.

The Order concluded with: "And with a view of encouraging the education of youths in Your Majesty's Service for Engineers, we beg leave further most humbly to propose that Your Majesty will be graciously pleased to establish four classes of Apprentices or Engineers' Boys, for the service of Your Majesty's steam vessels, with the following rates of pay: 1st Class, £1 14*s*.; 2nd Class, £1 6*s*.; 3rd Class, £1 3*s*.; 4th Class, 14*s*. 6*d*. a month."

Launch of *S.S. Great Western*

ON July 19, 1837, the S.S. *Great Western*—the *Queen Mary* of her day—was launched at Bristol. Designed by Isambard Kingdom Brunel and built by Patterson for the Great Western Steamship Company, which had been formed at Brunel's suggestion for connecting Bristol with New York, she was the largest vessel constructed up to the time she was launched. She was 236 ft. long, 35½ ft. beam, 59 ft. wide over the paddle boxes and of 1,320 tons. "Her scantling," wrote one author, "is equal in size to that of our line of battleships, it is filled in solid, caulked within and without up to the first futtock heads before planking, and all above this height is of English oak. The flooring is of immense length, each floor overrunning the other; they are strongly dowelled and bolted in pairs first and also together by 1½ in. bars of 24 ft. in length, driven in parallel rows, scarfing about 4 ft. She is trussed in the firmest and closest manner by iron and wooden diagonal and also shelf pieces, these including all the upper works, are fastened with screws and nuts to an immense extent." After being launched, the ship was towed to the Thames to have her engines fitted. She made her first voyage to America in April 1838.

Meteorology in the United States

AT the fifty-fourth quarterly meeting of the Franklin Institute of Philadelphia held on July 20, 1837, the report submitted contained the following statement: "Whereas, a considerable number of members of this Institute, in conjunction with members of the Philosophical Society, have recently devoted much time to the observations of the phenomena accompanying the various conditions of the atmosphere, with a view to ascertain the general laws by which the changes of weather are governed; and the belief is confidently entertained, that a continuance of these observations, and their extension over the widely spread territory of the United States, will enable us to determine many general facts of a highly important and useful character, therefore, Resolved, that the Joint Committee of the American Philosophical Society and the Franklin Institute be, and are hereby authorized, on the part of this Institution, to memorialize Congress for the purpose of obtaining the national aid in furtherance of this interesting object."

University Events

ABERDEEN.—The following degrees of D.Sc. have recently been awarded: E. M. Dodds, for a thesis entitled "Researches on the Internal Combustion Engine and its Fuels"; Dr. A. W. Downie, for a thesis entitled "Studies on Immunity to the Pneumococcus"; Dr. D. S. Raitt, for a thesis entitled "Stock Replenishment, Fishing Intensity, Yield Prediction and Ancillary Problems in relation to the Haddock Stocks of the North-East Atlantic"; Dr. H. E. Shortt, for a thesis entitled "Life-history and Morphology of *Babesia canis* in the Dog-Tick *Rhipicephalus sanguineus*".

The honorary degree of LL.D. has been conferred on Prof. T. Shennan, emeritus professor of pathology in the University.

BELFAST.—The degree of D.Sc. has recently been conferred on the following: Prof. W. A. Osborne (*honoris causa*), M. J. Lynn (botany) and R. H. Sloane (physics).

CAMBRIDGE.—The following University appointments have recently been made: Dr. O. M. B. Bulman, lecturer in palæozoology; Dr. J. K. S. St. Joseph, demonstrator in geology; M. Black, demonstrator in geology; J. D. Boyd, lecturer in anatomy; Dr. W. A. H. Rushton, lecturer in physiology; S. J. R. Reynolds and C. D. P. Jones, demonstrators in anatomy; A. L. Hodgkin, demonstrator in physiology; and Dr. G. N. Myers, demonstrator in pharmacology.

A. M. Barry has been appointed to a Frank Edward Elmore studentship as from October 1.

The Frank Smart prizes have been awarded to B. G. Wilkinson, Downing College (botany); M. G. M. Pryor, Trinity College (zoology).

Applications are invited for the Gwynaeth Pretty studentship, the holder of which shall devote himself to original research in the etiology, pathology and treatment of disease, with particular but not exclusive reference to those diseases which cripple or disable in childhood or early life. The studentship is of the annual value of £200 and is tenable for three years. Further information can be obtained from Prof. H. R. Dean, Department of Pathology.

Societies and Academies

Edinburgh

Royal Society, Edinburgh, June 7, 1937.

H. S. TAYLOR: Heavy hydrogen in scientific research (Bruce-Preller Lecture). Heavy hydrogen has led to interesting developments in theoretical and experimental aspects of reaction kinetics, especially in the fields of catalysis and photochemistry. Problems of molecular structure involving all types of spectral analyses of deuterium-containing compounds have also been solved. The biological and astronomical aspects of the problem were discussed, and the important role of deuterons, at high voltages, in the production of artificially radioactive elements and isotopes of known elements, particularly in the field of radiotherapy, was indicated.

A. C. AITKEN: Studies in practical mathematics. (2) The evaluation of the latent roots and latent vectors of a matrix. The paper develops and exemplifies a method, based on the repeated transformation of a vector, for finding all the roots and characteristic vectors of the secular equation and more general determinantal equations. By a simple auxiliary process a few poor or moderate first approximations are shown to be capable of yielding second and later approximations of high accuracy. Numerical examples are used to illustrate the routine of computation, which is well adapted to modern machines.

F. A. E. CREW and CH. AUERBACH: 'Spheroidal': a mutant in *Drosophila funebris* affecting egg size and shape, and fecundity. 'Spheroidal' eggs are broader and shorter than normal, with greater variability in both dimensions and also in the shape index. These differences, as well as the abnormal curves of regression of length on width and of volume on length, suggest fundamental deviations from the normal processes concerned in egg development. 'Spheroidal' females are remarkably infecund, and differ from normal in respect of the curve of laying performance from day to day.

FRANCIS GREENSHIELDS: Studies in the cytology of parthenogenetic reproduction of Hymenoptera Symphyta. (1) Chromosome number and individuality in three arrhenotokous species. The complement of O chromosomes in the male germ-tract of three arrhenotokous species of Hymenoptera Symphyta consists of 4 'morphological' pairs, and that for one of these species the 16 chromosomes in the female germ-track consists of 4 groups of 4, corresponding to the pairs in the male. Sex chromosomes are not distinguishable; which fact does not favour application of Whiting's theory of sex-determination to Hymenoptera Symphyta. It is suggested that true relationship between the sexes is of tetraploidy to diploidy, and that initial emergence of the parthenogenesis has been by polyploid evolution.

Paris

Academy of Sciences, May 24 (*C.R.*, 201, 1517–1596).

LUCIEN CAYEUX: New data on the existence of bacteria in the old sedimentary rocks. The results of work done on ferruginous oolites, with the aid of infra-red microphotographs. The existence of bacteria in the seas is proved back to the Huronian; they probably made their appearance still earlier. It is possible that bacterial action exercised a preponderating effect in sedimentary formations.

ALEXANDRE GUILLIERMOND and ROGER GAUTHERET: The property possessed by plant cells of excreting neutral red after having accumulated it in their vacuoles.

LOUIS BLARINGHEM: The double fertilization of flowering plants and the separation of the hybrids: from the correspondence of Hugo de Vries and Léon Guignard.

SERGE BERNSTEIN: Modification of the quadrature formula of Tchebycheff.

LUCIEN DANIEL: New researches on the variations of the apogamous dandelion.

MAURICE NICLOUX: The proportion of alcohol in water from the interstitial plasmas and of protoplasmic water, in an aquatic animal, is that of the external medium in which it is immersed. Experimental demonstration for the frog.

W. SLEBODZINSKI: The realization of a variety with affine connexion by a surface plunged in an affine space.

PAUL GILLIS: The equations of A. Haar of the calculus of variations.

CHARLES JACOB: The Gibbs phenomenon in the development of series of Hermite polynomials.

ROBERT FORTET: Linear operations not completely continuous.

HENRI CORBLIN: A compressor with two membranes for use with gases forming dangerous compounds with lubricants.

LÉOPOLD ESCANDE and GEORGES SABATHÉ: A weir inclined with respect to the axis of a canal.

MME. MARGUERITE MOREAU-HANOT: The theoretical study of toroidal high-tension collectors.

GEORGES BODIER: The influence of the earth circuit of lightning protectors in an electrical network.

ROBERT FORRER: The electronic lattice of the transition elements.

HENRI LACOSTE-TAYAN: The cycles of recoil of magnetic steels.

MARCEL LAPORTE: A law of emission of a radiation with continuous spectrum (white light) by xenon tubes.

MOHAMMAD MONADJÉMI: The materialization of the energy of the β-rays of thorium B+C.

FRANÇOIS BOURION and EMILE ROUYER: The determination of the hydration of the ions of calcium nitrate.

JEAN COURNOT and MARC BAUDRAND: The corrosion of riveted joints. Supplementing work described in a previous communication. The conditions of working are similar, but the two plates are of different materials.

MARCEL SERVIGNE and ETIENNE VASSY: An application of luminescence to quantitative analysis: the micro-estimation of the element samarium. In the particular case of samarium in very dilute solid solution, the intensity of the band studied is proportional to the concentration of the active element. With concentrations between $1{\cdot}07 \times 10^{-4}$ and $0{\cdot}082 \times 10^{-4}$ grams per gram of diluent (calcium tungstate) the accuracy of the measurements is about 5 per cent.

RENÉ DUBRISAY and GEORGES ARDITTI: The alteration of metals by carbon tetrachloride in the presence of water. Results obtained with copper and zinc are given.

MLLE. YVONNE GARREAU: The oxidation of hydroquinone by air in the presence of *n*-butylammonium sulphite.

MARC BASSIÈRE : The structure of cadmium nitride (hydrazoate). Description of the method employed for obtaining cadmium hydrazoate in pure crystals, with details of the crystallographic and X-ray study.

J. MALAVOY and F. JACQUET : The geological formations of Portuguese Guinea.

MLLE. MARGUERITE FROLLO : Study of the submarine breccias containing dolomitic elements in the dolomitic Trias of the eastern Carpathians.

NICOLAS STOYKO : The periodic variations of longitude.

EDOUARD BOUREAU : The presence of tracheids in the alternate wood of the radicle of conifers.

MARCEL MASCRÉ and RENÉ PARIS : The constitution of scoparoside (scoparine) of *Sarothamnus scoparius*. Scaparoside is a heteroside of the formula $C_{22}H_{22}O_{11}$, hydrolysable with difficulty, giving a molecule of rhamnose and a molecule of a flavone derivative, probably a quercitol methyl ether.

RENÉ SOUÈGES : The embryogeny of the Plumbagineæ. The development of the embryo in *Armeria plantaginea*.

ANDRÉ TOURNADE and MARC CHEVILLOT : Does the action of the vaso-dilator nerves amount to a liberation of acetyl-choline ?

PHILIPPE JOYET-LAVERGNE : Distinguishing the zones of oxidation in the living cell by the method of cobalt salts. In the living cell, whether plant or animal, the chondriome and the nucleole are two constituents which possess a catalytic oxidizing power sufficiently great to transform cobaltous salts into cobalt salts, a change shown clearly by the colour change.

YVES LE GRAND : The apparent rhythm of flickering.

MAURICE FONTAINE and RENÉ GUY BUSNEL : The localization and the nature of the flavine contained in the skin of the eel.

AUGUSTE LAFAY and BERNARD LAFAY : The introduction of artificial radioactivity into therapeutics.

Geneva

Society of Physics and Natural History, May 20.

P. ROSSIER : (1) Definition of stellar colour indexes. Photometers used for the determination of colour indexes are generally standardized in such a manner that the index is zero for the A_0 stars. There may be an advantage, especially in the case of photo-electric cells, in considering the index as the difference of two magnitudes, omitting this adjustment. (2) The Wien-Planck correction in the calculation of the magnitude of a star. This calculation makes use of certain sums the handling of which is somewhat inconvenient. It is possible to replace these by certain exponentials, with an error which never exceeds 0·03 magnitude.

J. PH. BUFFLE : The origin of the calcium bicarbonate in the waters of the River Versoix (Canton of Geneva). The river contains no free carbonic acid, and is not capable of dissolving the limestone which forms its bed. As, on the other hand, the proportion of calcium bicarbonate increases from the source of the river to its mouth, the origin of the salt must be external to the river. It is brought in by waters of infiltration, which fulfil the necessary conditions for dissolving the chalk of the strata which they traverse.

G. TIERCY and P. JAVET : The pulsation of variable stars of the Cepheid type. A study of the case where the periodic variation of the ray includes two terms, one of which has a period double that of the other.

P. BALAVOINE : The variation of the iodine value of drying oils according to their origin. The iodine values of drying oils, particularly linseed oil, vary according to the country of origin and the season during which they have been prepared. The value is higher when the oil is prepared at a higher temperature.

Vienna

Academy of Sciences, April 22.

H. MOLISCH : Influence of one plant on another which is remote from it. The principal results are given of a research arising out of the well-known property of ripe apples of accelerating the ripening of unripe ones stored with them. The full results are to be published in book form.

S. MEYER : The age of the sun, the decay constant of actino-uranium and the ratios of the amounts of lead, thorium and uranium on the earth.

N. v. SZENTPÁLY : Heating effect of radioactive minerals. A combined micro-calorimeter and thermostat is described.

F. VIEHFEGER : Loss of charge of α-particles in helium. For particles of velocity $1{\cdot}08 \times 10^9$ cm./sec., the mean free paths for capture and loss are 11·3 times the corresponding values for air.

M. MLADENOVIC : Nature of manilla resin.

E. BEUTEL and A. KUTZELNIGG : Production of a brilliantly fluorescent zinc oxide by partial decomposition of basic zinc carbonate.

E. KRUPPA : Projective geometry of a Hermitian plane.

R. INZINGER : Geometry of the Monge-Ampère differential equation of the second order.

J. KRAMES : (1) Cubic circular motion of space. (2) Geometry of the Bennett mechanism.

J. PIA : Recent researches on the Cetacea of the Vienna Miocene.

K. O. FELSER : Stratigraphically important corals from the upper Nassfeld strata and the Trogkofel chalk of the Carnic Alps.

G. E. KIELHAUSER : Carboniferous flora from the leat of the mill near the Rattendorf meadow in the Carnic Alps.

April 29.

FRANZISKA SEIDL : Observations of the diurnal variation of the electrical conductivity of the air in Fulpmes in the Stubai valley.

K. EHRENBERG : Two new remains of primates from the Miocene of Lower Austria. A right ulna and a humerus bone are described which possess characteristics of both the anthropoids and the lower primates. They are believed to belong to a new species which has been named *Austriacopithecus weinfurteri*.

May 7.

K. HILLEBRAND : Evolution of cosmic dust clouds. A permanent change in the distribution of matter which is initially uniformly dispersed can be brought about by inelastic collisions.

E. W. KELLERMANN : Coloration and luminescence of fluorite.

K. GRAFF : Visual colour excess of bright stars near μ Cephei.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

TWO UNIVERSITY DEMONSTRATORS IN ENGINEERING in the University of Cambridge—Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (July 17).

DEMONSTRATOR IN CHEMISTRY in King's College, London—The Secretary (July 20).

LECTURER IN PHYSICS (subsidiary mathematics) in the North Staffordshire Technical College, Stoke-on-Trent—The Clerk to the Governors, Education Offices, Town Hall, Hanley, Stoke-on-Trent (July 22).

DEMONSTRATOR IN ELECTRICAL ENGINEERING in the Military College of Science, Woolwich, S.E.18—The Commandant (July 30).

A FIELD GEOLOGIST for the Iraq Government—The Royal Iraqi Legation, 22 Queen's Gate, London, S.W.7 (July 31).

LECTURER IN HUMAN EMBRYOLOGY AND HISTOLOGY in the University of Glasgow—The Secretary (August 6).

DIETICIAN OR NUTRITIONIST for the Board of Education—The Secretary, Board of Education, Whitehall, S.W.1 (August 7).

ASSISTANT at the Royal Observatory, Greenwich—The Secretary of the Admiralty (C.E. Branch), Whitehall, London, S.W.1 (August 7).

MUSEUM ASSISTANT in the Woolwich Borough Museum—The Town Clerk, Town Hall, Woolwich, S.E.18 (August 31).

CURATOR of the University Museum of Archæology and Ethnology in the University of Cambridge—The Registrary (October 1).

FOULERTON RESEARCH FELLOWS IN MEDICINE of the Royal Society—The Assistant Secretary, The Royal Society, Burlington House, W.1 (October 16).

ESTABLISHED CIVIL ENGINEERING ASSISTANTS and an ASSISTANT ENGINEER in the Roads Department of the Ministry of Transport—The Establishment Officer, Ministry of Transport, Metropole Buildings, Northumberland Avenue, W.C.2.

TEACHING SCHOLAR in the Department of Zoology, University of Birmingham—The Secretary.

Official Publications Received

Great Britain and Ireland

Department of Scientific and Industrial Research. Forest Products Research Records, No. 17 (Wood Preservation Series, No. 3): Wood Preservatives. By N. A. Richardson. Pp. iii+13. (London: H.M. Stationery Office.) 6*d*. net. [36

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the Collaboration of the Meteorological Office. Vol. 4, No. 2 (July–December 1936). Pp. ii+55–116. (London: Royal Meteorological Society.) 2*s*. 6*d*. [36

Peace Year Book 1937. Pp. 418. (London: National Peace Council.) 2*s*. [36

The Lister Institute of Preventive Medicine. Report of the Governing Body, 1937. Pp. 28. (London: Lister Institute.) [46

Home Office, Ministry of Health and Scottish Office. Interim Report of the Inter-Departmental Committee on the Rehabilitation of Persons injured by Accidents. Pp. 20. (London: H.M. Stationery Office.) 4*d*. net. [46

British Polar Year Expedition, Fort Rae, N.W. Canada, 1932–33. (Published under the direction of the British National Committee for the Polar Year, The Royal Society, Burlington House, London.) Vol. 1: Discussion of Results; Meteorology, Terrestrial Magnetism and Aurora, Atmospheric Electricity. Pp. xv+336+5 plates. Vol. 2: Tables; Meteorology, Terrestrial Magnetism, Atmospheric Electricity. Pp. ix+228. (London: Percy Lund, Humphries and Co., Ltd.) [46

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1937 June 5. Pp. 38. (Greenwich: Royal Observatory.) [76

Transactions of the Royal Society of Edinburgh. Vol. 59, Part 1, No. 4: The Structure and Function of the Alimentary Canal of some Species of Polyplacophora (Mollusca). By Dr. Vera Fretter. Pp. 119–164. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 5*s*. 9*d*. [76

Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 47: Studies on the Ultimate Composition of Biological Material. Part 2: Spectrographic Analyses of Marine Invertebrates, with Special Reference to the Chemical Composition of their Environment. By D. A. Webb. Pp. 505–539. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 3*s*. [76

Board of Education: Science Museum. Report of the Advisory Council for the Year 1936. Pp. 51+6 plates. (London: H.M. Stationery Office.) 1*s*. 3*d*. net. [86

Technical Publications of the International Tin Research and Development Council. Series A, No. 53: The Effect of Cold-Work and Annealing on the Hardness of some Tin—Antimony, Tin—Antimony—Copper, and Tin—Antimony—Silver Alloys. By R. E. Leyman. Pp. 18+2 plates. London: International Tin Research and Development Council.) Free. [96

Royal Observatory, Edinburgh. Forty-seventh Annual Report of the Astronomer Royal for Scotland, 1936. Pp. 8. (Edinburgh and London: H.M. Stationery Office.) 2*d*. net. [96

Other Countries

Memoirs of the Peabody Museum of Natural History. Vol. 3, Part 4: The Merycoidodontidæ, an Extinct Group of Ruminant Mammals. By Malcolm Rutherford Thorpe. Pp. xxi+428 (50 plates). (New Haven, Conn.: Peabody Museum of Natural History.) 7 dollars. [156

Colony of Mauritius. R.A. Observatory Publications, No. 18: The Atmospheric Pressure at Mauritius: being a Survey and Discussion of Fifty-six Years' Observations made at the Royal Alfred Observatory. By M. Herchenroder. Pp. 21+12 tables. (Port Louis: Government Printer.) [156

Melbourne Observatory. Hourly Values of the Magnetic Elements at Toolangi, in 1932 and 1933. Observed and reduced under the direction of Dr. J. M. Baldwin. Pp. vi+73. (Melbourne: Government Printer.) [166

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 149: On the Natural Vibration of Semi-Cantilever Beam with one End Fixed or Pin-jointed. By Mineo Yamamoto and Ziro Suzuki. Pp. 319–336. 30 sen. No. 150: On the Characteristics of Microphones. Part 2: The Directional Characteristic. By Kôzi Satô Heizi Kawai, Keiiti Kubo and Rinzi Tate. Pp. 337–348+4 plates. 45 sen. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) [176

Bulletin of the American Museum of Natural History. Vol. 73, Art. 4: Results of the Archbold Expeditions. 16: Some Marsupials of New Guinea and Celebes. By G. H. H. Tate and Richard Archbold. Pp. 331–476. Vol. 73, Art. 5: Anatomy of the Head and Pelvic Fin of the Whale Shark, Rhineodon. By Robert H. Denison. Pp. 477–515. (New York: American Museum of Natural History.) [186

Proceedings of the United States National Museum. Vol. 84, No. 3006: Crested Millipeds of the Family Lysiopetalidæ in North America, with Descriptions of New Genera and Species. By H. F. Loomis. Pp. 97–136. (Washington, D.C.: Government Printing Office.) [186

Division of Fish and Game of California: Bureau of Commercial Fisheries. Fish Bulletin No. 49: The Commercial Fish Catch of California for the Year 1935. Pp. 170. (Terminal Island, Calif.: California State Fisheries Laboratory.) [186

New York Zoological Society. Report of the Director of the Aquarium. Pp. 20. (New York: New York Zoological Society.) [216

Geological Series of Field Museum of Natural History. Vol. 6, No. 17: Mounted Skeleton of Homalodotherium. By Elmer S. Riggs. Pp. 233–244. 15 cents. Vol. 7, No. 1: The Grinnell Ice-Cap. By Sharat K. Roy. Pp. 20. 25 cents. Vol. 7, No. 2: The History and Petrography of Frobisher's "Gold Ore". By Sharat K. Roy. Pp. 21–38. 20 cents. (Chicago: Field Museum of Natural History.) [216

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 23, No. 8: The Fishes of the Beni-Mamoré and Paraguay Basins, and a Discussion of the Origin of the Paraguayan Fauna. By Nathan E. Pearson. Pp. 99–114. (San Francisco: California Academy of Sciences.) [216

Straits Settlements. Annual Report of the Director of Gardens for the Year 1936. By R. E. Holttum. Pp. 18. (Singapore: Government Printing Office.) 1 dollar; 2*s*. 4*d*. [216

Society of Biological Chemists, India. Annual Review of Biochemical and Allied Research in India. Vol. 7, 1936. Pp. 165. (Bangalore: Society of Biological Chemists.) 2 rupees; 3*s*. [216

Bernice P. Bishop Museum. Special Publication 27: Canoes of Oceania. By A. C. Haddon and James Hornell. Vol. 1: The Canoes of Polynesia, Fiji and Micronesia. By James Hornell. Pp. ix+454. (Honolulu: Bernice P. Bishop Museum.) [216

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