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Defence and Industrial Efficiency

THE growth of economic nationalism during the last four or five years has in itself been directly responsible for some deterioration in the international situation through its effect on international trade and economic policy. Much more serious, however, has been its influence on the development of re-armament policies mutually inconsistent with and opposed to the principles of collective security. Formidable as are these dangers, they are but slight compared with those which arise from the orientation of national policy in certain countries in accordance with a militaristic spirit and a glorification of war itself, closely allied to the militarism which in pre-War Germany was a primary factor in precipitating conflict.

Not even the ruthlessness with which youth is being mobilised for war almost from the cradle in such countries as Germany and Italy, or the repercussions of the Italian-Abyssinian conflict have, however, brought home so clearly to the public in Great Britain the necessity for visualising national defence in terms of man-power and industrial efficiency and not merely in terms of air, military or naval forces and their armaments, as the publication of the Government's White Paper on defence* has done. The survey of international affairs and of re-armament in other countries which forms the first part of the Statement, disturbing as it may be, is almost completely overshadowed by the third and fourth sections, which deal with the co-ordination of defence and the means of securing the fullest and most effective use of the industrial capacity and the man-power available for the production of munitions of all kinds.

The Statement points out that the defence programme necessitates carrying through in a

* Statement relating to Defence. (Cmd. 5107.) (London: H.M. Stationery Office, 1936.) 3d. net.

limited period of time measures which will make exceptionally heavy demands upon certain branches of industry and upon certain classes of skilled labour, without impeding the course of normal trade. For its accomplishment, the task demands most careful organisation and the co-operation both of leaders of industry and of trade unions. In place of accumulating vast reserves of munitions, it is proposed to organise industry so that it can rapidly change over at the vital points from commercial to war production should the necessity arise.

The measures proposed by the Government include both the extension and duplication of existing Government factories, and the creation of a reserve source of supply by selecting firms not normally engaged in armaments work who would lay down the plant and machinery for a given output of selected articles, and sufficient orders would be guaranteed in peace time to allow of the requisite training in the work of production. The selected firm, while maintaining and developing its normal civil trade, will agree to use its organisation and commercial structure to set up some measure of munition production and thus create the reserve source of supply.

The organisation thus visualised is designed to overcome so far as possible that time lag in production upon which Major Lefebure laid such stress in his study of scientific disarmament. The plans contemplate, moreover, a measure of control over profits and costs to avoid the piling up of excessive profits which is so liable to characterise armaments production in war-time. It also attempts to deal with the equally difficult question of the supply of skilled labour, for which a considerably increased demand is anticipated.

These questions raise the whole of those problems of labour such as the dilution of labour, the training of unskilled men, the employment of women, which proved so difficult during the Great War. They cannot but have a profound effect on the economic life of the country, and the control of capital and labour involved, the diversion of economic energies may well have disastrous repercussions, unless planned and executed with regard less to the exigencies of the moment than to the ultimate welfare of the nation.

To urge the necessity of an adequate plan and of taking a long-range view is not to ignore or deny the need for improving the present position with reasonable speed. It does, however, point out the evils which may attend hasty decisions regarding the erection, for example, of new works in the strategically suitable depressed areas. Some of these areas owe their present difficulties largely to their association with munition work in time of war, and unless the new developments are wisely conceived as part of a continuous and long-range policy and not merely short-term or emergency measures, any relief they bring to the special areas may be temporary if not illusory and the forerunner of even worse conditions in the future. If we are merely to recreate in the districts dependent on shipbuilding, engineering and the metal industries the inflated surplus of skilled labour which characterised the war years, and rashly denude other areas such as Lancashire, the Midlands and Sheffield, the consequences can scarcely fail to be disastrous from an industrial, as well as an economic, point of view.

Considerations such as these account for the way in which attention has been focused on the third section of the Statement, which deals with the scheme for co-ordinating defence and outlines the appointment and duties of a special minister as Deputy Chairman of the Committee of Imperial Defence and of the Defence Policy and Requirements Committee, to afford some relief to the Prime Minister. The uneasiness and criticism apparent in the recent debate on the White Paper in the House of Commons are in fact to be attributed largely to doubts as to the efficiency of the measures of co-ordination proposed by the Government and whether they will really ensure that the problem of defence is dealt with as a whole and not, as has so often happened in the past, on departmental lines. Having regard to the highly technical nature of modern warfare, with its manifold contacts with and dependence

upon geographical and meteorological knowledge, engineering, chemistry and chemical industry, medical science, statistics, psychology and so on, it might have been expected that the new post of Deputy Chairman of the Committee of Imperial Defence would be filled by someone closely in touch with scientific and industrial developments. The Government has apparently decided otherwise, and Sir Thomas Inskip has been called to this onerous post.

Inevitably, perhaps, political events since the publication of the Statement itself led to political aspects being most prominent in the subsequent debate itself, and on the wider issues the speeches in this debate scarcely reached the level of those in the debate on the Ministry of Defence (Creation) Bill on February 14. The speech of Sir Austen Chamberlain on that occasion could scarcely be bettered as an exposition of the fundamental principles. Modern warfare, he pointed out, is an affair of nations, not of armies and of navies, and you must co-ordinate not merely the forces but also the whole of the civil activities of the population.

There is little in the Statement to suggest that the survey of our industrial resources referred to by Sir Austen has been handled with, or that the related question of labour and its use has received, the consideration it demands. We cannot consider recruitment for the services without considering the supplies for the services when they are actively employed, and the people who will be available to provide these supplies. These questions cannot be dealt with by departmental methods. They demand vision and creative minds, and a far-sighted view of national welfare as well as of the immediate and more technical problems of defence.

It is too late in the day to divorce considerations of defence from those of the general welfare. The difficulties which the fighting services find in obtaining recruits of a sufficiently high standard of physique or intelligence are a sufficient reminder that national defence is a matter, not merely of armaments and defence forces, but also of adequate education, nutrition and housing. A defence plan which disregards the general physical and mental welfare of the nation, makes no effort to deal with the insidious effects of long-continued unemployment especially among young persons, and provides inadequately for education or the health and recreation services of the country, will collapse at the first test through the weakening of national morale.

The supreme need is, as Sir Austen Chamberlain reminded us elsewhere, for a thinking mind on defence. The exigencies and disturbances which have in recent months forced attention on these problems may be welcomed if the lesson of the essential unity of such problems is learnt. We have wasted too much time and thought in attempting to discriminate between combatants and non-combatants and to restrict the methods of warfare, and Major-General Sir Henry Thuillier did good service when in an address at the Royal United Services Institution on February 6 he directed attention to the fallacy of such efforts. Moreover, it is at least arguable, as he pointed out, whether the mowing down of young conscripts by machine-guns is any more humane than dropping bombs on the civilian fathers and grandfathers whose cupidity and stupidity provoked war.

It may even be that, as Sir Henry Thuillier suggested, the interests of humanity would be better served if it was known in advance that the direct effects of warfare would not be confined to the combatant services. The realisation that civilians would be exposed to at least the same risks might induce more constructive efforts to establish peace and co-operation, and greater readiness to surrender those national rights which

most hinder the working of a system of collective security and constitute the gravest danger to peace.

These are not matters to which the scientific worker can be indifferent. He is concerned both in the elaboration of an adequate policy of national defence as well as in the consequences of a failure to build an adequate structure of peace. He has his part to play both professionally and as a citizen. No service he can render in the solution of the technical problems of defence is, however, more important than that he might give by his insistence on the necessity of planning defence policy in relation to a long-range view of the whole of the nation's resources of materials and manpower; and on a realistic view of warfare and its consequences which refuses to dissipate energy on side issues, such as the abolition of chemical warfare or the restriction of bombing to indefinable military objectives.

It is in the light of such a long-range policy and of such a spirit of realism that constructive and creative views of international affairs are likely also to emerge; views which will permit the establishment of a world order in which man may at last enjoy some measure of these powers with which science has endowed him, and which at the moment threaten to be used rather to his downfall.

Anthropology of the Torres Straits: *Finis Coronat Opus*

Reports of the Cambridge Anthropological Expedition to Torres Straits

Vol. 1: General Ethnography. By A. C. Haddon. Pp. xiv+421+11 plates. (Cambridge: At the University Press, 1935.) 40s. net.

THIS volume completes the record of the anthropological exploration of Torres Straits undertaken by Dr. Haddon and his companions in 1898, itself the continuation of the author's own earlier work in those islands in 1888. These investigations were supplemented by a trip made in 1914 by Dr. Haddon and his daughter Kathleen—now Mrs. Rishbeth—when some of the previous results were checked, fresh material collected and many photographs taken. Haddon was already middle-aged when he planned and led the Cambridge expedition, and something more than brief thanksgiving to whatever gods there be must be rendered by his companions in the Pacific for the active presence among them to-day of their leader

and friend. That no other could have written this volume as it is and ought to be written is manifest, but let us try to see what lay behind, not only the *Reports*, not only the expedition, but more important than these, the planning of the expedition.

Thirty-five years is so considerable a period that younger anthropologists do not always realise the condition of their science at that time. Until the Torres Straits expedition was planned, all anthropological material other than physical (physical anthropology was already taught in the older universities) had been collected by travellers and missionaries, that is as a by-product of other forms of exploration. It was Haddon who in Great Britain first determined that a special expedition having for its purpose the study of anthropology in the field should come into existence, and, even at that date, appreciated the need to link what we now call social anthropology with psychology in order to attain its full development.

Thus it was that Rivers, McDougall and C. S. Myers became members of the expedition. Here the leader—like so many outstanding men—was ahead of his time; the psychologists were not yet ready for the anthropologists. This must not be taken to imply that the work of the psychologists was not important; but their results raised no outstanding questions for subsequent solution. Intelligence tests were not then available (Binet did not publish his first scale until 1905, and it was not until 1908 that he showed how intelligence might be measured, using a single year as a scale unit), nor had more than a limited attention been paid to the unconscious, while the technique of its investigation had not even been proposed.

Nevertheless, this inclusion of psychologists was to lead almost immediately to a most important anthropological development, for it was in Torres Straits that Rivers elaborated the genealogical method, the most valuable single instrument of investigation that has yet been put into the hands of the social anthropologist. It was in an attempt to discover "whether certain aptitudes or disabilities were common to members of the same family [that] Rivers began to collect genealogies. He soon saw that this method of inquiry afforded precise information concerning vital statistics and it also helped to explain a number of social conditions. He collected kinship terms and incidentally the duties and privileges of kinsmen, and in this way he originated the genealogical method which in his hands and in those whom he inspired has led to a new and invaluable ethnological technique".

It is to be hoped that these preliminary remarks may not be regarded as superfluous or devoid of interest. They are, the reviewer believes, necessary in order properly to appreciate the Torres Straits *Reports*.

A short introduction is followed by a historical sketch and an account of the geography and geology of the islands, occupying in all less than fifty pages. The remainder of the work is devoted to the general ethnography of Torres Straits and such neighbouring areas as seem to have influenced the Straits or to have been influenced by them. Summarising each island or group, Dr. Haddon has availed himself of additional information, often obtained in answer to questions put to local residents, his chief informants for the Straits being the Rev. J. H. MacFarlane and "Jack" Bruce. For neighbouring areas, material collected by G. Landtman (Daru), F. E. Williams (the area west of the Fly), and Donald Thomson (Cape York Peninsula) has been utilised, and certain ceremonies are recorded, in view of wider distributions, even where there are no very obvious contacts.

Of these areas, Kiwai, in spite of its geographical proximity, does not appear to have directly affected the islanders; there have perhaps been more contacts with Daudai and the extreme west of (administrative) Papua. There has been considerable reciprocal influence between North Queensland and the Straits. Outrigger canoes are found on the Australian coast almost as far south as Cape Flattery, about 250 miles south of Cape York, and the ceremonial of the Australian Koko Ya'o in certain respects clearly recalls those of Torres Straits and New Guinea. The culture here I'wai is more Papuan than Australian, while the *okainta* initiation ceremony of the Koko Ya'o is a transplanted and modified *horiomu* of the coastal Kiwai-speaking tribes, who themselves took it from the Torres Straits. Again, the masks of the Koko Ya'o are clearly derived from Torres Straits. It is indeed obvious that the culture of New Guinea, including Torres Straits, has considerably influenced that of various tribes of the Cape York Peninsula of Queensland.

Summarising the culture history of Torres Straits, Dr. Haddon points out that while the islanders are physically and temperamentally Papuans, there is a linguistic difference between the eastern and western groups. The former speak a language definitely "Papuan", the latter "Australian". As already indicated, there is abundant evidence of cultural movement from New Guinea to Australia, while there is comparatively little evidence of the reverse process, nor is there any evidence, even linguistic, for the direct influence of Indonesia on Torres Straits.

Dr. Haddon points out that folk tales afford valuable *prima facie* evidence with regard to movements of culture, though obviously every item cannot be accepted as literally true. From this point of view the tales of the great culture heroes of Torres Straits become most important; that Sidu, the bestower of so many benefits, came from New Guinea fits entirely with the anthropological evidence:

"He instructed people in language, stocked reefs with the valuable cone shell and with other shells; he was the first to bring coconuts and bananas and other plants useful to man; but the greater fertility of the Eastern islands as compared with the Western is attributed to the treatment accorded to him in the different islands."

With the aid of such tales, Dr. Haddon has been able to sharpen the outlines of his reconstruction of the history of the islands:

"The earliest people were simple hunters and collectors, but the introduced art of the cultivation of the soil improved their mode of life. The natives of Muralug and the neighbouring islands

never really attained this second stage, and even in Mer three folk-tales refer to the cooking of aroids for food, which now are eaten only in times of scarcity; this may be a remembrance of a time anterior to the cultivation of yams. The story of Yawar shows that some of the inhabitants of Badu were then extremely incompetent gardeners."

Reference has just been made to Sidu, and in Murray Island the introduction of new and improved varieties of edible plants is accredited to named persons who came either from the western islands or from New Guinea. The spirit pantomimes with their songs and dances, and the masks, particularly those in animal form, came from Daru, which at

a particular period became a focus of social ceremonial, though there is nothing to show why this came about.

Apart from students of New Guinea and its peoples, this volume will be of special value to those interested in the movements of peoples within a limited area, for it constitutes an outstanding example of research of this kind.

It remains only to offer the congratulations of anthropologists to the "Grand Old Man of British Anthropology" on the vigour and critical judgment with which, in his eighty-first year, he has brought his great task to such a brilliant conclusion.

C. G. SELIGMAN.

Biochemical Progress

A Textbook of Biochemistry

Edited by Prof. Benjamin Harrow and Dr. Carl P. Sherwin. Pp. 797. (Philadelphia and London: W. B. Saunders Co., 1935.) 25s. net.

SOME justification is needed for producing another text-book of biochemistry; in this instance it is to be found in the array of authorities, both British and American, who have contributed to an advanced account of current biochemical knowledge. The book is, indeed, a kind of running 'collective' summary of the "Annual Review of Biochemistry"; some of the authors are common to both publications.

The editors invite special attention to three chapters on subjects that do not usually find place in biochemical text-books, those, namely, on the living cell, by Robert Chambers, whose technique has been the subject of so much admiration on both sides of the Atlantic; on immunochemistry, by Michael Heidelberger of Columbia University; and on the biochemistry of bacteria, yeasts and moulds, by P. W. Clutterbuck and H. Raistrick, who need no introduction to English readers.

The other contributors from Great Britain are J. C. Drummond (vitamins), Philip Eggleton (chemistry of muscle), John Knaggs (bone and teeth), and R. H. A. Plimmer (proteins). Moreover, many of the remaining 22 American names are household words among British biochemists, including those of Bloor, Cori, Luck, McCollum and Shohl.

Applying the method of random sampling to the book has revealed its usefulness quite apart from academic instruction. The chapter by Tipson, a colleague of Levene, gives exactly the information on nucleic acids that is required by any biochemist coming fresh to the subject. Drum-

mond's summary of the vitamin position is comprehensive and accurate, but has not Mattill equal claims with Evans and Sure to independent 'discovery' of vitamin E? Also it is surely not quite correct to say that irradiated ergosterol contains no toxic product other than calciferol itself, for the existence of toxisterol, which is not anti-rachitic, must be accepted as established by the Göttingen school, and tachysterol, the irradiation intermediate of lumisterol and calciferol, is also known to have marked toxic properties, though it shows no anti-rachitic potency. The important work of Williams and his colleagues at Columbia University promises to bring vitamin B₁ into the category of those vitamins the precise chemical constitution of which is known, but was apparently published too recently for Drummond to survey it in a chapter that was clearly saying the last word on all the vitamins at the time it was written.

Drummond's success in disentangling the 'vitamin B complex' story is worthy of high praise; not less so is Dr. Harrow's attempt to summarise the chemistry of all the hormones in the twelve pages of the thirtieth and last chapter. Some mention of Collip's theory of 'anti-hormones' might here have found an appropriate place. It is unexpected to find the nitro-phenols and ephedrine mentioned in this chapter, but quite justifiable and a good example of the editors' novel method of approach to many biochemical problems.

Sobotka's chapter on sterols and related substances brings out, as it should, the highly suggestive relationships between these normal constituents of animal and vegetable oils, certain hormones, at least one of the vitamins, and the carcinogenic compounds synthesised by Cook, Dodds *et al.*, but we have been unable to find mention

of the equally intriguing connexion with certain saponins and cardiac glycosides. It would have been useful, too, to have given for the two forms of "œstrin" the terms œstrone and œstriol, since they are rapidly receiving international recognition.

We have detected few printer's errors, and we can wholeheartedly commend the layout and production of the book, which has the unusual feature that it will open flat at any page. It would have been better, however, to combine the table of contents and the descriptions of the contributors

into a single table, and also to print the contributors' names at the heads of the chapters, instead of at the ends.

The whole book is an example of what excellent results may be achieved by the collaboration of English-speaking workers of two nations, provided always that the chairman—or editor—knows his job. In this instance the editors must have begun the task with a clear notion of exactly what they were trying to do, and it can be honestly said that they have succeeded in doing it.

A. L. BACHARACH.

Production and Use of Short-Wave Radiation

(1) Short Wave Therapy:

the Medical Uses of Electrical High Frequencies. By Dr. Erwin Schliephake. Authorized English translation by Dr. R. King Brown from the second and enlarged German edition. Pp. xiv+238. (London: The Actinic Press, Ltd., 1935.) 21s.

(2) Grundriss der Kurzwellentherapie

Physik, Technik, Indikationen; Einführung in die physikalisch-technischen und medizinischen Grundlagen der Anwendung kurzer elektrischer Wellen für Ärzte und Biologen. Von Dr. Wolfgang Holzer und Dr. Eugen Weissenberg. Pp. vi+189. (Wien: Wilhelm Maudrich, 1935.) 8 gold marks.

(3) Foundations of Short Wave Therapy:

Physics—Technics—Indications; an Introduction to the Physico-Technical Principles and Medical Applications of Short Electric Waves, for Physicians and Biologists. Physics and Technics, by Dr. Wolfgang Holzer; Medical Applications, by Dr. Eugen Weissenberg. Translated by Justina Wilson and Charles M. Dowse. Pp. 228. (London: Hutchinson's Scientific and Technical Publications, 1935.) 12s. 6d. net.

THE application of high radio-frequency currents to curative medicine and surgery has received considerable attention from research workers for some years past. The development of the technique at very high frequencies above 30 million cycles per second (wave-lengths below 10 metres) has materially increased the scope of this application. At these frequencies, thermal treatment of disease can be carried out by means of capacity currents in the body, which is placed between the plates of a condenser in the oscillatory circuit. By a suitable choice of frequency, the currents can be made to have a varying heating effect in different kinds of tissue; in this way it may be possible to apply thermal treatment to a

diseased portion of the body, while leaving the surrounding portions almost unaffected.

(1) Dr. Schliephake is already well known as an active worker in this field on the Continent, and it is useful to have available an English translation of his book on the subject. The bulk of the volume deals with the application of high-frequency electrical oscillations to the treatment of various diseases. The influence of the electric field on the growth of bacteria is described, together with the physiological and pathological effects on men and animals. Many examples are given of successful treatment by this method, these being largely derived from the author's own experience.

(2) More than two thirds of the second book is devoted to a discussion by Dr. Holzer of the practical methods of the production of very high-frequency electrical oscillations, and to the thermal effects resulting from their application. In the remaining portion, Dr. Weissenberg describes the medical application, with the results obtained in the treatment of various diseases. The book concludes with a bibliography of nearly 250 references on the whole subject.

(3) Quite recently an English translation of the foregoing book by Holzer and Weissenberg has appeared and this will be appreciated by those interested in the study of this subject.

The assessment of the value of this form of treatment of bodily diseases must naturally await a period of trial of its actual application to medical practice. It is evident from the pioneer work already carried out that there are many aspects of the subject which await closer and more systematic investigation: in the meantime, however, it is useful to have, in the form of the books here referred to, a summary of the work already carried out, and this will be found of great interest to all those concerned with the subject of physical medicine.

British Rainfall 1934:

the Seventy-fourth Annual Volume of the British Rainfall Organization. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1934 as recorded by over 5,000 Observers in Great Britain and Ireland. (M.O. 385.) Pp. xvi+299. (Air Ministry: Meteorological Office.) (London: H.M. Stationery Office, 1935.) 15s. net.

THE total rainfall during 1934 in the British Isles was exactly normal or 100 per cent, the figure for England and Wales being 95, Scotland 110 and Ireland 105. The run of mainly dry months which began in November 1932 continued through part of the year, and the effect of the drought is illustrated in the frontispiece, which shows Rudyard Lake in Staffordshire dried up. The event of the year, however, was the intense and persistent rain of the very warm December—in many places the wettest December on record. In this month nearly every part of the British Isles was wet, but by far the greatest excess occurred in the south of England, where in a few places the rainfall was more than 300 per cent of the average. The entire south-west of England and most of Wales had between 10 in. and 20 in. in December, as did also the Downs in the counties south of the Thames. Places on the flanks of Dartmoor received the enormous amount of 25 inches—not much less than that which fell on Snowdon, which had the greatest monthly total, namely, 30.8 inches. Practically none of the country south of the Thames had less than 6 inches, but north of the Thames, in the Midlands and East Anglia, the amount was below 5. This distribution was quite typical of very wet winter months in the south of England, where the rains in the hilly country south of the Thames are often very intense.

Original articles include one by Dr. J. Glasspoole giving a useful collection of heavy falls of rain in 24 hours from 1865 until 1934; another by Messrs. Bilham and Hay on rains at Kew lasting between 1 and 48 hours during the period 1878 to 1927, and a third by Messrs. Bilham and Lewis on a 'day and night' rain-gauge.

L. C. W. B.

Essentials of Tissue Culture Technique

By Gladys Cameron; Illustrations and Chapter on Photomicrography by C. G. Grand. Pp. xvi+134+9 plates. (New York: Farrar and Rinehart, Inc., 1935.) 3 dollars.

THIS admirable book should be acquired by everyone who uses the tissue culture technique. It contains delightfully clear and precise descriptions of most of the chief tissue culture methods and the apparatus and laboratory accommodation required, and also deals in great detail with such general matters as the arrangement and ventilation of the laboratory, sterilisation, cleaning of glassware and the preparation of physiological solutions. There is a chapter by C. G. Grand devoted to photomicrography, and the book concludes with four useful appendixes, one of which enumerates the principal pitfalls which the beginner is likely to encounter, and will doubtless prove a boon to many readers. The references to

literature are listed in a bibliography and should have been more carefully checked, as at least two of the references to special techniques are wrong.

Although some of the procedure recommended is in the reviewer's experience unduly elaborate, the author very sensibly distinguishes between necessity and luxury when discussing equipment, and suggests cheap and serviceable substitutes for some of the more costly articles recommended. This greatly enhances the value of the book for those whose laboratory funds are limited.

The author is to be congratulated on having treated a complicated subject in such an orderly and lucid manner, and even research workers with considerable experience of tissue culture are likely to find useful information in this volume. H. B. F.

India's New Constitution:

a Survey of the Government of India Act 1935. By J. P. Eddy and F. H. Lawton. Pp. xi+239. (London: Macmillan and Co., Ltd., 1935.) 6s. net.

IN preparing this summary of the provisions of the Government of India Act, 1935, the authors, of whom one is an ex-judge of the High Court of Judicature, Madras, have shown a full appreciation of the importance of the historical point of view. They indicate how, in its main provisions, the act represents a logical development of a policy, which has been followed, slowly, but on the whole consistently, over a long period of time—the policy of introducing Western representative institutions into India. To grasp this is an essential condition of an understanding of the present position and of the conditions which have preceded it. Hence in each section of their exposition of the terms of the act, as for example in regard to the Crown, the States, federation, provincial autonomy and like matters, the way for examination of the relevant provisions is prepared by brief, but lucid, summaries of the essentials of earlier development.

Although intended primarily for the assistance of the layman, a free use of textual quotation, references to cases of constitutional interest and detailed appendixes make this a handy book of reference for the professional man.

A Textbook of Practical Botany:

for Intermediate and Higher School Certificate Students. By Dr. William Leach. Pp. x+160. (London: Methuen and Co., Ltd., 1935.) 4s.

THIS publication is the outcome of experience gained by the author in the organisation and supervision of large classes of students. The subject matter and material, however, do not differ from that chosen for most elementary courses in the subject. The book covers the syllabus of university intermediate and Higher School Certificate courses. At this stage, few students find a practical book necessary, or even desirable. The book should, however, prove valuable to 'private' students, and also as a useful guide to teachers who wish to organise a similar course in practical botany.

The Beilby Layer

By G. I. Finch and A. G. Quarrell

THE nature of polish has aroused considerable interest for nearly three centuries. Thus Hooke¹, in 1665, showed that grinding merely forms grooves, the fineness of which is determined by the grain-size of the abrasive, and from this he argued that the effect of a polishing powder was simply to cut very fine grooves. Herschel² supported this hypothesis in that he regarded polishing as equivalent to a grinding action producing grooves of such fineness as to be invisible under the microscope.

This view was generally accepted until 1901, when Rayleigh³ pointed out the difference in effect produced by the same powder according to the nature of the backing material which served to force the polishing powder into contact with the surface. Thus he showed that only a matt finish could be obtained when a fine emery powder was backed by a glass sheet, whilst a pitch backing enabled a polish to be achieved. Rayleigh concluded that with a yielding support, such as pitch, the material is worn away almost molecularly. Between 1902 and 1921, the late Sir George Beilby⁴ made a close microscopic study of the effects produced by polishing a wide range of substances, and came to the conclusion that polish was the result of a flowing of the material, whereby the surface became coated with an amorphous layer. Among other striking experiments, he polished an antimony surface which had previously been ground with finest emery paper. Beyond occasional circular holes with smooth, rounded edges, the appearance of which was consistent with viscous flow of the antimony surface, no trace of the grinding furrows could be detected in the polished surface. Etching, however, removed the polished layer and restored to view the furrows left by the emery.

Beilby also postulated the formation of an amorphous layer whenever two crystal faces are rubbed together. Thus, he explained the hardening of metals produced by cold-working as being due to the formation between sets of slip planes of an amorphous cementing layer inhibiting further slip. It was this extension of Beilby's theory which first attracted most attention and led to its being vigorously attacked, particularly by Continental workers. Benedicks⁵, in particular, in refusing to accept the idea of an amorphous surface layer, reiterated his belief in the crystalline nature of the polish layer and suggested, indeed, that Beilby's

results really supported this older view. To account for the hardening of metals, Benedicks postulated a process of multiple twinning leading to an interlocking of the crystals, whilst Tammann⁶ maintained that a repeated cleavage would suffice to account for the known phenomena without the assumption of the formation of an amorphous material. It was also suggested that the mechanical production of a vitreous layer under conditions in which only the crystalline state should be stable was improbable; but Desch⁷, who was an early supporter of Beilby's views, has pointed out that this objection does not take account of the fact that the laws of heterogeneous equilibrium as usually expressed are only applicable when the pressure considered is of the hydrostatic kind, and quite different conditions may obtain when unsymmetrical pressure is applied. He also believed that Tammann's explanation, which envisaged the formation of intercrystalline cavities, was unlikely, whilst Gough⁸ rendered Benedicks' hypothesis untenable by showing that single crystals of face-centred cubic metals did not necessarily twin even though they hardened on working.

Desch⁷ has enumerated a number of properties of the polish surface which on the whole appear to support Beilby's hypothesis. Thus the polish layer displays greater chemical activity and is anodic to the crystalline material. The density is less than for the crystalline substance, which would be expected since a random arrangement occupies a greater space than a regular packing. On polishing a metal, the electrical conductivity is diminished and the hardness increased.

Thomson⁹ was the first to take advantage of the new technique of electron diffraction in order to throw fresh light upon the structure of the polish layer. X-rays are unsuitable for this purpose because they are scattered in the main by extra-nuclear electrons, with the result that, owing to deep penetration, any information they might have given about the structure of the surface film is masked by the effects produced by the underlying material. Electrons, however, are scattered almost wholly by the nucleus, and the penetration is therefore slight. Hence any structural evidence obtained by the scattering of electrons from a surface is restricted to the immediate surface film. Thomson was unable to obtain patterns from polished surfaces of metals such as gold, iron, lead,

aluminium and copper, and attributed this to the surface being covered with an amorphous layer resembling a super-cooled liquid.

A more detailed examination was carried out by French¹⁰, who followed by electron diffraction the change in structure with increasing degree of polish. He found that the sharp rings given by the originally crystalline surface became more and more blurred as the polishing progressed until, with the highest polish, the pattern consisted of two indistinct broad haloes on a diffuse background. French concluded that the ring broadening was due to a decrease in crystal size and that the breadth of the haloes in the final polish pattern could be explained by supposing either that the crystals had been reduced in size until they contained only a few unit cells, or that the process had gone so far as to destroy all semblance to a crystalline structure, leaving an amorphous film in which the limiting distance of atomic approach was the only orderly feature. Such a structure should give a pattern similar to that afforded by a gas or liquid, the halo radii depending upon the closest distance of atomic approach; and using Wierl's¹¹ relationship, French found by calculation halo radii agreeing fairly well with those of his polish patterns.

Randall and Rooksby¹², in criticising these conclusions, suggested that the haloes obtained by French were in effect the two most prominent normal pattern rings blurred by reduction in crystal size, such blurring and consequent increase in background leading to the disappearance of all other rings. They attributed any discrepancy between ring and halo radii to the effect postulated on theoretical grounds by Lennard-Jones, according to which the lattice parameters of small crystals should differ from those of larger crystals. Randall and Rooksby based their criticisms mainly upon a series of X-ray patterns of graphite and various carbons; but it may be pointed out that whereas only two of the graphite pattern rings are intense, the crystalline surfaces of the metals studied by French give rise to several prominent rings, though the corresponding polish patterns only contain two haloes.

Germer¹³, who maintained that the polish layer was crystalline, obtained merely a general scattering from polished surfaces and attributed this to the surface being so levelled that the electrons entered and left through the same crystal face, and he expressed the view that, with a comparatively slight inclination of the reflecting faces to the surface, an inner potential of 15 volts would, in the case of nickel, for example, suffice to merge all the rings into a generally diffuse background. It is difficult to see how this result can be arrived at; furthermore, Germer's view does not take into

consideration the existence of the haloes in French's patterns.

Kirchner¹⁴ regarded the polished surface as polycrystalline and attributed French's results to a specular reflection, the slight displacement of the maxima being due to refraction. In recalling Thomson's view that reflection from a polycrystalline surface is essentially a case of transmission through crystallites projecting above the surface, Kirchner pointed out that broadening of the rings with increasing degree of polish is not necessarily evidence of a reduction in crystal size, but may be equally well ascribed to a levelling of the surface such as to reduce the extent to which the crystals project above it. This effect should lead to a broadening of the rings until groups of neighbouring rings merged together to form ill-defined haloes.

Raether¹⁵, who had been associated with Kirchner in his earlier experiments, later gave an account of the structural changes observed during the mechanical working of surfaces. Polished, burnished and hammered iron, nickel, copper, silver, cadmium and gold surfaces all gave the characteristic halo pattern observed by French. According to Kirchner's explanation, the inner halo should lie between the 111 and 200 diffractions in the case of face-centred cubic metals; but although Raether found that this was so with gold and silver, for metals of lower atomic number such as nickel and copper the halo lay inside the 111 ring. The atomic separations calculated from the two halo radii by Prin's¹⁶ intensity distribution function for a liquid agree so satisfactorily as to support the view that the haloes are due to diffraction by a monatomic liquid. He therefore concluded that not only polishing, but also burnishing and hammering, cause a superficial layer, between 10 Å. and 100 Å. thick, either to flow or to break up into crystallites containing only a few unit cells, which are so pressed together as to give a compact structure in which the metal atoms are in densest packing with a mean distance of atomic approach.

Raether also examined polished single crystal faces of various non-conductors such as rocksalt, calcite, fluorite and pyrites, and obtained patterns which were typical either of reflection from the single crystal face or transmission through projecting crystal fragments integral with the main single crystal or through loose fragments on the crystal face. The halo pattern, however, never appeared. Hopkins¹⁷ also failed to obtain any evidence of a vitreous layer on polished calcite.

Darbyshire and Dixit¹⁸ extended French's experiments, particularly to structures other than cubic, and also obtained halo patterns with a ratio of the corresponding spacings of 0.55 as previously found by Raether. The interatomic distances calculated from the halo radii by

Ehrenfest's equation compared well with those given by Keesom's relationship in the case of zinc, gold, silver, molybdenum, copper, chromium, silicon and selenium; but were too low in the case of bismuth, antimony, tellurium, cadmium and lead, sometimes by as much as 20 per cent. But these metals, and also tin which Miwa¹⁹ found to behave similarly, are exceptional in that, as has been pointed out by Hume-Rothery²⁰, ionisation is probably more or less incomplete in the solid. Darbyshire and Dixit concluded that all their halo patterns were due to the amorphous condition of the polish layers. On the other hand, Miwa, whilst accepting the vitreous layer idea in the case of copper, silver, chromium, iron, cobalt, nickel and zinc, attributed the patterns of abnormally large halo radii obtained from polished tin, cadmium and antimony to crystallites of such minuteness as to have very low resolving power. In support of this view, however, Miwa relies largely upon an antimony film obtained by condensation *in vacuo* being amorphous, though his corresponding pattern affords clear evidence of its being composed of exceedingly small crystals.

Kirchner²¹, in still adhering to the view that the polish layer is crystalline, bases his objections to Beilby's theory on experiments in which he has found that evaporated metal films often give halo patterns by reflection but sharp rings by transmission, and he ascribes this to a difference in the grain size effective in diffracting the beam. Thomson²², however, has pointed out a difficulty in accepting this explanation in so far as relates to the patterns from polished metals. Since there is no appreciable effect of refraction, the surfaces through which the electrons pass must make angles exceeding about 5° with the electron beam. Taking the effective penetration of electrons as 4×10^{-6} cm. and the angle as 5° , the depth of the part of the crystal affected would be at least 2×10^{-7} cm., and this would be sufficient to give very much sharper rings than are, in fact, observed from a polished surface.

Thus although at this stage the balance seemed on the whole to incline towards Beilby's view of the nature of polish on metals, the issue was still in doubt when Finch, Quarrell and Roebuck²³ discovered that the polish layer has the peculiar property, not possessed by the corresponding crystalline metal surface, of being able to dissolve crystals of a foreign metal at room temperature. Their experiments consisted in forming a crystalline metal film on a cool metal substrate by condensation in the evacuated electron diffraction camera. During deposition, the development of the pattern was observed on the fluorescent screen and the subsequent changes followed. The substrate was either highly polished or consisted of a previously

polished surface which had been suitably etched to expose a polycrystalline surface. The polished surface gave no coherent pattern when the initial treatment had consisted of a vigorous high-speed buffing, though specimens polished entirely by hand gave typical halo patterns. The absence of haloes in the case of the buffed specimens was probably due, as Thomson²⁴ has suggested, to a slight waviness of the surface producing so much further blurring due to variable refraction as to lead to their virtually complete submergence in the general background.

It was observed by Finch, Quarrell and Roebuck that immediately upon deposition of a zinc film on polished copper, a brilliant and well-defined diffraction pattern characteristic of crystalline zinc was obtained which, however, rapidly faded, until after a few seconds no vestige of the pattern remained, thus showing that the crystalline structure had been destroyed. In one experiment, twelve successive zinc deposits were flashed over, and with each layer, except the last, the diffraction pattern vanished at a rate decreasing with each successive deposit. Thus the pattern yielded by the last layer but one was still faintly visible four minutes after deposition, but had completely vanished after five minutes, whilst after an initial period of weakening the pattern from the last deposit remained unchanged, even after four hours. Evidently the zinc layers had been dissolved by the polished copper surface and formed a solution which, with the final zinc layer, became saturated. On the other hand, a single zinc film deposited on an etched, that is crystalline, copper substrate gave a pattern which showed neither loss in brilliancy nor other change in appearance during the $1\frac{1}{2}$ hours for which it was observed. Similar results were obtained with zinc, lead, silver, tin and later with cadmium and lithium deposited on polished and etched substrates of copper, iron, zinc, lead and gold. Finch, Quarrell and Wilman²⁵ also found that whilst electrodeposition during 30 seconds at 0.1 amp./dc.m.² sufficed to form a permanent crystalline zinc layer on crystalline copper, three minutes were necessary if a polished copper electrode were used as substrate.

Just as the persistence of the diffraction pattern from the deposit on an etched substrate is evidence of the permanence of its crystal structure, so is the disappearance of the pattern when a polished substrate is used proof of the loss of crystalline structure in the deposit; and we are left with the conclusion that the polish layer, unlike the crystalline surface, readily dissolves metal crystals and in so doing exhibits a property typical of the metal in the liquid state. Thus the evidence in support of Beilby's conception of the vitreous nature of the polish layer seems conclusive.

Hopkins²⁶ and Lees²⁷ have recently measured the thickness of the Beilby layer on polished metals. Hopkins thinned the polish layer by cathodic sputtering under conditions permitting of measuring the rate of removal, and he found that a hand-polished gold surface gave a pattern characteristic of crystalline gold after a layer of about 30 Å. had been removed by sputtering. Lees, in working with gold and copper surfaces, reduced the polish layer by electrolytic etching and arrived at similar estimates of thickness, and also concluded that the polish film was supported by a layer of crystals orientated by the polishing action.

It is natural to suppose that the depth of the Beilby layer is influenced by the vigour of the polishing action, and several observations have been made which confirm this. Thus it is not easy to demonstrate the solution of zinc crystals in a lightly hand-polished copper surface, though the effect is so striking when the final polishing is preceded by a vigorous machine buffing. Also, Finch, Quarrell and Wilman²⁵ have examined the working surfaces of four aeroplane engine cylinder sleeves. Two were honed and ready for service whilst the others had been run-in for 40 hours and 140 hours respectively. After removal of the protective grease layer by washing with petrol-ether, the external and internal surfaces of the virgin sleeves both yielded patterns characteristic of a random crystal structure and in which α -iron rings

were prominent. The run-in surfaces, on the other hand, after degreasing gave the halo pattern typical of the Beilby layer. The thickness of this layer was such that although a single light stroke with No. 000 emery paper sufficed to break through the Beilby layer on a hand-polished steel specimen, several such abrasions were necessary before the haloes gave way to the normal ring patterns of the virgin sleeve surfaces. Thus it seems that the process of running-in an internal combustion engine can be likened to a vigorous polishing action, in that it consists in the formation on the working surfaces of an amorphous Beilby layer of considerable depth.

¹ Hooke, "Micrographia", Observation II (1665).

² Herschel, quoted by Rayleigh, *Proc. Roy. Inst.*, **16**, 563 (1901).

³ Rayleigh, *Proc. Roy. Inst.*, **16**, 563 (1901).

⁴ Beilby, "Aggregation and Flow of Solids", Macmillan (1921).

⁵ Benedicks, *Rev. Met.*, **19**, 505 (1922).

⁶ Tammann, *Z. anorg. Chem.*, **113**, 163 (1920).

⁷ Desch, "The Chemistry of Solids", p. 164, Cornell University Press (1934).

⁸ Gough, Aeronautical Research Committee, Rep. and Mem., 1432 (1930).

⁹ Thomson, *Proc. Roy. Soc., A*, **128**, 649 (1930).

¹⁰ French, *Proc. Roy. Soc., A*, **140**, 637 (1933).

¹¹ Wierl, *Ann. Physik*, **8**, 521 (1931).

¹² Randall and Rooksby, *NATURE*, **129**, 280 (1932).

¹³ Germer, *Phys. Rev.*, **43**, 724 (1933).

¹⁴ Kirchner, *NATURE*, **129**, 545 (1932).

¹⁵ Raether, *Z. Phys.*, **86**, 82 (1933).

¹⁶ Prins, *Z. Phys.*, **56**, 617 (1929).

¹⁷ Hopkins, *Trans. Farad. Soc.*, **31**, 1127 (1935).

¹⁸ Darbyshire and Dixit, *Phil. Mag.*, **108**, 961 (1933).

¹⁹ Miwa, *Sci. Rep. Tôhoku Imp. Univ.*, **24**, 222 (1935).

²⁰ Hume-Rothery, "The Metallic State", p. 307, Clarendon Press (1931).

²¹ Kirchner, *Trans. Farad. Soc.*, **31**, 1114 (1935).

²² Thomson, *Trans. Farad. Soc.*, **31**, 1116 (1935).

²³ Finch, Quarrell and Roebuck, *Proc. Roy. Soc., A*, **145**, 676 (1934).

²⁴ Thomson, *Phil. Mag.*, **18**, 640 (1934).

²⁵ Finch, Quarrell and Wilman, *Trans. Farad. Soc.*, **31**, 1077 (1935).

²⁶ Hopkins, *Trans. Farad. Soc.*, **31**, 1095 (1935).

²⁷ Lees, *Trans. Farad. Soc.*, **31**, 1102 (1935).

Metallic Wear in the Presence of Lubricants

THE sliding of one metal surface over another without the occurrence of an undue amount of wear is a problem which arises in every branch of engineering. Successful lubrication and the maintenance of a bearing surface depend upon a wide variety of factors, including those of a mechanical, a metallurgical and a chemical nature. Wear is largely determined by the affinity of one metal for another, the fouling or adhesion of one to the other leading to a roughness; the extent of this roughening and of the consequent wear is determined by the continuity of the film of lubricant separating the two metals, this continuity in turn depending upon the nature of the lubricant and the load it can support without rupture of the film. Our knowledge of lubricated surfaces was extended in 1932 by the work of Parish and Cammen in America, who found that below the film of lubricant there exists a small quantity of oil in the cavities or pores of the

surface layers of the metal. Since this work was carried out, however, very little attention seems to have been given to the problems of metallic wear, despite their great importance to engineers, metallurgists, chemists and physicists.

Major interest in metallic wear centres to-day upon the problems involved in the successful running of automobile and aeroplane engines. Here bearing pressures and temperatures are high, and every endeavour must be made to provide bearing surfaces which will give a satisfactory service life under the stringent conditions imposed. Despite the existence of one or two contradictory examples, the old-established concept of a duplex structure, of hard particles embedded in a softer matrix, still prevails, and shows no indication of being superseded. There is, however, one other aspect of metallic wear upon which a certain amount of attention has recently been focused; this is associated with problems of die-fouling in

the pressing of hollow metal products, where pressures are heavy and drawing speeds relatively high. The adhesion of the metal being drawn to the working surface of the die steel resembles the seizure of a bearing, and the effects of load, speed, temperature, lubrication and nature of the metal surfaces in contact all play an important part in the phenomenon as a whole.

A METHOD OF WEAR TESTING

This interesting phase of the study of metallic wear formed the basis of a paper recently contributed by Dr. H. W. Brownsdon in opening a general discussion on the subject organised by the Institute of Metals. It was found that experimenting on the actual drawing equipment was slow and inconvenient, and that some means for making rapid comparative tests under controlled conditions was required for the fuller investigation of the phenomenon. Accordingly a simple machine was designed and constructed (Fig. 1), consisting primarily of a hardened steel wheel about 1 inch in diameter, rotating in contact with flat samples of the metals under investigation, under known conditions of load, speed, lubrication, time and temperature. A measure of the amount of wear is thus given by the length of the oval impression made in the sample (Fig. 2).

Early in the investigation it was found that alloys differ considerably in the degree to which fouling of the steel wheel occurs, and that wear,

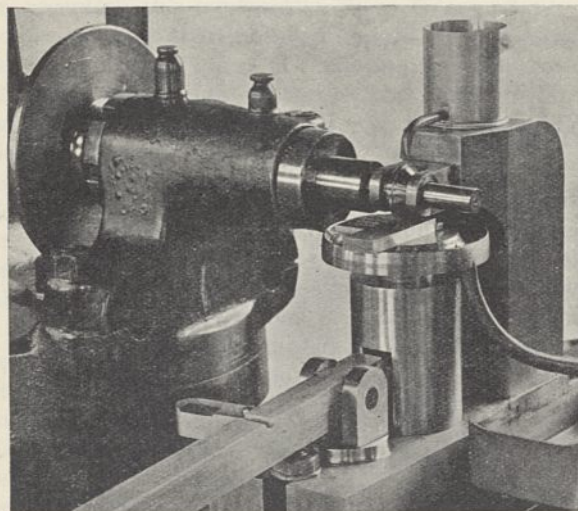


FIG. 1. Wear testing machine.

as measured by the length of the impression, increases with fouling of the wheel. It was also found that the results obtained with a particular alloy when using a mineral oil and a soap solution may vary considerably, and that the value of a lubricant as a preventative of wear cannot be completely determined apart from the metals or

alloys with which it is used. The value of additions such as oleic acid and stearic acid to a straight mineral oil in the improvement of lubricating properties was clearly brought out in the experiments made. The effect of time upon wear was also discussed by Dr. Brownsdon, the results indicating that wear occurs in the early stages of

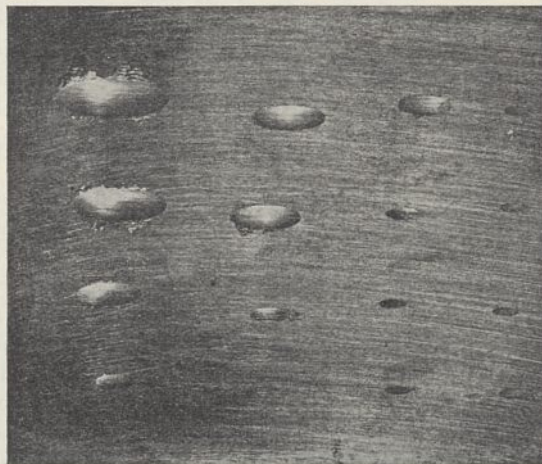


FIG. 2. Form of impression made in wear testing.

the experiment when the load per unit area is high, the film of lubricant later building up to such a thickness as to prevent further serious wear.

Another result illustrating the complexity of the study of wear problems, and one showing that every condition of material and lubricant has to be considered separately, is that when a straight mineral oil is used, the behaviour of cupro-nickel is better than that of the brasses, whereas with castor oil of the same viscosity there is less wear on the brasses than on cupro-nickel.

Experiments with seven different oils on various metals gave widely different results with variations in the roughness of the wheel and of the load. An austenitic stainless steel showed quite good wearing properties when the wheel had an 00 emery finish, whereas, using a wheel with a 1M finish, the wear was greater in that material than in any other employed. These tests again emphasised the necessity for carrying out a series of tests under widely varying conditions before attempting to draw wide and general conclusions.

THE MECHANISM OF WEAR

An important contribution to the discussion which followed the presentation of Dr. Brownsdon's paper was made by Dr. N. K. Adam, who maintained that the contact between metal surfaces is probably at a very few points only at any one moment. The process of wear is thus a matter of adhesion between the points on opposite surfaces which are in contact; it might indeed be assumed

that wear occurs only at points where molecular contact exists. The function of the film of lubricant is to prevent such contact—to provide a cushion between the metal surfaces thick enough to prevent the molecular attractions of one surface reaching across to the other. A high adhesion between the oil and the metal tends to prevent the squeezing out of the film, which accounts for the beneficial effect of certain additions to mineral oils.

Dr. F. P. Bowden referred to some recent experiments showing that the frictional heat developed on sliding can raise the surface temperature of metals sufficiently to cause melting at the points of contact. Measurements had provided direct evidence that the surface flow of metals in polishing is brought about by actual melting, and

it was suggested that under many conditions of sliding and rubbing, the high temperature and the melting of the surface are important factors in the wear of metals.

The method of wear testing devised by Dr. Brownsdon was criticised by a number of speakers in the discussion, mainly on the grounds that the conclusions derived from the test were not in agreement with the results of long practical experience of the relative merits of alloys employed for bearing purposes and of the value of the duplex microstructure. Examples were cited of results completely negated in practice. On the other hand, the test has proved of value with extreme pressure lubricants and is capable of giving reproducible results in the hands of other workers.

Obituary

Prof. C. Lloyd Morgan, F.R.S.

CONWY LLOYD MORGAN, who died at his house in Hastings on March 6, at the age of eighty-four years, was born in London on February 6, 1852, the second son of a solicitor, J. A. Morgan. On reaching boyhood, he was sent to the Royal Grammar School, Guildford, which was in those days an essentially classics school, with Dr. Merriman as headmaster, an Oxford scholar of considerable distinction. On leaving school, and with the view of taking up engineering as a profession, Lloyd Morgan proceeded to the Royal School of Mines, where he was Duke of Cornwall scholar, Murchison medallist and De la Beche medallist. Here in due time he gained his diploma as associate in mining and metallurgy.

But during the period of his professional training, the rector of Weybridge, where his parents were then living, induced Lloyd Morgan to read Berkeley's "Principles" and Hume's "Enquiry", chiefly as an initiation into the realm of philosophy. Indeed, under this guidance he began at length to wrestle with Spinoza, "quite the finest bit of coral", he was told, "for philosophic gums". Immediately after obtaining his diploma, he spent several months on a tour to North America and Brazil, during which time, partly through reading Darwin's "Voyage of a Naturalist", he became deeply interested in biological science. In fact, before setting out on this tour, he was fortunate enough to come under the influence of T. H. Huxley; and when, on one occasion, he told him of his interest in philosophy, Huxley remarked: "Whatever else you may do, keep that light burning. Only remember that biology has supplied a new and powerful illuminant". Accordingly, on returning to London, he followed Huxley's suggestion and took a course under him in biology at South Kensington, working also in his laboratory. A few encouraging words from

Huxley lent support to the conviction at which he had gradually arrived, that the borderland problems of life and mind afforded a promising plot for an effort at intensive cultivation under the spade work of careful observation.

The thought of engineering as a profession was consequently abandoned. Yet Lloyd Morgan had somehow to earn a living, and tried his hand at teaching. After occasional work in schools, he obtained in 1878 the post of lecturer (in physical science, English literature and constitutional history) at the Diocesan College, Rondebosch, near Cape Town. There he served for five years. Shortly after his return to England, he was appointed as lecturer in University College, Bristol, to carry on, for the rest of the session 1883-84, the work in geology and zoology relinquished by Prof. W. J. Sollas, who had been called to Trinity College, Dublin. At the close of that session, his appointment as lecturer was renewed; and in due course he became professor, Sir William Ramsay being at that time principal of the College. When Ramsay in 1887 accepted the chair of chemistry in University College, London, Lloyd Morgan succeeded him as principal of the Bristol College and continued to hold this office until 1909. In the capacity of principal he worked assiduously to place the College in such a position as to justify the grant of a university charter; and, when ultimately in 1910 the charter was obtained, it was generally recognised that it was largely through his persistent efforts. He accepted the position of first vice-chancellor of the new University, but only on the understanding that it was to be an interim appointment; and when, after three months, Sir Isambard Owen was chosen for the office, he relinquished it, and became the first occupant of the new chair of psychology and ethics. This chair he held until he retired in 1919, at the age of sixty-seven years.

Possessed from early life, as he himself has recorded, with an ineradicable *cacothetes scribendi*, Lloyd Morgan was a voluminous writer. During his Bristol period he published: "The Springs of Conduct; An Essay in Evolution", in 1885; "Animal Biology", in 1887; "Animal Life and Intelligence", in 1890; "Introduction to Comparative Psychology" and "Psychology for Teachers", in 1895; "Habit and Instinct", in 1896; "Animal Behaviour", in 1900; and "Instinct and Experience", in 1912. After his retirement, there appeared from his pen two volumes of Gifford Lectures, delivered in St. Andrews, entitled "Emergent Evolution", in 1923, and "Life, Mind and Spirit", in 1926; "Mind at the Crossways", in 1929; "The Animal Mind", in 1930; and "The Emergence of Novelty", in 1933. He was also a frequent contributor to NATURE, *Mind* and other periodicals, and was the author of several articles in the "Encyclopaedia Britannica".

As one of the borderland problems of life and mind, it was natural that Lloyd Morgan's early researches should be directed upon the facts of instinct. Soon after settling in Bristol, he undertook a prolonged series of experiments and observations on young chicks and ducklings hatched in an incubator with the object of ascertaining the relation of instinct to intelligence. As an outcome partly of these investigations, he reached the general conclusion that while instinct and intelligence are in the most intimate relationship throughout very nearly the whole range of animal behaviour, yet the original exercise of an instinct cannot be determined by intelligent consciousness. Instinctive behaviour comprises, then, those complex groups of co-ordinated acts which, though they contribute to experience, are, on their first occurrence, not dependent on individual experience. Such initial instinctive behaviour depends solely on how the nervous system has been built through heredity; and it is, he urged, the business of scientific interpretation to disentangle the factors that are prior to individual experience and those that result therefrom.

Later, Lloyd Morgan devoted much attention to the problems of colour vision. Acknowledging that there is a physical world of current events, existent in its own right, in so far as it is in nowise dependent upon being perceived by any finite mind, he yet resisted the view that colour has its being in that physical world. Colour as experienced is, he insisted, an indication or a sign of the presence of specific chemical changes in the retina and the choroid under advenient electromagnetic influence. It is there that colour signs have their genesis; it is thence that they are projicient on to the objects of vision. Colour, in other words, is the psychic sign correlated with certain specific events in the organism. In fact, secondary qualities generally may be said to be properties extrinsically real in relation to our persons—not only our minds but also our bodily organisation, as recipient of advenient influence and as the seat of intervenient processes and thus contributory to projicient reference.

It was doubtless largely through these and other allied biological researches that Lloyd Morgan was

led to the more ambitious project of attempting to build a philosophy on scientific foundations. The system of thought which he ultimately propounded was what he called a philosophy of evolution, but evolution as meaning the coming into existence of something in some sense new; and this something new, in a specialised sense, he labelled, adopting G. H. Lewes's term, "emergent", as contrasted with resultant. Resultant rearrangement, he allowed, runs through the whole process of physical Nature, and gives its own type of continuity; yet it affords no sufficient interpretation of atoms, or molecules, or crystals, because it disregards the supervenience of a new kind of substantial relatedness at each critical stage in the ascending course of events. Looking then at the world at large, we find (a) an array of physico-chemical events; (b) an array of vital events which occur only in organisms; and (c) an array of mental events which occur only in some organisms. The contention is that in vital events there is a new *kind of relatedness* which does not obtain at the lower level of physico-chemical events; and, in mental events, a further kind of relatedness which does not obtain in vital events as such. The chief bar to the acceptance of this contention is, it seemed to him, the acceptance, under the influence of a long tradition, of a radical dualism between the physical and the psychical. But he rejected that dualism, and maintained that there are no physical events, no integral systems of such events, that are not also psychical events and integral psychical systems. There is one evolution in both attributes—distinguishable, but nowise separable. Hence there are not two worlds—a physical world and a psychical world—but one world, psycho-physical throughout.

Lloyd Morgan accepted, then, fully and frankly, the most thoroughgoing naturalism in the field of science, which includes the psychical no less than the physical attribute of natural reality; and in that field he found a progressive supervenience of new kinds of relatedness in accordance with an orderly plan. But philosophy, he held, cannot rest content with mere naturalism. It requires something more, something of the nature of a relating and directive Activity of which the *de facto* relatedness and the observed changes of direction (with which science is concerned) are the manifestation; and it seemed to him that Causality (as distinguished from the naturalistic causation) is the universal operation of Spirit manifested everywhere and everywhen. He discerned in Nature one immanent Causality, of which the whole course of evolution affords diverse manifestations. Emergent evolution in the temporal world is, he contended, dependent upon the eternal non-emergent being of God.

To all those who had the privilege of knowing Lloyd Morgan, his distinguished personality with its innate courtesy, its sympathetic manner, and its clear, rational insight remains a precious memory of what a life devoted to science and philosophy may mean. Lucid, methodical and facile as a lecturer, he was regarded with genuine affection by his colleagues and students of earlier and later years.

G. DAWES HICKS.

Mr. Oskar Barnack

THE optical industry is peculiarly one in which development seems to take place around individuals of special genius. We have only to think of names like Dollond, Fraunhofer, Abbe, and many others of later times to realise that this is so. Even to-day there are few optical firms without some one or two special persons around whom the whole activity seems to centre.

The firm of Leitz mourns the death, on January 16 at the age of fifty-seven years, of a technical leader in Oskar Barnack, probably best known to the world as the inventor of the Leica camera. He appears to have been a man of this type. Beginning his serious work in connexion with the design and improvement of cinematograph apparatus, he realised before the Great War that if a camera were made small and precise, pictures might be obtained which would bear a great deal of enlargement. An experimental model of the Leica was produced in 1913.

One advantage of such small cameras is that since the depth of focus for the object-space is dependent solely on the diameter of the lens, one can obtain a great depth of focus by the use of a small camera

using a lens of small actual aperture and small stop number, and the enlarged pictures have thus some advantages even over those made from cameras of larger size. Certainly the Leica has been a very popular camera since it first appeared on the market in 1924. Barnack was responsible for the design of a number of useful accessories.

Somewhat delicate in physique, Barnack was at once a firm disciplinarian, and a kindly leader of those employed under him. In this age of mass-production, it is worth while to remember how much any living industry must always owe to such individuals.

L. C. M.

WE regret to announce the following deaths :

Prof. P. F. Kendall, F.R.S., emeritus professor of geology in the University of Leeds, on March 19, aged seventy-nine years.

Mr. C. R. Richards, formerly director of the Department of Science and Technology of the Pratt Institute and a founder of the New York Museum of Science and Industry, on February 21, aged seventy years.

News and Views

Report of the Broadcasting Committee

THE Broadcasting Committee was appointed last year by Sir Kingsley Wood to consider the constitution, control and finance of the broadcasting service in Great Britain, and has now presented its report (Cmd. 5091. London : H.M. Stationery Office, 1936. 1s. 3d. net). The Committee states that it was impressed by the influence of broadcasting upon the mind and spirit of the nation and the immense issues involved. Its recommendations are directed towards the strengthening and securing of the position the B.B.C. has happily attained. It recommends that from the end of this year its charter should be extended for a term of ten years. The large measure of freedom from direct Parliamentary control makes it necessary to have some form of staff representation, and it suggests the constitution of one or more internal associations. It is difficult to give protection to those who are engaged to broadcast for remuneration. The B.B.C. should make it clear, therefore, that it welcomes criticism and that it would not exclude any person from an engagement merely because he had expressed adverse opinions on its activities. Most people will agree that the Exchequer should not retain any part of the net revenue collected from listeners until the Corporation has received an income sufficient to ensure the full and adequate maintenance and development of the service. The estimates show that during the next few years the necessary amount will be about 75 per cent of the licence revenue remaining after the deduction of the proportion required to cover Post

Office costs. The avowed policy of the B.B.C. is to hold the scales even between the various political parties, and on the whole this has been done successfully. As the broadcaster who has the last word during an electoral contest is at a great advantage because there can be no adequate reply to whatever he may say, it has been agreed that political broadcast should cease for three days before a poll.

THE published lists show that music takes up two thirds of the total time for all the programmes, and only half as much serious music is given as light music. The Committee looks forward to the time when every school will have wireless receiving apparatus as part of its normal equipment. At the present time, there are more than 3,500 schools in Great Britain regularly listening. Relay exchanges are organisations for receiving broadcast programmes and distributing them to subscribers over a local wire network. If the subscriber supplies his own loud speaker, the charge made is usually 1s. 6d. a week, but he must take out a licence. This method has the great advantage of requiring in the subscriber's premises nothing more than a switch and a loud speaker. In Germany, a standardised receiver has been designed and is sold at a low fixed price. A similar procedure in Great Britain might well be of benefit to the poorer classes, and should be considered by the B.B.C. and the wireless trade. Although direct advertisement should remain excluded from the broadcast service, 'sponsored' items, that is items provided gratuitously by any person with or

without an acknowledgment of such provision, by means of the broadcasting service, might be permitted. This would be specially useful in the earliest stages of television broadcasting. We are glad that the Committee has recommended that the Empire service should receive express authorisation and should be fostered and developed, and that the appropriate use of languages other than English should be encouraged. In conclusion, the technical investigation of interference with broadcast reception should be expedited, and compulsory limiting powers sought if necessary.

New Northern Ireland Broadcasting Station

THE new Northern Ireland Regional Station of the British Broadcasting Corporation was opened on March 20 by the Duke of Abercorn, Governor of Northern Ireland. This new transmitting station is situated at Lisburn, about nine miles south-west of Belfast. An illustrated technical description of the station given in *World Radio* of March 20 shows that the design is based upon the experience obtained by the B.B.C. in the erection and operation of the other regional stations. The total power output of the new transmitter is 100 kw., and its electrical circuit is very similar in general design to that of the long-wave national transmitter at Droitwich. In normal circumstances the power supply for the station is obtained from the system of the Electricity Board for Northern Ireland, which has installed duplicate overhead feeders connected to its 33,000 volt ring main. An emergency supply has, however, been installed, in the form of a 600 horse-power Diesel engine driving a 400 kw. three-phase alternator. In addition to the transmitter hall and machine room, the station building contains a control room and office and studio accommodation.

A FEATURE of great technical interest in the Northern Ireland station is the use of a steel mast about half a wave-length high as the actual aerial, the object of which is to reduce fading as much as possible on the outskirts of the service area. This mast is a cigar-shaped lattice steel structure, 475 feet in height, supported by two sets of stays. The base of the mast rests on a ball-and-socket carried on a heavy plate which is insulated from the concrete foundation by porcelain cylinders. The mast is surmounted by a sliding top-mast, consisting of a steel tube with a horizontal ring at the top. The maximum height of this top-mast is 75 feet, but the electrical length in use has been adjusted to suit the operating wave-length of the station. The aerial tuning circuits are contained in a building at the foot of the mast, and concentric feeders connect these circuits to the output end of the transmitter.

Dr. H. H. Poole: Award of the Boyle Medal

THE Council of the Royal Dublin Society, on the unanimous recommendation of the Science Committee, decided at its meeting on February 13 to award the Boyle Medal to Dr. H. H. Poole. Dr. Poole, in his capacity as registrar of the Society, has

charge of the Society's scientific publications and of its stock of radium, from which originates almost the whole supply of emanation for the Dublin hospitals. The method of preparation is that originally worked out by Joly and since improved by Dr. Poole, a number of whose papers relate to radium therapy. Dr. Poole's first work, beginning in 1910, was done in the geological field under Joly's inspiration, and a series of papers was published on the thermal conductivity and specific heat of minerals in their relation to the general question of continental displacement. At a later date, Dr. Poole became interested in the measurement of daylight, characteristically because his colleagues in the biological field required help. He has now made the subject of photo-electric cells and light measurement peculiarly his own, and the practical application to the measurement of diurnal and season variation in daylight and the penetration of light waves into woods and especially into the sea have been valuable. The stream of work on this subject is still in full progress, and a total of some twenty-eight papers have appeared in the last ten years, many in collaboration with Dr. W. R. G. Atkins, of the Marine Biological Laboratory, Plymouth.

American Flood Devastation

EVERY now and again, Nature seems to take an impish delight in playing havoc with man's efforts to control her vagaries, flinging aside his puny restraints and sweeping both him and his works into a common destruction. One of her most potent agencies is water, and the catastrophic visitation which, following sudden heavy rains and melting snows, descended on fourteen highly industrialised and commercial States in the eastern part of the North American continent during the past week or ten days is the latest example of her indiscriminate violence. On March 18, with little or no warning, the Pennsylvanian towns of Johnstown and Pittsburgh, notable centres of the steelwork industry, found their streets submerged to depths of 10-15 ft., and in places considerably more, so that the unfortunate inhabitants were speedily reduced to dire straits from shortage of food and drinking water. Many were compelled to spend a night of terror perched on the roofs of their houses, scantily clothed, while a number of them, approaching one hundred, regrettably lost their lives in the darkness and confusion. Johnstown was the scene of a terrible disaster in May 1889, when a reservoir above the city collapsed, causing the loss of 3,000 lives. Pittsburgh, too, had a serious flood in 1913. On the present occasion, the estimates of damage to property run to 40 million pounds sterling at Pittsburgh and to 7 millions at Johnstown, at which latter place some 8,000 persons are said to be homeless. The whole countryside, in fact, in eastern Pennsylvania has been more or less under water.

PRACTICALLY simultaneously, the rivers in all the New England States, with those in New York, New Jersey, Delaware, Maryland, Virginia, West Virginia

and Ohio, rose to flood heights. The River Connecticut broke down dams and bridges, inundating towns and low-lying districts, and causing factories to close, throughout its entire length from northern New Hampshire to Long Island Sound. In the State of Massachusetts, industry and transport were similarly paralysed. The damage to property in New England is put at more than ten million sterling. Farther south, the River Potomac has been badly swollen and the city of Washington was invaded. Although at the time of going to press the floods are reported to be subsiding in the afflicted districts, apprehensions are entertained as to the creation of new danger areas when the augmented waters of the Ohio reach the Mississippi at Cairo (Illinois). Portsmouth (Ohio) and Cincinnati are threatened, and hurried precautionary measures are being taken. So widespread has been the calamitous visitation that it has extended even into Canada, affecting the provinces of Ontario, Quebec and New Brunswick. Fredericton, the capital of New Brunswick, has been largely under water, in addition to large stretches of the adjoining country.

'Bush' Culture in the New Hebrides

OWING to recent economic developments in the islands of the Pacific, it is becoming increasingly difficult for the anthropologist to find material for observation there in the field of social and cultural anthropology. The sophistication of the native through European contacts has indeed always been a difficulty, but post-War development, especially plantation employment, has led to a rapid disintegration and even a blurring of the memory of tribal institutions. Such, for example, was the experience of Miss Beatrice Blackwood in the Solomon Islands, when she was compelled to seek the remoter islands of the group before she could begin her investigations. A similar experience befell the members of the Oxford University expedition to the New Hebrides. It is noted in the recent report of the Oxford University Exploration Society that it was only in the bush that unspoiled material was to be found. Here, however, conditions are still to a considerable extent unchanged, as was indicated in the account of the natives of Malekula given before the Royal Geographical Society on March 16 by Mr. T. H. Harrison, who resided on this island of the New Hebrides from August 1934 until July 1935, and took a census of the inhabitants of this and the adjacent small islands. He assesses their numbers at approximately 10,000.

THE Malekulans are not entirely unknown to European science. They were studied intensively by the young Cambridge anthropologist J. Deacon, whose recent untimely death when on his return will always be held a heavy loss to science. Mr. Harrison, however, is of the opinion that the natives of Malekula, who have come under scientific observation through their European contacts, are free from the effects of certain psychological elements, which he observed as present among the inhabitants of the northern areas. Here man-hunting is both a sport and an ever-present cause of fear. War, arising out

of inter-village vendettas, is perennial. The people of Amok, a large village of 1,000 inhabitants, are real 'man-bush' and are referred to as such by their neighbours. During the year Mr. Harrison was with the Big Nambas, thirty men were killed and about seven were successfully taken back and eaten. Among the bush people the effect of the impact of the white man has been practically nil. They are still primitive-minded and dangerous in the old New Hebridean way. Notwithstanding this, Mr. Harrison maintains that these peoples are in many ways the most admirable in the Pacific. They have all their old zest and vigour, the will to live and their dogmatic pride. Yet though their mind is unimpaired, civilisation is rotting them away through disease. In 1932 whooping cough carried off six hundred Big Nambas, and in 1934 influenza caused about one hundred deaths.

Orthodox and Proselyte in Hinduism

AN interesting sidelight on the interplay of religious and political cross-currents is afforded by the ceremonial admission to Hinduism of proselytes of both sexes and all ages to the number of one hundred and fifty, which took place in an initiation by the Pandit Madan Mohan Malaviya on March 17 at Bombay. This was in part a demonstration against the attitude of the more rigidly orthodox Hindus, and in part a phase of the widespread movement, of long standing, but now of increasing civil importance, of adding to the nominal roll of Hinduism. This policy, which may fairly be regarded as liberal, is at present to some considerable extent influenced by the threatened danger that the Untouchables, irked by their ritual disabilities and the intolerance of the orthodox, may withdraw entirely from Hinduism, with serious political repercussions. An interesting account of the initiation by the venerable septuagenarian Pandit is given by the Bombay correspondent of *The Times* in the issue of March 18. It consisted of a purification ceremony, in which, to the recitation of sacred texts, the converts, with foreheads adorned with the holy red powder, bathed in the river and then bowed before the Pandit Malaviya, who sat under the holy peepal tree. He then gave to each a portion of *Panchgarya*, the sacred compound of the five products of the cow—milk, curd, ghee, urine and dung. When this had been consumed the Pandit whispered in the ear of each the *Nama Shivaya*, which is supposed to open heaven's gateway, and each convert vowed to speak the truth, to observe cleanliness, and to abstain from beef and liquor. To each was then given a petal of the sacred tulsi plant, a rosary card with rules of conduct and a piece of cloth on which were printed incantations. It is hoped by the reformers, it is stated, that these neo-Hindus will be accepted as full members of the community by the orthodox within ten years.

Tobacco Disease in Australia

THE tobacco-growing industry in Australia has in recent years suffered heavy losses from the disease commonly known as 'downy mildew' or 'blue-mould' (*Peronospora tabacina*). To raise disease-free seedlings in the principal growing areas by customary methods

has become almost impossible. Importation of plants from New Zealand has been attempted, but without marked success; and efforts have been made to establish seed-beds at Hermansburg Mission Station in Central Australia, where possibly infestation may not occur. Happily a means of overcoming the difficulty appears to have been demonstrated by Dr. H. R. Angell, of the Council for Scientific and Industrial Research. His method is to allow benzol (or certain other hydrocarbon mixtures) to evaporate in the seed-beds during the night time and on dull days when the beds are under cover. While neighbouring untreated control beds may be completely destroyed, those subjected to the vapour remain healthy; in fact, no development follows even from artificial inoculation. During the present season extensive trials have been made in New South Wales, Victoria, South Australia and Western Australia with uniformly successful results. It is true that there remains a risk of infection when the seedlings are planted out, but this is relatively slight compared with the danger in the seed-beds; and it would appear that an economical, practical and effective means of destroying what is perhaps the greatest obstacle in the way of stabilising the tobacco industry in Australia has been developed and proved.

Importance of Small Coal

WHEN Dr. F. S. Sinnatt addressed the Institution of Civil Engineers on "Some Major Problems in the Utilisation of Coal" on March 17, he gave first place to the choice of coal suitable in composition, properties and preparation for the purpose in view, and emphasised the importance of collecting such information. Quoting examples from the work of the Coal Survey, he showed the great diversity of properties, even in one seam, and over comparatively small distances. Until these variations are exactly established, progress in rational marketing will be hampered. The needs of the consumer change. Large coal is in less demand, and is to an increasing extent being actually broken. The technique of mining, which has been designed to conserve lump coal, may be radically altered in favour of machine mining, which is prone to produce more fine coal. The breakage of coal is becoming of paramount importance to the coal industry, and involves many problems still requiring solution, and these are chemical, physical and particularly engineering. The disposal of fine coal dust involves consideration of the combustion of pulverised fuel, which steadily extends, hitherto mainly in large units. For small units, coal can now be obtained ready pulverised, and the Fuel Research Station has developed a new burner with which it can be burnt with a short flame. The use of pulverised fuel in Lancashire boilers thus becomes practicable, with advantage to the performance. Apparently output of steam may be doubled without loss of efficiency. The development of firing with pulverised fuel in small units will call for means for retaining the emission of grit and sulphur, and although this has been solved so far as large power stations are concerned, there is still scope for plant suitable for smaller units.

Atmospheric Pollution

THE twenty-first report of the Investigation of Atmospheric Pollution issued by the Department of Scientific and Industrial Research (H.M. Stationery Office. 5s.) may be summarised in one sentence: "The general cleanness of our atmosphere is not improving"—a statement opposed to an impression widely held. The observations recorded in London seem particularly to point this way, and to show that while Metropolitan conditions get worse, provincial conditions improve. Some of the worst figures are recorded at London stations, compared with which the industrial areas in the provinces appear relatively good. This must be disquieting to residents of the Metropolis, and emphasises the need for more energy to promote the consumption of fuel by methods which minimise the emission of tar, soot and sulphur acids. Some of the anomalies suggest the need for caution in interpretation. After all, the figures relate only to the sites where examples are taken, and these are relatively few, and a statistical analysis by Mr. B. H. Wilsdon shows that other factors such as rainfall influence the results. The report deals with observations made for the year ending March 1, 1935, and it may be that increased industrial activity has involved an increased consumption of fuel which has compensated for some improvement in method of combustion.

Cine-Radiography

RÖNTGEN announced his discovery of X-rays late in 1895. A few years afterwards, attempts were made to get cinematograph records of the pictures obtained by them; but they were crude. It was found that a speed from a $\frac{1}{2}$ to 1 second is perfectly effective for a good many movements. In a paper read to the Institution of Electrical Engineers on March 19, Mr. Russell J. Reynolds gave the latest developments in cine-radiography. There are two methods in general use. In the direct method, a band of film is placed in the position normally occupied by the fluorescent screen. This has the disadvantage that the dimensions of each exposure must be at least 4 in. \times 5 in. A film of this size is very costly, and an apparatus capable of moving it at the rate of 8 or more exposures per second is cumbersome and difficult to design. In the indirect method, the image on the fluorescent screen is photographed with an ordinary cinematograph apparatus. The chief difficulty in obtaining a sufficiently brilliant image on the screen lies in the fact that the film is minute and moves at a high speed. The heavy currents necessary wear out the tubes quickly, and it is dangerous to expose the patient to intense radiation for the time necessary to take the film. It has to be remembered also that the effect of the rays is cumulative. Mr. Reynolds gives full particulars of the apparatus he has evolved to overcome the difficulties of the indirect method. It gives a sufficiently brilliant screen picture to impress itself satisfactorily on the film when exposed for only a small fraction of a second. The film is protected from exposure to the rays, and the exposure of the patient to the rays is harmless. By this apparatus the radiologist obtains a rapid, inexpensive

and permanent record of the functioning of the heart, lungs, thorax, etc. These records can easily be sent by post to the specialist in charge of the case.

The Royal Cornwall Polytechnic Society

THE annual report of the Royal Cornwall Polytechnic Society for 1935 provides ample evidence that although the Society has passed its centenary (see also p. 547 of this issue), age does not diminish its activities, and that it continues to play an important part in stimulating interest in education and industry throughout the county. Foremost among its proceedings are its exhibition and summer meeting, held last year at Penzance. At the exhibition both art and science were well represented, while the industrial exhibits included a working model of the flotation process of separating minerals that contain an excess of sulphides. There was also a special section of scientific apparatus used for teaching. The report contains three original memoirs, one on the ancient mining districts of Cornwall by Mr. F. J. Stephens, another on Cornwall's part in ceramic history by Mr. E. A. Rees and a third on some minor foundries of Cornwall, based on material collected by the late Mr. S. Michell. It also includes the report of the Cornwall Rainfall Association for 1934 and the report on the Falmouth Observatory, with meteorological notes and tables for 1935. The observatory receives a grant from the Falmouth Town Council, and is inspected periodically on behalf of the Air Ministry. In a comparison of the records at Falmouth with those in other parts of England and Wales, Mr. W. T. Hooper, the superintendent of the observatory, says: "It will be seen therefore that the maximum temperature range at Falmouth was 52°, as compared with 79° elsewhere, and our hottest day was 13° cooler, and our coldest day 14° warmer than the extreme temperature as a whole. This equability is the outstanding characteristic of our local climate." As regards sunshine, "in the year's aggregate, percentage and daily average, Falmouth is a good third in order of merit".

Working to Music

IN the factory of the Standard Motor Co., Ltd., of Coventry, the employees work to music. According to the British Motor Number published with *The Times* of March 17, those sections of the factory where the noise is not too great are fitted with loud-speakers all supplied from a radio-gramophone unit. At set times during the day, programmes are given. When a suitable wireless programme is available it is given. At other times gramophone records bought by the Company are played. In those parts of the factory where the work is of a monotonous nature the music is particularly helpful, engendering an atmosphere of cheerfulness. Dance tunes and simple rousing marches are the most popular. Among other privileges many of the workers are allowed to smoke. Morning coffee and afternoon tea are provided, workpeople being allowed half an hour of freedom to visit the buffet in groups. The factory is designed to produce a complete car every four minutes. The parts of the car are carried on an ever-moving conveyor—the chassis

taking 2½ days to complete its circuit—the various processes such as body painting and the assembling of the car, which takes 2½ hours, being co-ordinated. The workers are proud that only very rarely has a customer calling for delivery had to wait for his car. Conveyors take the materials from worker to worker, each one of whom performs a single operation. On the test beds the 9 horse-power models are not run under their own power but driven electrically. As the energy consumed is at once recorded, a sufficient indication of their condition and the general tightness of their parts is obtained. The Standard Co. plans to produce three hundred cars a day, and when the present extensions are completed will have a floor space of more than a million square feet.

An International Air Force

A MEMORANDUM on the functions of an international air force has been issued by the governing committee of the New Commonwealth and by the Parliamentary Group of the British Section of the Society. Discussing the uses of an international air force, it is emphasised that the code of policing regulations to be drawn up must distinguish between acts of aggression and cases of default. Two distinct policing functions are involved—those of defence and of enforcement. The role of the international air force is that of a reinforcing agency, aimed at bringing aggressive action to a standstill. It is precluded from assuming the offensive, but to be effective the intervention of an international air force must be made in the shortest possible space of time. The main objective would be to paralyse the military activities of the aggressor and compel him to desist from hostilities, and distinction between military objectives and civilian centres is unlikely to be practicable. An international air force might also conceivably be called upon to enforce the decisions or awards of an international court or tribunal, but its main object is deterrent and its functions are those of a police and not of a military force. Attention is also directed to the psychological factors involved.

Empire Fibres Exhibition

AN Empire Fibres Exhibition is open at the Exhibition Pavilion of the Imperial Institute, South Kensington, S.W.7, until April 9. The object of the exhibition is partly to interest the general public, and especially school-children visiting the Institute, in vegetable fibres of the Empire, in the various methods of preparation for the market and in the different products into which they are converted; partly to interest technical experts and business men in existing and potential uses for Empire fibres. A series of eight stands or 'bays' comprise the exhibition. Two central bays, facing each other, are devoted to flax and linen exhibits organised by the Linen Industry Research Association with its headquarters at Lambeg, Northern Ireland. Here there are a number of exhibits showing the cultivation and processing of flax and its conversion into linen; also the various lines of research carried out at the Lambeg Research Institute under the guidance of the director, Dr. W. H. Gibson, and at the Flax

Research Institute near Sandringham under Mr. G. O. Searle. There are also stands illustrating, for New Zealand, the cultivation and uses of phormium fibre, and for India, jute, sunn hemp, coir and palmyra. The Hard Fibres Section of the British Empire Producers' Organisation has arranged a comprehensive group of exhibits of sisal and sisal manufactures, the collection and display of which were entrusted to Dr. Gibson and his sisal research staff at Lambeg. Other stands display Mauritius hemp, Ceylon coir, West African piassava, Cyprus hemp and manila hemp from Borneo.

British Speleological Research

It will be remembered that one of the purposes with which the British Speleological Association, of which Sir Arthur Keith is president, was founded recently, was that of holding annual conferences for the discussion of problems relating to this branch of investigation and for the co-ordination of the results of research in all matters affecting the study of caves. The first of such conferences will be held, by invitation of the Mayor and Corporation, at Buxton on July 24-27 next. The conference is free to members of the Association, but others who are interested in cave exploration may attend on payment of a fee of five shillings. The Association is already actively at work in various directions. A bibliography of papers on British speleology is in course of preparation, and a catalogue is being compiled of all prehistoric artefacts now in public or private collections which have been found in British caves. Preparations are also being made for an important undertaking, which will be of considerable scientific interest and ultimately of no little public service. A survey is to be made of the more important underground rivers and streams with the view of assisting the Inland Water Survey Committee of the Ministry of Health. In view of the necessity of conservation of water supply and the weaknesses in this important branch of public service revealed recently by climatic conditions, this work of the Association cannot fail to assume a position of some importance. Particulars of the forthcoming conference and of the objects of the Association may be obtained from the Honorary Secretary and Treasurer, Mr. G. H. Hill, The Museum, Buxton.

Announcements

THE first soirée this year of the Royal Society will be held in the rooms of the Society at Burlington House, London, W.1, on May 28. The second soirée will be held on June 30, and, in connexion with the Second International Congress for Microbiology, a further soirée will be held on July 29.

At the annual general meeting of the Ray Society held on March 12, the following officers were re-elected: *President*, Sir Sidney Harmer; *Treasurer*, Sir David Prain; *Secretary*, Dr. W. T. Calman. Dr. Robert Gurney was elected a vice-president, and Dr. G. P. Bidder, Dr. Malcolm Smith, and Captain Cyril Diver were elected new members of Council. It was announced that the first volume of Mr. F. J. Killing-

ton's monograph of the British Neuroptera, forming the issue for 1935, would shortly be published. The second volume of this work will form the issue for 1936. Among the works in preparation are monographs of the British freshwater planarians, by Mr. P. Ulyott, and on the British Tunicata, by Dr. John Berrill.

A DISCUSSION on "The Design of a Family Budget", with special reference to food, will be held at a joint meeting at the Royal Society of Arts of the Engineers' Study Group on Economics and the Association of Scientific Workers on March 31 at 7.45 p.m. A report from Section A of the Engineers' Study Group will be presented by Dr. E. H. Tripp, and the discussion will be opened by Sir John Orr; contributions to the discussion will be made by Sir Daniel Hall, Sir Frederick Gowland Hopkins, Mr. G. D. H. Cole and others. Further particulars can be obtained from the honorary secretary of the Engineers' Study Group, Hazlitt House, Southampton Buildings, Chancery Lane, W.C.2 (telephone, Holborn 1068).

IN connexion with the exhibition of Very Low Temperatures at present on view in the Science Museum, a series of lectures will be delivered in the Lecture Theatre of the Museum on Wednesdays from April 1 until May 27. Each lecture will commence at 5.15 p.m. Prof. M. W. Travers will speak on the development and uses of low temperature; industrial uses of low temperatures will be discussed in three lectures by C. G. Bainbridge, J. T. Randall and Dr. I. J. Faulkner, respectively; while the approach to the absolute zero will form the subject of lectures by Dr. J. D. Cockcroft, Prof. F. A. Lindemann and Prof. F. Simon, respectively. Admission, which is free, will be by ticket only, for which applications should be sent as soon as possible to the Director, The Science Museum, London, S.W.7.

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

A head of the Engineering Department of the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (April 4).

A principal of the Radcliffe Junior Technical School and Technical College—The Secretary of Education, Town Hall, Radcliffe (April 4).

A lecturer in mathematics and physics in the Cheltenham Technical College—The Secretary (April 6).

An assistant (grade III) for abstracting scientific and technical literature for the Department of Scientific and Industrial Research—The Establishment Officer, 16 Old Queen Street, Westminster, S.W.1 (April 15).

A University professor of anatomy in St. Bartholomew's Hospital Medical College—The Academy Registrar, University of London, S.W.7 (April 17).

A senior lecturer in biochemistry in the University of Liverpool—The Johnston Professor of Biochemistry (April 17).

A lecturer in agricultural chemistry in the Edinburgh and East of Scotland College of Agriculture—The Secretary (April 18).

Recent Scientific and Technical Books

Volumes marked with an asterisk (*) have been received at "NATURE" Office

Mathematics : Mechanics : Physics

Alexandroff, Paul, und Hopf, Heinz. Topologie. Band 1: Grundbegriffe der mengentheoretischen Topologie, Topologie der Komplexe, Topologische Invarianzsätze und anschließende Begriffsbildungen, Verschlingungen im n -dimensionalen Euklidischen Raum, Stetige Abbildungen von Polyedern. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 45.) Roy. 8vo. Pp. xiv + 636. (Berlin: Julius Springer, 1936.) 45 gold marks.

Bertrand, Léon, et Roubault, Marcel. L'Emploi du microscope polarisant: caractères optiques des minéraux des roches taillés en lames minces, leur détermination. 8vo. Pp. 170. (Paris: J. Lamarre, 1936.) 40 francs.

Boddington, A. Lester. Statistics and their Application to Commerce. Seventh edition. Roy. 8vo. Pp. 372. (London: Sir Isaac Pitman and Sons, Ltd., 1936.) 12s. 6d.

Brillouin, Léon. Notions élémentaires de mathématiques pour les sciences expérimentales: à l'usage des candidats au Certificat d'études physiques, chimiques et biologiques et à la licence ès sciences. (Collection P. C. B.) Ex. Cr. 8vo. Pp. viii + 252. (Paris: Masson et Cie, 1935.) 40 francs.*

British Association for the Advancement of Science. Mathematical Tables, Vol. 5: Factor Table giving the Complete Decomposition of all Numbers less than 100,000. Prepared independently by J. Peters, A. Lodge and E. J. Ternouth, E. Gifford, and collated by the British Association Committee for the Calculation of Mathematical Tables. Med. 4to. Pp. xv + 292. (London: British Association, 1935.) 20s. net.*

Chambers, F. W. The Arithmetic of Time and Distance. (Macmillan's Senior School Series: Arithmetic Terminal Book A.) Cr. 8vo. With Answers and Notes. Pp. 90 + xxiv. (London: Macmillan and Co., Ltd., 1935.) 1s. 3d.

Davis, Harold T., Computed and compiled under the direction of F. Tables of the Higher Mathematical Functions. Vol. 2. (Published as a Contribution of the Waterman Institute for Scientific Research, Indiana University.) Sup. Roy. 8vo. Pp. xiii + 391. (Bloomington, Ind.: The Principia Press, Inc., 1935.)*

Donder, Th. de. Théorie invariante du calcul des variations. 8vo. Pp. 229 + xi. (Paris: Gauthier-Villars, 1935.) 35^{fr} francs.

Eck, Bruno. Einführung in die technische Strömungslehre. Band 2: Strömungstechnisches Praktikum. Roy. 8vo. Pp. vi + 96. (Berlin: Julius Springer, 1936.) 5.70 gold marks.

Fulford, R. J. Junior Revision and Mental Tests in Geometry. Cr. 8vo. Pp. viii + 80. (London: University Tutorial Press, Ltd., 1936.) 1s.

Haas, Arthur. Atomtheorie. Dritte, völlig umgearbeitete und wesentlich vermehrte Auflage. Roy. 8vo. Pp. viii + 292 + 5 plates. (Berlin und Leipzig: Walter de Gruyter und Co., 1936.) 8.50 gold marks.*

Hausmann, Erich, and Slack, Edgar P. Physics. Demy 8vo. Pp. viii + 776. (London: Chapman and Hall, Ltd., 1936.) 20s. net.*

Hund, August. Phenomena in High-Frequency Systems. (International Series in Physics.) Med. 8vo. Pp. xv + 642. (New York and London: McGraw-Hill Book Co., Inc., 1936.) 36s.*

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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. 538.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Effect of Promoters on Molybdenum Catalysts in Hydrogenation

EXAMINATION of the molybdenum sulphide catalysts used for hydrogenation has shown that they are not completely resistant to the effect of heat treatment; X-ray diagrams taken before and after several hours' heating show that the heating results in an increase in the particle size of the catalyst, with a consequent decrease in the surface area and loss of catalytic activity.

Attempts have been made to eliminate this sintering by the addition of promoters, and experiments have led to a general investigation into the effect of promoters on molybdenum compounds used as hydrogenation catalysts. In the course of this investigation, it has been found that a particularly effective method of introducing the promoters is to prepare the catalyst from the appropriate heteropoly acid with the promoter as the central atom in the complex¹.

These heteropoly acids and their salts can be divided into two groups², with twelve and six molybdenum atoms respectively grouped about the central atom, and represented by the general formulæ:

- (a) $R_n [X. (Mo_2O_7)_6]$ X = P, Si, As, Th, Sn, etc.
 (b) $R_n [M. (MoO_4)_6]$ M = Cr, Ni, Co, Cu, etc.
 R = H, NH₄, K, etc.

The ammonium salts of the acids were used, and the catalysts heated in hydrogen for six hours at 480° C. Thus each catalyst was subjected to identical heat treatment before determination of its surface area and catalytic activity were made, and furthermore, catalysts with high initial but transient activities were deactivated.

The efficiencies of the catalysts were tested by measuring their activity in the catalytic hydrogenation of phenol at atmospheric pressure, determinations being made over a range of temperatures so as to enable calculations of the heats of activation to be made. In the brief summary given below, results for experiments carried out at 350° C. only are given. The rate of passage of phenol (in grams phenol per gram catalyst per hour) was 0.8 gm. in the first series, and 0.45 gm. in the second.

Catalyst	Promoter	Activity (per cent conversion of phenol)
First series		
Mo oxide	Unpromoted	24.0
" "	Th	18.3
" "	Sn	14.1
" "	Si	78.5
Mo oxide } V oxide }	P	51.9
Second series		
Mo oxide	Unpromoted	28.3
" "	Ni	83
" "	Cr	c. 80
" "	P	97.7
" "	Supported on alumina gel	41.5

The mixed oxide catalyst in the first series was prepared from a mixed complex heteropoly acid of vanadium and molybdenum², with phosphorus as the central atom. The unpromoted molybdenum oxide was prepared from ammonium molybdate.

The promoters given above fall distinctly into two classes: the first containing P, Ni, Cr, and Si, which result in a marked enhancement of the catalytic activity of the molybdenum oxide catalyst, and the second, Sn and Th, which have an equally well-marked depressing action on the activity.

Fuller details of these experiments, together with results of attempts made to elucidate the nature of the promoter, will be published later.

F. E. T. KINGMAN.
ERIC K. RIDEAL.

The University,
Cambridge.

¹ See also Brit. Pat., 371, 833.

² Abegg Auerbach, "Handbuch der Anorganischen Chemie", vol. 4, part 1, 2nd half, p. 977.

Infantile and Maternal Mortality in Relation to Nutrition

IN the course of investigations into the maternal and infantile death rates of different areas, carried out in connexion with the work of the Joint Council of Midwifery, it has been discovered that a hitherto unsuspected correlation between these two rates exists if they are charted in successive years instead of in the same year, the infantile rates being shown for the year preceding the maternal. It has also appeared that this correlation, which is very marked in distressed areas, and especially during years of industrial depression, is lessened and even reversed in prosperous districts and in good years. The average level of both rates is also much higher in districts in which unemployment is severe than in other areas. The maternal death rate of the five principal coal-mining counties, for example, for the years 1928-34 is 41.05 per cent higher than that prevailing in Middlesex and Essex, and for the years 1927-33 the infantile death rate is 50.98 per cent above.

That nutrition rather than other environmental factors underlies these figures is suggested by the fact that the correlation between the two rates appears in successive, and not in the same year. Climatic, epidemic and other similar influences have their effect on both death rates in the year in which they occur, and should tend to produce a correlation between the two rates in the same year. Good or bad nutrition, however, extends its effects over a period, and it seems natural to suppose that the infantile death rate should be the first to show the effects of malnutrition, owing to the adverse influence

of insufficient nourishment upon nursing mothers, while the same cause would not express itself in a rise in the maternal death rate until the expectant mothers affected by it gave birth some months later, their deaths thus being registered for the most part in the succeeding year.

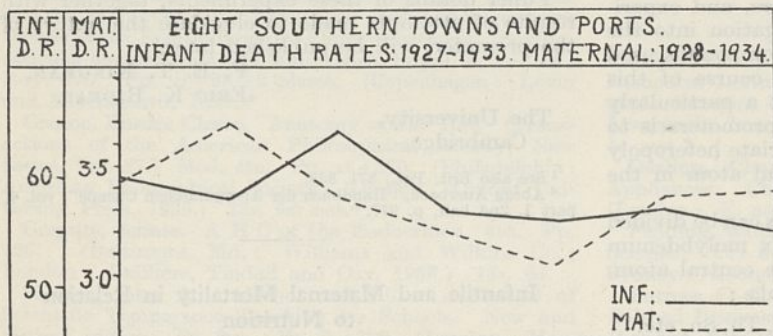
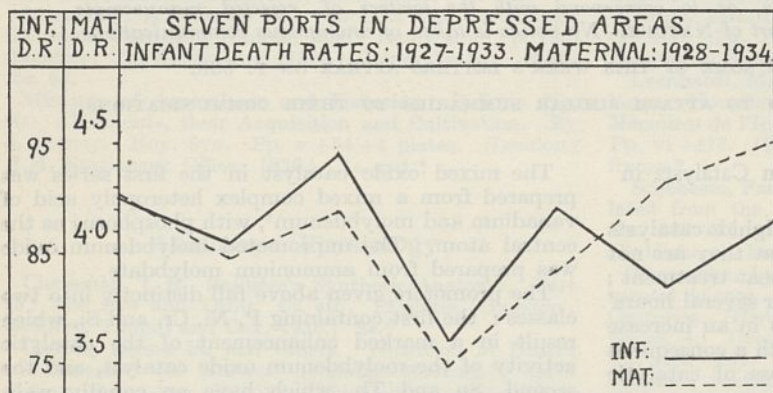


FIG. 1. GRAPHS ILLUSTRATING CORRELATION BETWEEN INFANTILE AND MATERNAL MORTALITY IN SUCCESSIVE YEARS.

Above: Seven ports in depressed areas (Birkenhead, Cardiff, Hull, Liverpool, Newcastle-on-Tyne, Sunderland and Swansea). Population 2,174,000. Average infantile death rate (under 1 year) 1927-33 = 87 per thousand live births. Average puerperal death rate 1928-34 = 3.99 per thousand total births. Note close correlation, especially in bad years, and rise in maternal death rate.

Below: Eight southern towns and ports (Brighton, Bristol, Croydon, East Ham, Plymouth, Portsmouth, Southampton and West Ham). Population 1,648,000. Average infantile death rate (under 1 year) 1927-33 = 58 per thousand live births. Average puerperal death rate 1928-34 = 3.36 per thousand total births. Note absence of correlation except in bad years, and low level with steady fall in both rates.

Experimental work, with the view of testing the effect of improved nutrition, especially with regard to the so-called 'protective' foods, has been carried on in the Rhondda Valley, Glamorgan, during 1935, by the National Birthday Trust Fund, with striking success, the maternal deaths dropping from 34 in 1934 to 13 in 1935. It is noteworthy that the principal drop occurred in the non-septic category, the deaths in which fell from 17 to 1. It is in this category that improved nutrition might be expected to produce the greatest effect.

The experiment is being continued in the Rhondda area during 1936, and also extended to adjoining areas in order to cover a population of approximately 360,000.

J. E. WILLIAMS.
(Hon. Secretary,
Joint Council of Midwifery.)

47 Eaton Place,
S.W.1.

Equilibrium Constants and Velocity Constants

THERE is a wide and constantly growing experimental material which proves that within a group of closely related chemical reactions, there is a linear relationship between the logarithms of the velocity constants ($\log k$) and the logarithms of the equilibrium constants ($\log K$):

$$(1) \log k = \alpha \log K + \text{const.}$$

This equation can be generalised in various ways: Pairs of k and K may be introduced, belonging to two different but closely analogous reactions¹. The 'group of reactions' might be meant to include a set of chemically identical reactions proceeding in different solvents or might be even extended to mean the continuous variations of an electrode process with changing over-voltage.

A further generalisation² has recently been attained by observations on substituted benzene derivatives. For various types (A , B , C) of reactions of a series of benzene derivatives (1, 2, 3 . . . j . . .), linear relationships of the following types are found:

$$(2) \log k_A^{(j)} = \alpha \log k_B^{(j)} + \text{const. } (j = 1, 2, 3 \dots);$$

$$(3) \log K_C^{(j)} = \alpha \log K_D^{(j)} + \text{const. } (j = 1, 2, 3 \dots);$$

and also of type (1), namely:

$$(4) \log k_E^{(j)} = \alpha \log K_F^{(j)} + \text{const. } (j = 1, 2, 3 \dots).$$

We offer an explanation of these widespread relationships by a law of thermodynamics which we have applied to the reaction velocity constant. In thermodynamics,

$$\frac{\partial \log K}{\partial f} = \frac{\beta}{RT};$$

that is, the logarithmic shift of the equilibrium constant due to the change of an external field parameter f is equal to the derivative β of the difference in free energy between the initial and final states with respect to f divided by RT . In our analogous equation³,

$$\frac{\partial \log k}{\partial f} = \frac{\beta_r}{RT}$$

β_r is the derivative of the difference in free energy between the initial and transition states with respect to f .

We assume that within a group A of closely related chemical reactions, some field parameter f assumes the values $f_1^{(A)}$, $f_2^{(A)}$, $f_3^{(A)}$. . . while $\beta^{(A)}$ or $\beta_r^{(A)}$ remains constant. We have then:

$$RT \log K^{(A)} = \beta^{(A)} f^{(A)} + \text{const. or}$$

$$RT \log k^{(A)} = \beta_r^{(A)} f^{(A)} + \text{const.}$$

Similarly for the reactions B :

$$RT \log K^{(B)} = \beta^{(B)} f^{(B)} + \text{const. or}$$

$$RT \log k^{(B)} = \beta_{\tau}^{(B)} f^{(B)} + \text{const.}$$

Assuming further that the values $f_1^{(A)}, f_2^{(A)}, f_3^{(A)} \dots$ are proportional to the corresponding values $f_1^{(B)}, f_2^{(B)}, f_3^{(B)} \dots$, we obtain the relationships (2), (3) and (4), which include all types of linear relationships referred to above. For example, if group A signifies a reaction of the benzoic acids while B signifies a reaction of the cinnamic methyl esters, the ordinals j and l indicating the paranitro- and parachloro-derivatives respectively, then we assume that the paranitro- and parachloro-groups act as external fields on the reactions A and B , and that the intensities of the fields are related by :

$$f_j^{(A)} / f_j^{(B)} = f_l^{(A)} / f_l^{(B)} ;$$

while $\beta^{(A)}$ and $\beta^{(B)}$, or $\beta_{\tau}^{(A)}$ and $\beta_{\tau}^{(B)}$ remain constant all through the groups A and B .

In a series of papers to be submitted to the *Transactions of the Faraday Society*, evidence is given for the correctness of this theory, and at the same time, it is linked up with the more detailed mechanism suggested by Horiuti and one of the authors⁴ in explanation of the linear relationships of type I found by Brønsted for the acid-base catalysis and by Tafel for over-voltage.

M. G. EVANS.
M. POLANYI.

University,
Manchester.
Feb. 17.

¹ For a recent review see Hammett, "Some Relations between Reaction Rates and Equilibrium Constants", *Chem. Rev.*, **17**, 125 (1935).

² Burkhardt, Ford and Singleton, *J. Chem. Soc.*, **17** (Jan. 1936).

³ *Trans. Farad. Soc.*, **31**, 875 (1935).

⁴ *Acta Physicochemica U.S.S.R.*, **2**, 505 (1935).

Zeeman Effect of the Hyperfine Structure Components of the Mercury Resonance Line 2537 Å.

WITH reference to my earlier investigation¹ some new experiments have been carried out with filtered and unfiltered sigma-components of the hyperfine structure lines of the mercury resonance line 2537 Å. in fields from zero to 11,000 gauss. In my experiments, light of wave-length 2537 Å. passed from a Wood resonance vessel through a Mrozowski² filter, consisting of a column of mercury vapour in a magnetic field, and a Glan prism which separated the light polarised at right angles to the field. Such filtered light of 0 and +11.5 components (corresponding to the mercury isotopes 200 and 202) passed afterwards through an absorption vessel of 15 mm. length which was placed in a second field. The intensity of the light which passed through the absorption vessel was measured photo-electrically. The absorption Curve I (Fig. 1) represents the course of the relative intensity J of the sigma-light of the 0 and +11.5 components as a function of the field H (in kilogauss). Curve II reproduces the results of the analogous measurements for all the hyperfine structure lines.

The course of Curves I and II is in good accordance with the theoretical diagram³ of the Zeeman effect of the hyperfine structure lines. Moreover, assuming

that the normal sigma-components have 3/2 of the Lorentz displacement, there follows from the position of the last minimum of Curve I (8,250 gauss) the distance 37.0 Å. between the B line (corresponding to the isotope 199) and the component of the isotope 202, which is in good accordance with the spectrographic measurements of MacNair⁴ (36.9 Å.). From the position of the last minimum of the Curve II (10,450 gauss) there results the distance 47.2 Å. between the centres of intensity of the extreme components of the hyperfine structure lines; according to MacNair, this distance amounts to 46.9 Å.

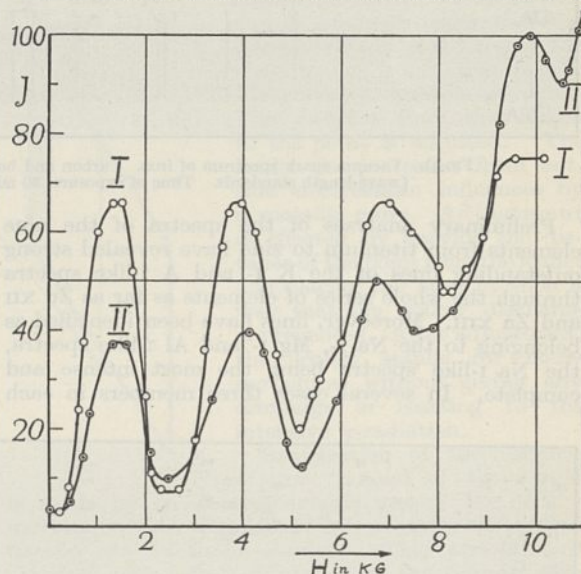


FIG. 1.

The experiments are being continued. More detailed information will be published in the *Helv. Phys. Acta* and *Mém. Fac. Sci. Univ. Vyt. le Gr. (Lithuania)*.

A. ŽVIRONAS.

Physical Laboratory,
University,
Kaunas, Lithuania.
Jan. 24.

¹ A. Žvironas, *Helv. Phys. Acta*, **7**, 684 (1934). *Mém. Fac. Sci. Univ. Vyt. le Gr. (Lithuania)*, **9**, 123 (1934).

² S. Mrozowski, *Bull. Acad. Polon.*, **1**, 464 (1930). *ibid.*, **2**, 489 (1931).

³ A. Žvironas, *Helv. Phys. Acta*, **7**, 695 (1934).

⁴ W. A. MacNair, *Phys. Rev.*, **31**, 986 (1928).

Na I-like Spectra of the Elements Titanium to Copper (Ti XII-Cu XIX)

A CONCAVE grating spectrograph, designed by Prof. M. Siegbahn and constructed in the workshop of this laboratory, has recently been focused and tested. The grating, ruled at this institute with 576 lines/mm. on a glass mirror of 5 m. radius, is used at a grazing angle of 4°, and the plate-holder covers the range from 0 to 200 Å. A vacuum spark was used as a light source. In connecting the condensers (total capacity 0.4 μF.) with the electrodes, care was taken to reduce resistance and self-inductance so far as possible in order to increase the ionising power of the spark.

The high dispersion (0.3-0.5 Å./mm.) and the great luminosity of the spectrograph combined with the

increased intensity of the spark have yielded essentially new possibilities for the study of the spectra of very highly excited atoms. Using aluminium electrodes, for example, about 500 lines of the spectra Al IV to Al XI, covering the range 130 Å. to 35 Å., were recorded during a ten-minute exposure.

We actually utilise a large source of X-rays, and we rely on the lateral close-packing of the diffracted rays obtained by the reflection at low angles of parallel radiation to obtain a sharp line. This is the essential difference in the techniques (Fig. 1). We rely on the simple 'foreshortening' effect, which

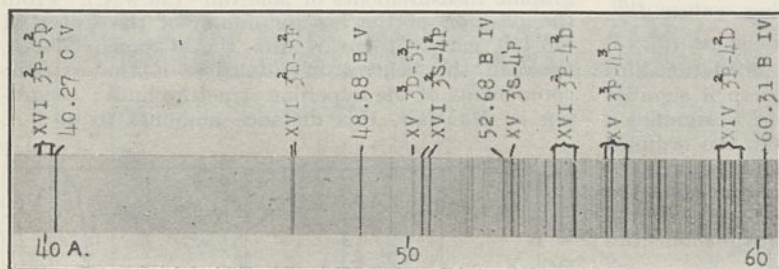


FIG. 51. Vacuum spark spectrum of iron. Carbon and boron lines as [wave-length standards. Time of exposure, 30 min.

Preliminary analyses of the spectra of the nine elements from titanium to zinc have revealed strong outstanding lines of the K I- and A I-like spectra through the whole series of elements as far as Zn XII and Zn XIII. Moreover, lines have been identified as belonging to the Na I-, Mg I- and Al I-like spectra, the Na I-like spectra being the most intense and complete. In several cases three members in each

to be reinforced by rays like *EC*. Although the total power of the diffracted beam is reduced by absorption, one can in this way obtain an increase in power per unit area, that is, in the intensity of the lines. In practice, there is a compromise, depending on the absorption coefficient, between the width of the incident beam and the glancing angle.

The beams we use are not strictly parallel—if this were so, the probability of getting a reflection at all would be very low—but since we greatly limit the divergency, the focusing effect is negligible.

We can actually make double use of this principle of foreshortening for obtaining small, intense, nearly parallel beams of monochromatic or polarised monochromatic X-rays. Take the case where we wish to obtain polarised copper *K α* radiation, as a variation of the method originally proposed by George. Consider the (311) reflection from a single copper crystal cut with its plane surface at about 37° to the (311) planes. In Fig. 2, the *XY* shaded area repre-

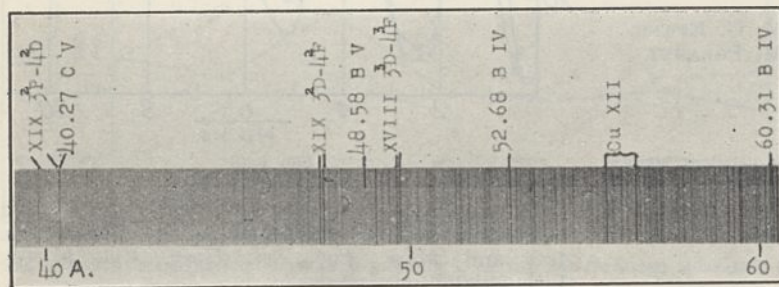


FIG. 2. Vacuum spark spectrum of copper.

of the series $3d^2D - nf^2F$ ($n = 4 - 6$) and $3p^2P - nd^2D$ ($n = 4 - 6$) and two members of $3s^2S - np^2P$ ($n = 4 - 5$) are present. The two most persistent transitions, $3d^2D - 4f^2F$ and $3p^2P - 4d^2D$, have been traced through copper, Cu XIX. The analyses of the Na I-like spectra have been completed in full detail and will soon be published elsewhere.

BENGT EDLÉN.

Physics Laboratory,
University,
Uppsala.
Feb. 25.

New Technique for obtaining X-Ray Powder Patterns

IN our letter in NATURE of November 16¹, we described a new technique for obtaining X-ray powder patterns using flat specimens. Dr. Brentano maintains² that the method is, in its principles, the same as his focusing method. Dr. Brentano has always used beams diverging from a line source of X-rays, and it follows that for great source to specimen distances the diffracted beams are focused at glancing angle. This is the only resemblance between his method and ours.

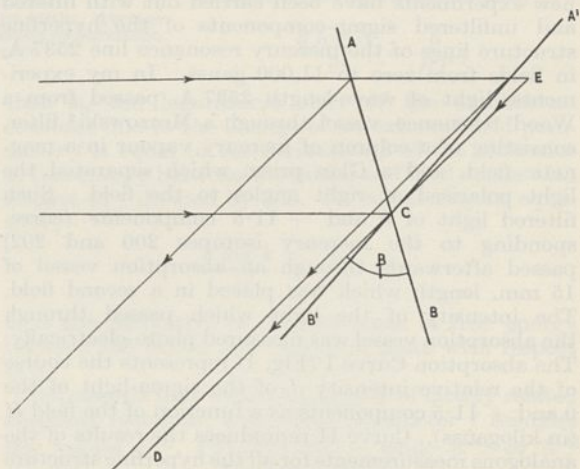


FIG. 1.

sents the source of X-rays, which we will take to be 7 mm. \times 7 mm. By taking rays off at 8° to the target surface, an intense parallel beam, 7 mm. long

in the Y direction but foreshortened to 1 mm. in the X dimension, is obtained. This is incident on the (311) planes at the reflection angle ($45^\circ 5'$) so that the diffracted beam comes off at about 8° to the surface in the Y direction, resulting in a foreshortening of the Y dimension to 1 mm. Thus we obtain an intense nearly parallel beam about 1 mm. square in section. If the crystal be arranged so that the rays are reflected perpendicular to the Y direction, then the X dimension is further foreshortened while the Y dimension remains constant, giving us a line source approximately (7 mm. \times 0.1 mm.). In this single crystal method the multiple diaphragm

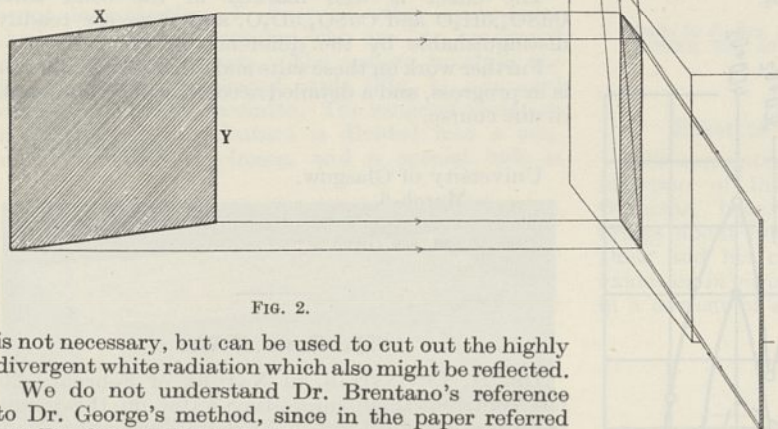


FIG. 2.

is not necessary, but can be used to cut out the highly divergent white radiation which also might be reflected.

We do not understand Dr. Brentano's reference to Dr. George's method, since in the paper referred to³, Dr. George states that he uses a crystal of copper cut parallel to the (311) planes and not oblique as Dr. Brentano states.

In our previous letter we used the expression "new technique" and did not claim a new principle. It appears, however, that we have made a new application of the old principle of foreshortening.

In conclusion, we should like to acknowledge fully the work which Dr. Brentano has done in connexion with flat specimens, which he has shown to be the most convenient and the most accurate for intensity work.

R. A. STEPHEN.
R. J. BARNES.

Philips Industrial X-Ray Service
Laboratory,
6a Ridgmount Street, W.C.1.

¹R. A. Stephen and R. J. Barnes, *NATURE*, **136**, 793 (1935).

²J. Brentano, *NATURE*, **136**, 988 (1935).

³W. H. George, *NATURE*, **136**, 180 (1935).

A New Counter for α -Particles

If a sufficient potential difference be applied between a point and a leaf of aluminium or platinum foil, then when α -particles fall on the region of the point, a discharge occurs and the leaflet flies back from the point in consequence of the lowering of the potential difference and the lessening of the electrostatic force of attraction. We can observe this phenomenon with the help of a low magnification or even without a microscope.

The point is a small cylindrical conductor of diameter 0.2–0.5 mm. and length 2 mm. The cylindrical conductor is not very sharp and is fastened to the insulator with the help of India ink. A potential of + 2,500 volts is given to the point through the resistance of the ink on the insulator carrying it.

The resistance may vary from some scores to some hundreds of megohms, according to the desired 'period' of the meter and size of the jump-off of the leaflet. The higher the resistance the longer the point takes to charge up, the greater the amplitude of the jump, and the longer the time of return of the leaflet to the former state, and vice versa.

The length of the leaflet used was 2–2.5 cm., width a few millimetres and thickness some hundredths of a millimetre. Besides aluminium and platinum, leaflets of glass metallised by cathode sputtering can be used. In order that the leaflet should not come too close to the point, a stop with a regulating screw is provided. The distance from the leaflet to the point is adjusted. The leaflet is protected from outside electrostatic influences by a metallic cone. Adjustment is effected by varying the distance of the point from the leaflet and placing the stop in such a way that the 'yellow' discharge is prevented. After adjustment, the leaflet stands for hours motionless without giving any discharge or reacting to the intensive γ -radiation.

Registration of the number of the 'jumps' of the leaflet is made by an electromagnetic meter. For this a carbon contact regulated by a screw is placed behind the platinum leaflet. This arrangement makes possible the registration of the 'jumps' with the help of a telephone or loud-speaker. Besides, it is easy to register the 'jumps' on a photographic film with the help of a ray reflected from the surface of the leaflet, or to observe the ray on a screen.

The potential is transmitted from a battery of condensers charged by a 250-volt accumulator and transformed from connexion in parallel to connexion in series with the aid of a revolving commutator.

S. S. WASSILEW.

State University of Central Asia,
Tashkent, U.R.S.S.

Flame Speeds in Moist Carbon Monoxide-Oxygen Mixtures

THE results obtained by Payman and Wheeler¹ for speed of propagation of flame in mixtures of carbon monoxide with oxygen contradict those obtained by Bone². According to Payman and Wheeler, the speed is a maximum for the stoichiometric mixture, whilst according to Bone there are two maxima in the speed curve, one at 75 per cent carbon monoxide which is sharply defined and another, less sharply defined, for the stoichiometric mixture.

In connexion with a recent communication of Payman and Wheeler³ some results obtained by us may be of interest⁴. In one series of experiments, mixtures covering a wide range—20–92.5 per cent carbon monoxide—were ignited by a condensed discharge at one end of a closed tube 430 mm. long and 20 mm. diameter, using pressures from 150 mm. to 400 mm. The moisture content was kept constant throughout by saturating the mixture with water

vapour at 0° C. The flame velocity was measured by a photographic method over the 15–30 cm. section of the tube where the speed was already constant. Results obtained with initial pressures of 400 mm. and 200 mm. are shown in Fig. 1. At 400 mm. there are two sharp maxima corresponding to the mixtures: $2\text{CO} + \text{O}_2$ and $4\text{CO} + \text{O}_2$. At 200 mm. pressure the maximum corresponding to the stoichiometric mixture is smoothed out, whilst that for the $4\text{CO} + \text{O}_2$ mixture remains. It may be noted that the curve for the change of velocity of the detonation wave D taken from the data of Campbell and others, and represented in Fig. 1, also passed through a maximum for the mixture $4\text{CO} + \text{O}_2$.

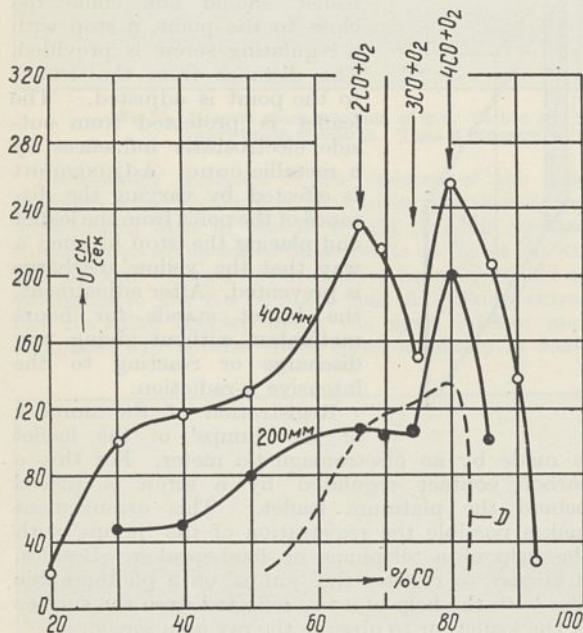


FIG. 1.

It seems clear to us that the form of the curve for the flame velocity in $\text{CO} - \text{O}_2$ mixtures is connected not with the hygroscopic conditions as suggested by Payman and Wheeler, but with a change in one of the main kinetic parameters, namely, the temperature of spontaneous combustion for constant time lag. Unfortunately, no systematic studies in this direction appear as yet to have been made.

V. VORONKOV.
A. SOKOLIK.

Institute of Chemical Physics,
Leningrad.
Jan. 16.

¹ W. Payman and R. V. Wheeler, *J. Chem. Soc.*, 1835 (1932).

² W. A. Bone and J. Bell, *Proc. Roy. Soc. A*, **143**, 1 (1934).

³ W. Payman and R. V. Wheeler, *NATURE*, **136**, 1028 (1935).

⁴ V. Voronkov and A. Sokolik, "The Normal Combustion of CO with Air and Oxygen", *J. Phys. Chem.* (Russian), in the press.

⁵ C. Campbell, C. Whitworth and Woodhead, *J. Chem. Soc.*, 59 (1933).

Influence of Heavy Water on the Colour of Hydrated Salts

THE announcement by Joos and Böhm¹ of the displacement of the absorption lines produced by replacement of the water of crystallisation in potassium chrome selenium alum by heavy water renders it desirable to present a preliminary note

on results of a somewhat similar nature which have been obtained here.

The blue colour of the solution obtained by dissolving anhydrous copper sulphate in 99.5 per cent heavy water is noticeably less intense than that of a solution of equal strength in ordinary water. Colorimetric determination shows that a column of 5 cm. of the heavy water solution is matched by a column of 4.1 cm. of the solution in ordinary water. Comparison is difficult, however, due to a difference in tint, the heavy water solution being slightly greener. The absorption spectra of these solutions are under investigation.

The effect is well marked in the solid salts $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and $\text{CuSO}_4 \cdot 5\text{D}_2\text{O}$, and these are readily distinguishable by the difference in tint.

Further work on these salts and other salt deuterates is in progress, and a detailed account will be published in due course.

JAMES BELL.

University of Glasgow.
March 6.

¹ *Phys. Z.*, **36**, 826 (1935).

The Gases of War

DR. H. LEVINSTEIN, in *NATURE* of February 29, has contributed an interesting letter on the manufacture of mustard gas in England during the Great War, and has objected to my statement that none of British manufacture was actually fired on the Western Front. On the other hand, Fries and West in their book on "Chemical Warfare", p. 153, refer to the French as "the only one of the Allies that manufactured and fired mustard gas", and further state that "the Levinstein process would have been a tremendous gain, had the war continued". Julius Meyer also in "Der Gaskampf" says that it was only made by Germany's enemies towards the end of the War in quite small quantities, and moreover that the French Army was the only one of the Allies that used it. Elsewhere it has been stated that the French transferred to the British such mustard gas as we did fire.

I have not, therefore, been the only one to make this statement, but when we consult those who were in responsible positions in connexion with the matter, it becomes evident that it is incorrect. Thus M. Moureu in "La Chimie et la Guerre" gives a list of the Allies to whom the French sent mustard gas, and Great Britain is not there mentioned. Brigadier-General (now Sir) Harold Hartley, who was Assistant Director of Gas Services and Controller of the Chemical Warfare Department, said (*J. Royal Artillery*, **46**, 492; 1919–20): "Our disappointments in 1918 were due to the fact that we did not get mustard gas until the end of September." "Mustard gas was used to a small extent in the preparation for the attack on the Hindenberg Line on September 30th and gave good results. The French had used it first in June with great success." Major-General Foulkes, who commanded the Special Brigade, says in his book "Gas": "We first used mustard gas of our own manufacture on the Fourth Army front on the night of 26th September 1918, when 10,000 shells were fired with very remarkable results."

The incident shows how an erroneous statement may be made and repeated even when everyone is

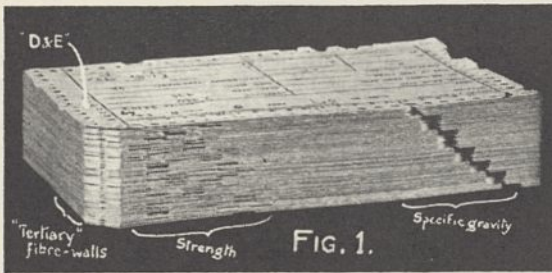
trying to tell the truth. There was, however, a period of fifteen months between the recognition of mustard gas in the German shells and the use of it in British shells, although in the actual manufacture of the chemical product there was no delay.

ARTHUR MARSHALL.

London.
March 16.

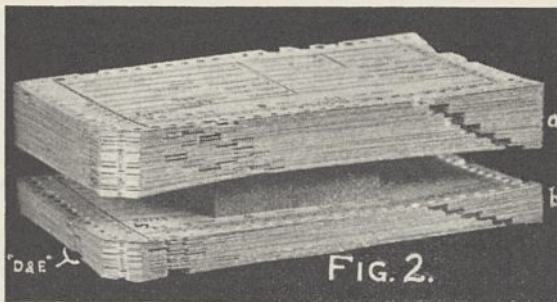
A Use for the Paramount Sorting System

MCKAY¹ has recently described certain advantages of the Paramount Sorting System in handling statistical data. Adopting McKay's method in a recent investigation, I observed other advantages which may interest workers who are less concerned with statistical methods. The system involves the use of specially perforated cards (Fig. 1), one card being used for each specimen. The range of variation encountered in any feature is divided into a convenient number of classes, and a special hole is



allotted to each class. To record the data for a particular specimen the appropriate hole is notched (hand tools can be obtained for this purpose). The edges visible in Fig. 1 show the recording of three interrelated features.

Once the data are recorded, the cards are easily sorted by pushing a rod through the hole representing any class and allowing the notched cards to fall out. The cards in Fig. 1 are arranged in order of specific gravity of specimens of timber under investigation, and the closeness of the relation between specific



gravity and any other recorded feature may now be seen at once by glancing at the arrangement of the other notches. In the present instance the relation between strength and specific gravity was limited by the presence of 'tertiary walls'² in the wood fibres. Specimens with abundant tertiary walls (Fig. 2b) were segregated by pushing the rod through the holes D and E. It may be seen that in the remainder (Fig. 2a) there is a distinct tendency for strength to increase with specific gravity. It is also a simple matter to recognise the cards of specimens which are unusual in

respect of any feature and to pull out the card with all data recorded.

It is suggested that the method may be useful to investigators interested in the relations between three or more variables.

Needless to say, the time consumed in notching cards is much more than counterbalanced by the time saved in repeated sortings and by the time which would otherwise be spent in plotting graphs.

S. H. CLARKE.

Forest Products Research Laboratory,
Princes Risborough,
Aylesbury,
Bucks.

¹ Supp. to *J. Roy. Stat. Soc.*, 1, 62 (1934).
² *NATURE*, 128, 1078 (1931).

Effect of Insulin on Plant Respiration

THE concentration of blood sugar decreases after injection of insulin in man and other animals. Opinions, however, differ as to whether insulin brings about increased oxidation of carbohydrates¹. Dhar and his collaborators² have found increased oxidation *in vitro* of sugars and other organic materials in a current of air in presence of insulin.

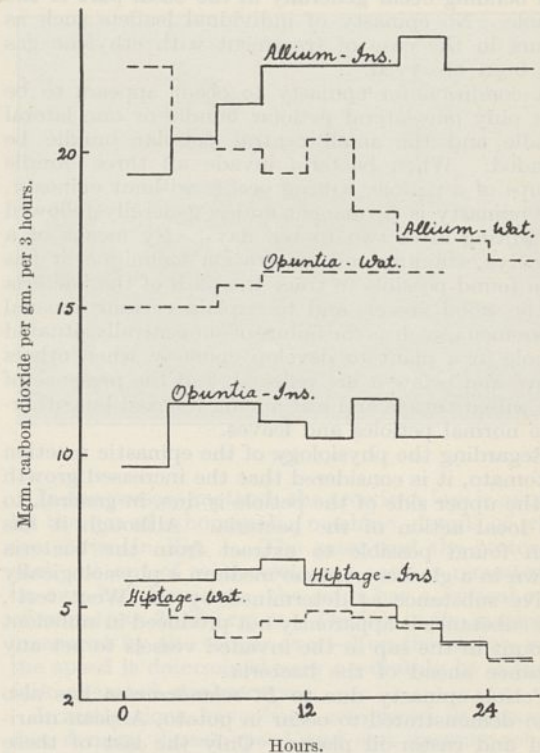


FIG. 1. Effect of injection of water and of insulin on plant respiration. Measurements for *Hiptage* were based on fresh weight and the others on their dry weights.

In order to note the effect of insulin on plant metabolism, a solution of insulin (40 units in 100 c.c.) was injected in plant materials by means of a vacuum pump. It was found that the leaves of *Hiptage madagascariensis* and *Allium tuberosum* respired at a higher rate when injected with insulin than when injected with water. Phylloclades of *Opuntia Dillenii* into which insulin had been injected showed, however, a

definitely lower rate of carbon dioxide evolution. The amounts of solution injected were 0.30 gm. in *H. madablota*, 0.43 gm. in *A. tuberosum* and 0.36 gm. in *O. Dellenii*, and the amounts of water injected in the controls were 0.32 gm., 0.38 gm., and 0.38 gm. respectively per gram of the fresh materials.

Further work is in progress.

N. L. PAL.

U. N. CHATTERJI.

Department of Botany,
University of Allahabad,
Allahabad.
Jan. 20.

¹ J. J. R. Macleod, "Carbohydrate Metabolism and Insulin". Longmans, 1926.

² N. R. Dhar, "New Conceptions in Biochemistry". Indian Drug House, Allahabad, 1932.

Effect of Inoculation of Plant Stems with *Bacterium solanacearum*

AN experimental study of two primary symptom reactions of tomato and other plants to invasion by the vascular parasite *Bacterium solanacearum*—namely, petiole-epinasty and adventitious root production—has been made. It has been found that in the tomato epinasty is confined to the lower petioles irrespective of whether the inoculation is made at the top or the bottom of the stem. Growth and bending occur generally in the basal part of the petiole. No epinasty of individual leaflets such as occurs in the case of treatment with ethylene gas has been observed.

A condition for epinasty to occur appears to be that only one lateral petiolar bundle or one lateral bundle and the small central petiolar bundle be invaded. When bacteria invade all three bundle groups of a petiole, wilting occurs without epinasty. The epinasty is permanent and is generally followed by wilting after two to ten days. By means of a new dye, staining and maceration technique, it has been found possible to trace the path of the bacteria in the wood vessels and to explain certain unusual phenomena, such as the failure of one centrally situated petiole in a plant to develop epinasty when others above and below it are reflexed, and the presence of one wilted petiole and leaf among reflexed but otherwise normal petioles and leaves.

Regarding the physiology of the epinastic reaction in tomato, it is considered that the increased growth on the upper side of the petiole is due, in general, to the local action of the bacteria. Although it has been found possible to extract from the bacteria grown in a glucose-peptone medium a physiologically active substance as determined by the Went test¹, this substance is apparently not produced in sufficient amount in the sap in the invaded vessels to act any distance ahead of the bacteria.

Petiole-epinasty due to *B. solanacearum* has also been demonstrated to occur in potato, African marigold and castor-oil plants. Only the last of these has previously been recorded as showing epinasty as a result of bacterial invasion. Potato shoots are very sensitive and the epinastic reaction is rapid. There is some evidence in the case of the potato and also the other two plants mentioned above, which suggests that the bacteria can cause the reaction from a distance; but in general here, as in tomato, bacteria are present in one lateral petiolar bundle when epinasty occurs.

With regard to adventitious root formation in tomato, I find, from a detailed histological study

of numerous plants, in contrast to Smith² and Hutchinson³, that in the majority of cases the bacteria are present in some or all of the wood vessels outside which the roots develop. The formation of adventitious roots in tomato, as a result of infection, is believed to involve causal factors besides that of stimulation. A substance has been obtained from *B. solanacearum* which stimulates active adventitious root formation in tomato and African marigold; but evidence is accumulating to show that in tomato partial blockage of vessels or blockage of a portion of a vascular system also plays an important part. Frequently where complete blockage of vessels by bacteria in a vascular strand running through an internode occurs, no roots develop. This suggests that, in the absence of food supplies, adventitious roots fail to develop even though the root stimulating substance is present in greater concentration. An experimental study of adventitious root formation arising after wounding and after artificial blockage of the vessels with substances such as cocoa fat and gelatin is being carried on in order to throw further light on this point.

The reactions described above are closely similar to those induced by ethylene, carbon monoxide and β -indolyl-acetic acid as shown by Crocker, Zimmerman and Hitchcock⁴ and Hitchcock⁵.

B. J. GRIEVE.

Botanical Department,
University,
Melbourne.
Jan. 21.

¹ Went, F. W., *Rec. Trav. Bot. neerl.*, **25**, 1 (1928).

² Smith, E., "Bacterial Diseases of Plants", p. 199 (1920).

³ Hutchinson, C., *Mem. Dept. Agr. India Bact. Ser.*, **1**, 2 (1913).

⁴ Crocker, Zimmerman and Hitchcock, *Contrib. Boyce Thomp. Inst.*, **4**, 177-218 (1932); **5**, 1-17 (1933).

⁵ Hitchcock, A., *Contrib. Boyce Thomp. Inst.*, **7**, 87-95 (1935).

A Chromosomal Basis of Tumours

IN 1927, Muller showed that X-rays and radium can produce mutational changes. In a continuation of this work on irradiation, I have observed changes in chromosomal number in accordance with findings of other investigators.

It may be mentioned that the cells of tumour tissues usually have an abnormal number of chromosomes as their peculiar feature. In the autumn of 1935, I applied the salivary gland method to the determination of the chromosome number in tumour tissue. At the same time I conducted experiments with *Drosophila melanogaster* treated with tar, in order to find out if there are carcinogenic factors, other than X-rays and radium, which can produce mutations.

Of the specimens of *Drosophila* treated in such a way, twenty-five per cent died. The remainder showed quite normal development. But in the F_1 and F_2 generations there was a large decrease in the number of offspring (4 and 5, instead of 100-200), and there were changes in the sex ratio in different lines. This may be due to the appearance of a lethal gene.

Quite similar to such an influence in evoking mutational and cancerous changes is the effect of oestrogenic hormones, which is in full accordance with the striking fact that always during the oestrous cycle the meiotic divisions are accompanied by proliferation of the *mucosa uteri*. This phenomenon can be clearly demonstrated by the statistical data

of tumour frequency. Tumours are most frequently in the tissue influenced by sexual hormones or by the phenanthrene substances similar to tar (1-2 benzopyrene). The sexual hormones are necessary for the above-mentioned divisions. We must also consider the thyroid, the antagonistic parathyroid glands, which must play a part in the fat metabolism of an organism (cholesterol contained in fats and lipoids has a phenanthrenous basic group).

I suggest, therefore, that the tumours can be exogenous in origin, that is, evoked by such factors as irradiation or chemical substances (phenanthrenous derivatives and so on). On the other hand, the tumours can be of endogenous origin, being produced by the efficiency of the so-called 'segregators' (in the sense of Demerec's assumption) or genes inducing the somatic segregations of chromosomes.

B. M. SLIZYŃSKI.

Animal Breeding Institute,
Jagellonian University,
Cracow.
Jan. 28.

Double Stars and the Cosmogonic Time-Scale

IN a recent note¹ Sir James Jeans has brought forward arguments in favour of the equipartition of energy in the orbital motion of double stars. As he has pointed out, the existence of equipartition would be opposed to the 'short time-scale' of the universe. Some remarks on this interesting subject are perhaps not superfluous:

(1) The argument that the number of orbits whose eccentricity is less than e will be proportional simply to e^2 holds, not only in the case of the equipartition of energy, but also in a more general case, when the density in the phase space is an arbitrary function of the whole energy of the binary system.

(2) If the perturbations from passages of other stars are responsible for the distribution of eccentricities of binaries with known orbits, they would be also sufficient for the production of equipartition between the double stars with the more distant companions ($r_{AB} > 100$ astron. units). It is easy to see that in this case the Boltzmann's factor $e^{-u/\theta}$ is nearly equal to unity and the relative number of the double stars with the distances between companions confined within the limits r and $r + dr$ will be simply proportional to $r^2 dr$. However, Öpik² in his valuable work has shown that this number is proportional to dr/r . Therefore, the distribution of the distant companions is not in accord with the long time-scale hypothesis.

(3) In the case of the long time-scale, we should expect the existence of some sort of dissociative equilibrium between double stars of large separation and single stars. It is easy to compute that the theoretical ratio of the number of distant pairs and single stars in the dissociative equilibrium is many thousand times smaller than the observed ratio. Therefore the dissociative equilibrium for the distant companions is not yet achieved.

We may conclude that the observational data of double-star astronomy do not support the long time-scale hypothesis.

V. AMBARZUMIAN.

Astronomical Observatory,
University, Leningrad.
Feb. 21.

¹ NATURE, 136, 432 (1935).

² Tartu Observatory Publications, 25 (1924).

PROF. AMBARZUMIAN seems to have misunderstood my main point. I did not intend to claim that equipartition actually exists—Prof. Ambarzumian's arguments (2) and (3) are sufficient to disprove this—but that *in certain respects* there is a tolerably good approximation to equipartition. To obtain perfect equipartition would, of course, require an infinity of time; to obtain the observed approximation requires time of the order of 10^{13} years. I cannot see that Prof. Ambarzumian's remarks in any way challenge this position, so that it seems to me that the observational data he mentions are not opposed to the long time-scale of 10^{13} years, but only to an infinitely long time-scale.

J. H. JEANS.

Losses in Electrical Machinery due to Open Slots

ONE of the difficulties in design and manufacture of electrical machines is the separation of the true iron loss from the loss due to open slots.

In all the experimental investigations so far published, the apparatus used has included both these losses. The true iron loss could only be measured separately by making substantial changes in the building and arrangement of the apparatus, which introduces changed conditions and some degree of uncertainty.

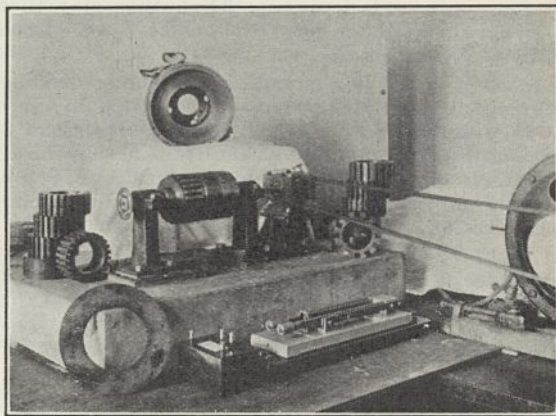


FIG. 1.

In the present method, the true iron loss is avoided by the use of a homopolar machine, details of which are shown in Fig. 1. The rotor and the stator are each cut out of solid steel, and each is mounted on its own ball bearings; the rotor has a critical speed of more than 20,000 r.p.m. The loss in the machine is measured by the torque exerted on the stator, while the speed is determined very accurately by a tuning fork operated stroboscope.

Investigations have been completed in regard to flux density, linear speed and slot opening relative to gap length; while effects of variations in slot pitch, ratio of slot opening to slot pitch and the nature of the material opposite the teeth are now being examined.

It is hoped to use speeds, in the case of turbo-alternator materials, up to 18,000 ft. per min.

K. ASTON.

Department of Electrical Technology,
Indian Institute of Science,
Bangalore.

Jan. 16.

Promoter Concentration and Catalysis

IN a recent publication¹ attention has been directed to the critical concentration of silica required to give the maximum increase in the activity of molybdenum oxide catalysts used in the decomposition of hexane at 500°. A survey has now been made of the concentration required with a wide range of other promoters, and it is found that in the case of oxides of sodium, chromium, cerium, aluminium, barium, boron and thorium, the ratio of the number of atoms of these elements to 100 atoms of molybdenum is the same as that previously observed with silicon.

When, however, the promoter is an easily reducible oxide such as that of lead, iron or copper, the promoter concentration required is only half that which is necessary in the above case.

Again, using molybdenum oxide as a catalyst for the conversion of phenol to benzene by hydrogenation at 450° at atmospheric pressure, the optimum concentration is found to be much higher than for the previous reaction, but again is practically identical in the cases of silica and alumina respectively. The active oxide of molybdenum may, however, be quite different under the alternative conditions of experiment.

These observations appear to be of interest with relation to the nature of promoter action, and it is intended to discuss them fully at an early date.

R. H. GRIFFITH.

Fulham Laboratory,
The Gas Light and Coke Company.
March 9.

¹ Griffith and Hill, *Proc. Roy. Soc., A*, **148**, 193 (1935).

Points from Foregoing Letters

THE efficiency of several promoters in increasing the catalytic activity of molybdenum oxide (used in the hydrogenation of phenol to benzene) is given by F. E. T. Kingman and Prof. Eric K. Rideal. The presence of phosphorus, nickel, chromium or silicon compounds enhances the activity, whilst tin and thorium compounds depress it. The authors state that they have also determined the surface area of the catalysts investigated.

A survey of the concentration of promoters leading to maximum catalytic activity of molybdenum oxide shows, according to Dr. R. H. Griffith, that there is a constant optimum molecular ratio for silicon, sodium, copper, chromium, cerium, aluminium, barium, boron and thorium; with lead, iron and copper a molecular concentration only half as great is needed.

Graphs showing a close correlation between the death rate of infants and that of mothers in depressed areas, when charted in successive years instead of the same year, are submitted by Lady Williams. The author ascribes this correlation to the effect of malnutrition expressing itself first in the infants, owing to the insufficient nourishment of nursing mothers, and afterwards its effect on the mothers themselves becomes apparent.

A generalised expression, from which the known relationship between the velocity and the equilibrium constants of certain related chemical reactions can be deduced as specialised cases, is derived by M. G. Evans and Prof. M. Polanyi from thermodynamic principles.

From an investigation of the Zeeman effect of the hyperfine structure lines of the mercury resonance line 2537 Å., Dr. A. Zvironas concludes that the experimental results are in good accordance with the theoretical values.

With new equipment for vacuum spark spectroscopy, giving essentially improved conditions for the study of spectra of very high ionisation, Prof. B. Edlén has photographed the spectra of the elements titanium to zinc in the region 30–200 Å. Preliminary analyses have resulted in tracing the Na I - like isoelectronic sequence through the whole series of elements including copper, Cu XIX.

Mr. R. A. Stephen and Dr. R. J. Barnes state that the method used in their technique for obtaining X-ray powder patterns from flat polycrystalline specimens, and for obtaining an intense, mono-

chromatic, polarised X-ray beam from a single crystal is simply an application of the principle of 'fore-shortening'.

A new counter for alpha-particles consisting of a very thin leaflet of aluminium or platinum, attracted to an insulated point conductor kept at a potential of + 2,500 volts, is described by S. S. Wassiliew. When an alpha-particle falls within the region of the point, a discharge occurs and the leaflet flies back from the point.

Graphs showing the speeds of propagation of flames in carbon monoxide - oxygen mixtures of various concentrations, and at different pressures, are given by V. Voronkov and A. Sokolik. They consider that the form of the graphs is connected not with hydroscopic conditions but with a change in the temperature of spontaneous combustion for constant time lag.

J. Bell finds that copper sulphate solutions in heavy water are lighter in colour than solutions of equal concentration in ordinary water, and a slight difference in tint is apparent. This difference is also found in the solid salts $\text{CuSO}_4 \cdot 5\text{D}_2\text{O}$ and $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

N. L. Pal and U. N. Chatterji state that they found an increased rate of respiration on injection of insulin in leaves of *Hiptage madablota* and *Allium tuberosum*, but a decrease in respiration in the flattened stems (phylloclades) of *Opuntia Dillenii*.

An account is given by Dr. B. J. Grieve of leaf movement and adventitious root formation in tomato and other plants due to invasion by the vascular parasite *B. solanacearum*. Although a substance has been obtained from the bacteria which causes bending in oat coleoptiles and initiates strong root development in tomato, Dr. Grieve considers that other factors, such as partial blockage of vessels, are also involved.

Prof. V. Ambarzumian states that the observational data of double-star astronomy are definitely against the 'long time-scale' of the universe (10^{13} years). Sir James Jeans disagrees, claiming that the data are only opposed to an infinitely long time-scale.

Prof. K. Aston describes an investigation undertaken to determine losses in electrical machinery due to open slots. The method consists in the measurement of the torque on the stator of a homopolar machine under various conditions of flux density, speed and slot proportions.

Research Items

Ethnology and Cultural History in California

THE quantitative technique in ethnological studies invented by J. Czekanowski in 1911, and since developed by the Polish school of anthropologists, has been applied by Dr. Stanislaw Klimek to the data relating to the Indians of California collected in recent years by A. L. Kroeber and others, supplemented by field studies to supply deficiencies in material essential to the inquiry. The technique makes use of the methods of statistics applied to cultural 'elements' determined not by logic but empirically. Of the elements, more than eight hundred in number, differentiated by Kroeber, four hundred and eleven are selected as conforming to the criteria of the technique. On the results of this statistical study (*Univ. California Pub. in Amer. Ethnol. and Archaeol.*, 37, 1) the author has based a review of racial and cultural succession in California. The most ancient period which can be reached is that of Hokan-Yuki, of which the former is the older. The latter came in from the north along the coast, as is indicated by the importance of the Arctic physical type in their composition. The Hokan-Yuki culture is the most primitive in America, the gathering of vegetable products being the economic basis of life. The Hokan were Paleo-American in physical type. The second historical period begins with the Penutian expansion, of which the local origin cannot be particularised. The coiling technique, the bull-roarer and avoidance of the parent-in-law are characteristic. They shattered the earlier culture. They were followed by the Shoshonean, who introduced no important difference in type, but brought the gabled house and moieties in social organisation. The Athabaskan-Algonkin expansion introduced a profound modification in northern California. The most important components were the brachycephalic central Asiatic element and secondarily the Pacific element. The north-western culture extending from Alaska to the north-west of California in the latter becomes thinner and less marked going inland from the coast. A stratum representing cross-roads of Plains Indians and north-west is the youngest.

Breathing Mechanism in Birds

BAER, in 1896, put forward the suggestion that owing to the importance of rigidity in the thoracic basket, during flight it remained practically unaltered, so that any respiratory movements were confined to the air sacs in the vicinity of the clavicles. This statement has been fairly widely copied. As the result of a detailed anatomical and experimental investigation on the pigeon and crow, Zimmer (*Zoologica*, 33, No. 5, Heft 88; 1935) has come to different conclusions. In flight the sternum is kept relatively still, but in the downstroke the ribs move in such a manner as to raise the back, and at the same time the pectoralis muscle pulls the coracoids apart and so broadens the chest. Those movements are reversed during the upstroke. There is thus no fundamental difference between the method of breathing during flight and while at rest. The frequency, however, is increased about fourteen times. The curves further show that this synchronisation is not compulsory,

and in gliding the same respiratory mechanism is brought into play but its frequency lessened. The independence of wing stroke and respiration is doubtless of importance in birds that sing during flight.

Butterflies of Abyssinia

PROF. G. D. HALE CARPENTER has recently published a comprehensive paper on the above subject (*Trans. Roy. Entom. Soc. Lond.*, Dec. 1935). It is, in the main, a faunistic survey, and the author has derived his material from various sources. These include published records; specimens contained in the British Museum (Natural History) and in the museums of Oxford and Tring; and an extensive collection of butterflies made by Sir Arnold H. Hodson in south-west Abyssinia in 1925-27. As a result of his studies, Prof. Carpenter is able to give an extensive catalogue of the known species of Abyssinian Rophalocera and their distribution. In the general discussion brief summaries are given of work on other Abyssinian invertebrates, mainly from papers on the results of the Omer-Cooper-Scott Expedition of 1926-27. From the geographical aspect, the region, as a whole, presents certain difficulties since the political boundaries embrace territory of diverse faunistic types. The mere record "Abyssinia" is of little value, and altitude is of prime importance. The adoption of the 1,500-metre level allows of the exclusion of the essentially Somaliland type of country while admitting forms characteristic of "Abyssinia". The fauna of the area thus defined comprises many species of butterflies widely spread over Africa, but where division is possible, it shows the character to be predominantly East African. But detailed analysis shows also a Western element and a slight Palearctic intrusion.

Recent and Fossil Mollusca of Tonga

IN his paper "Recent and Fossil Marine Mollusca of Tongatabu" (Bernice P. Bishop Museum, Bulletin 131, 1935), Mr. Jens Mathias Ostergaard studies the marine mollusca, both recent and fossil, of the island of Tongatabu, Tonga; his chief purpose being to throw light on the geological age of the limestones of the island and on the climatic and ecological conditions under which they were formed. The formation in question is a comparatively recent one, and living species are well represented by fossils. Of the 38 species of fossil marine molluscs collected in Tonga and identified, 27 were found living in the surrounding waters, and the remainder have been reported as living in the south or central Pacific. None was found to be extinct. Several species found only in the fossil state in the island seem to thrive in the warmer waters of the Pacific, indicating a higher temperature when the fossiliferous limestone was being laid down than at the present time. The resemblance between these deposits and the limestones of Oahu, Hawaii, is striking, and the author is of the opinion that the age of the Tongatabu limestone, like that of Oahu, is late Pleistocene; and it seems that warmer conditions existed in both regions during their formation. The island of Tongatabu,

Tonga, lies almost exactly the same distance south of the equator as the island of Oahu, Hawaii, lies north of it. Similarity in the species of marine molluscs in the two regions is not very close, but a few gastropods, such as *Cypræa caput-serpentis* and *Conus ebraeus*, are abundant in both. Four species of *Cypræa*, *C. lynx*, *tigris*, *vitellus* and *erosa*, which appear to be extinct in Hawaii are common in southern Tonga. *C. erosa* is, however, common as a fossil in Oahu. Probably the principal cause of the difference is that in southern Tonga the temperature of the sea is higher during the warmer part of the year than in Hawaii. It is found that most of the marine molluscs spawn in Hawaii when the water temperature is highest; therefore if the minimum temperature for spawning is infrequently reached, extinction of certain species may result.

Snowdrop Mould

THE hardness of the snowdrop plant renders it proof against the attacks of most fungus diseases; but Mr. D. E. Green (*Gardeners' Chronicle*, February 8, 1936) has shown that the fungus, *Botrytis galanthina*, can actually cause serious trouble. The disease is not new, and was first described many years ago by Berkeley and Broome. It is now found extensively in the northern counties of England. Infected plants produce a shapeless mass in place of foliage and flower, whilst fructifications of the fungus appear quickly upon it. Shining black sclerotia, about half a millimetre in diameter, are also formed, and constitute the real menace of the disease, since they remain in the soil around rotting bulbs, and can infect future plantings. Sterilisation of the soil with formalin solution is the control measure advocated in the paper.

Mutations in Tobacco Mosaic Virus

A REPORT, dated January 27, and issued by Science Service from Washington, D.C., announces the discovery by Dr. H. H. McKinney that the ordinary type of tobacco mosaic often mutates into a yellow type, which can be propagated as a continuous pure strain. A similar capacity has also been recorded for a virus disease of wheat. The report goes on to quote the findings of Dr. W. M. Stanley, who has isolated a protein substance which appears to be the virus itself, and then mentions the paradox of a mutation arising in a non-living thing. This would perhaps seem needless, for lack of demonstration of the protein nature of the virus has been one of the main objections to its inclusion as a living organism. The findings of Dr. McKinney and Dr. Stanley have little value when interpreted as a paradox; but taken together, constitute most welcome evidence towards a vitalistic conception of the nature of the virus.

Geology of Rajputana

A MOST important contribution to the Pre-Cambrian geology of India was presented by Dr. A. M. Heron at the inaugural meeting of the National Institute of Sciences (*Trans. Nat. Inst. Sci.*, 1, pp. 17-33, 1935), when he summarised the results of nearly twenty-seven years' work in Rajputana, mainly on the Pre-Vindhyan systems. The Bundalkhand gneiss, and a complex of migmatites including granites of probably more than one age, are proved to be older than the Aravalli system. The latter comprises an immense thickness of sedimentary rocks which vary from east to west through every degree

of metamorphism up to composite gneisses. Near the base of the system volcanic rocks locally reach great thicknesses, ranging from amygdaloids to garnetiferous hornblende-schists. The Raialo series of quartzite and limestones, followed by mica-schists, is separated from the Aravallis by a major unconformity. Another major unconformity separates the Delhi system from the Raialo series. In the main synclinorium the Delhi system has five sub-divisions: basal grits and conglomerates being followed by quartzites, phyllites and biotite-schists, calc-schists, and calc-gneisses. Above these are the granites and rhyolites of the Malani series. Besides these and the oldest granites of the area, granitic intrusions are known to succeed the Aravalli system and the Delhi system, making at least four different ages of Pre-Vindhyan granites. An important suite of basic and ultra-basic rocks, older than the Malani but younger than the Erinpura (post-Delhi) granite, has been discovered. Dr. Heron is preparing a memoir on the great synclinorium of the Delhis and its environment. Judging from the synopsis now issued, it will be a geological document of unusual interest.

Atomic Weight of Uranium Lead

THE atomic weights of several samples of radiogenic lead, including several for mixtures of radium G and actinium D obtained from thorium-free minerals, have been determined by G. P. Baxter and C. M. Alter (*J. Amer. Chem. Soc.*, 57, 467; 1935).

Source of lead	Atomic weight
Uraninite, Besner, Parry Sound, Ontario	206.05
Pitchblende, Great Bear Lake, Canada	206.06
Cyrtolite, Hybla, Ontario	206.20
Cyrtolite I, Bedford, New York State	205.93
Cyrtolite II, Bedford, New York State	206.07
Curite, Katanga, Belgian Congo	206.03
Galena, Yancey Co., North Carolina (common lead)	207.21

The value for Great Bear Lake lead agrees with that found by Marble. When corrected for slight contamination with ordinary lead the value is reduced to 205.99. Since the source mineral is about 1,400 million years old, this result constitutes strong evidence against the contention of von Grosse that the rate of production of Pb^{207} is higher than that of Pb^{206} , and supports the conclusion of Holmes (*NATURE*, Sept. 6, 1930, p. 348) that the periods of uranium I and actino-uranium are of the same order. Baxter and Alter point out that the atomic weight of uranium lead does not appear to vary systematically with the age of the mineral source. The result—206.027—for Katanga curite (age c. 600 million years) agrees with that obtained simultaneously by Hönigsmid—206.030—from another portion of the same sample. The very low atomic weight of the lead from the first sample of Bedford cyrtolite remains puzzling. The four original determinations averaged 205.924; a fifth determination gave the value 205.938; and the sixth, now recorded, gave 205.954; the average of all is 205.931. It should be noted in view of the wide 'spread' that only a very small amount of the Bedford I material was available.

Map of the London Area

A MAP of the London area on a scale of half an inch to the mile has been published (Southampton: Ordnance Survey. 3s. 6d. net) in one large sheet. This map is designed to show the boundaries of various administrative areas, counties, parliamentary divisions, metropolitan and municipal boroughs, urban and rural districts, civil parishes, the

Metropolitan Police District, the Metropolitan Traffic Area, the London Transport Board, the London Traffic Area and catchment areas. On a grey groundwork of the usual topographical details the boroughs and urban districts are shown in colour shading, and other divisions by various colour lines. The whole is intricate but as clear as such a maze of varied boundary lines can be. Names of administrative areas are overprinted in colour. The grey background showing faintly through the colour is sufficiently clear to locate the boundaries. The margin has grid references and mileage to important towns.

Snow and Rime Crystals

IN the *Journal* of the Faculty of Science of Hokkaido Imperial University, 1, No. 7, some interesting papers are published on snow, rime and frost crystals. The first paper, by U. Nakaya and T. Terada, gives a record of simultaneous observations of the mass, falling velocity and form of individual snow crystals. When the weather is not cold, snow falls in the form of flakes, each flake consisting of many crystals. The authors' research was carried out at a cottage half-way up a mountain at an altitude of 1,030 metres. There is little doubt that snow grows as crystals at a high altitude and falls a considerable distance before becoming a flake. It was found that the thickness of a plane dendritic crystal of snow was about 0.01 mm. and was independent of its dimensions. Its falling velocity in air (30 cm./sec.) was practically independent of its dimensions and so also was the velocity of powder snow (50 cm./sec.). In the case of 'needles', the longer needle falls more rapidly than the shorter one, the velocities ranging between 30 cm. and 70 cm. per second. The second paper, by U. Nakaya, suggests that the formation of a type of snow crystal may be inferred from the formation of the corresponding rime crystal. It was found that a dendritic plane crystal takes on an average about one hour to fall a kilometre, if we make the assumption that the crystal keeps throughout the final shape observed on the earth's surface. The main difficulty in artificial production is how to suspend the crystal in air for such a long time. The delicate form and design of a snow crystal must have been developed step by step while it is falling through various strata of the atmosphere, and the authors consider that a study of the crystal may lead to a knowledge of the structure of the atmospheric layers. All the papers are illustrated by photographs.

Disintegration of Light Elements by Slow Neutrons

NITROGEN disintegrations produced by neutrons have been observed in a cloud chamber by Bonner and Brubaker (*Phys. Rev.*, February 1). The reactions ${}^7\text{N}^{14} + {}_0n^1 \rightarrow {}^6\text{C}^{14} + {}_1\text{H}^1$ and ${}^7\text{N}^{14} + {}_0n^1 \rightarrow {}_2\text{He}^4 + {}_2\text{He}^4 + {}_3\text{Li}^7$ were observed, but most of the collisions observed were to be attributed to ${}^7\text{N}^{14} + {}_0n^1 \rightarrow {}_5\text{B}^{11} + {}_2\text{He}^4$. This reaction was observed with both fast and slow neutrons. When produced by slow neutrons, the two particles recoil in opposite directions and look like a single track. The energy given out is estimated from the length of these tracks as 2.33×10^6 volt, and the mass of the nitrogen nucleus is calculated to be 14.0085. When the disintegration is produced by fast neutrons, a difficulty arises in that kinetic energy is not conserved. Some energy may disappear as a γ -ray or as excitation energy of the B-nucleus. The disintegration of boron by slow neutrons, previously known from ionisation chamber

work, has been studied by D. Roaf in a cloud chamber containing boron trifluoride (*Proc. Roy. Soc., A*, February 1). The energy of the reaction ${}_{10}\text{B}^{10} + {}_0n^1 \rightarrow {}_3\text{Li}^7 + {}_2\text{He}^4$ was found, and the mass of B^{10} calculated.

State of Helium at Low Temperatures

HELIUM is peculiar in that the solid state can exist only under a pressure greater than about 25 atmospheres. At lower pressures a liquid state persists down to the lowest temperatures, though at 2.19°K . there is a discontinuity in the specific heat. F. London (*Proc. Roy. Soc., A*, February) shows that the liquid below this temperature goes into an ordered state which is probably such that the statistical distribution of the atomic distances is nearly that of a diamond lattice. The atoms cannot, however, be definitely localised in a spatial lattice. The reason for this peculiar behaviour lies in the zero-point energy of the helium. London calculates the zero-point energy by applying quantum mechanics to a system of rigid spheres representing the atoms. At low pressures the diamond lattice has the lowest energy, while when the molecular volume is reduced by pressure the most stable arrangement is a face-centred cubic one.

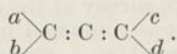
Colloidal Fuel

A COMPREHENSIVE survey of the available information on this subject is contained in a paper entitled "Colloidal Fuel", read at a recent meeting of the Institution of Chemical Engineers by Dr. A. B. Manning and Mr. R. A. A. Taylor. The authors point out that these fuels are the most compact fuels known, in that their potential heat content per unit volume is a maximum, that they are not liable to spontaneous heating and that, as their density is greater than one, they can be prevented from catching fire by means of a light water seal. Although colloidal fuels have not so far been put to serious use, the results of the few large-scale tests which have been carried out indicate that their combustion does not present any special difficulty. It appears that the economic size to which the coal can be reduced without incurring excessive grinding costs is about the same as that normally used when firing with pulverised fuel, and that the problem is to produce a suspension which will be stable over a period of several months. One method is by admixture of small quantities of sodium stearate with the warm oil, when a gel structure is obtained, the gel acting as an elastic solid towards the coal particles and supporting them indefinitely. High-boiling tar oils possess the property of dispersing bituminous coals more or less completely when the powdered coal and oil are heated together. Petroleum oils do not exhibit this effect, although it may be produced by the addition of tar oils to the suspension. More recently, it has been found that by blowing air through the heated oil, certain oxidation products are produced which stabilise the suspension. Descriptions are given of methods developed at the Fuel Research Station for assessing the stability of a suspension, a settling tube containing the suspension being used as a compound pendulum, and also for detecting oils capable of developing the gel structure referred to. The authors conclude that the use of colloidal fuels is likely to be considered seriously with the advent of higher fuel oil prices; and that, though numerous means have been tried, proposed or indicated for making otherwise unstable oils stable, at present the simplest means is probably to select a suitable oil.

Modern Stereochemistry

ONE of the fundamental contributions of chemistry to our knowledge of the properties of atoms is the conception of discrete valency bonds with definite directions in space. This conception rests upon an immense mass of experimental evidence, and its principal features must be retained in the new pictures of atoms and molecules which are now being developed on the basis of modern physical theories. The relation between the old and the new atom models was a notable feature of the discussion on "Stereochemistry" held by the Chemical Society on January 16.

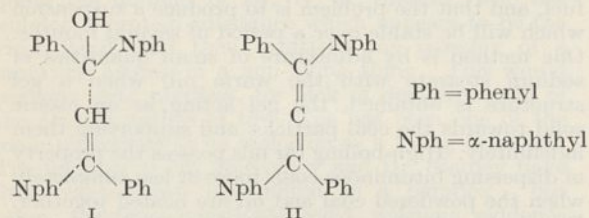
Dr. W. H. Mills opened the discussion with a brief survey of the success of the old tetrahedral model of the carbon atom. It accounts in simple fashion for the dissymmetry of compounds of the type $Cabcd$, for the lack of free rotation about a double bond, and for the linear configuration of acetylene and other compounds containing a triple bond. A further deduction from the tetrahedral model is the dissymmetry of allene derivatives of the type



The possibility of optical activity in these compounds was predicted by van't Hoff in 1875; the isolation of allene derivatives in optically active forms was first achieved by Mills and Maitland in 1935.

Dr. Maitland later in the discussion gave experimental details of this very interesting work. From the tetrahedral model it is readily seen that four different groups attached to the allene residue are not necessary. Compounds of the type

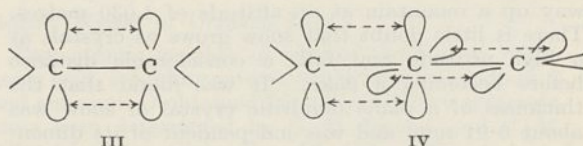
should also be resolvable since the plane passing through Cab at one end of the molecule is at right angles to the plane through Cab at the other end. After a great deal of fruitless work, success was



attained with the allene derivative II, which was prepared by dehydrating the alcohol, I, with *d*- or *l*-camphorsulphonic acid in dilute benzene solution. Most of the product was the racemic form, but the use of an asymmetric dehydrating agent gave about five per cent of the optically active hydrocarbon. Its high rotation ($[\alpha]_{5461} \pm 438^\circ$) revealed its presence in the mixture, and its solubility relations allowed it to be separated from the inactive form and to be isolated in an optically pure condition; *d*-camphorsulphonic acid produced the *d* form of the allene whilst the *l*-acid gave the *l*-allene.

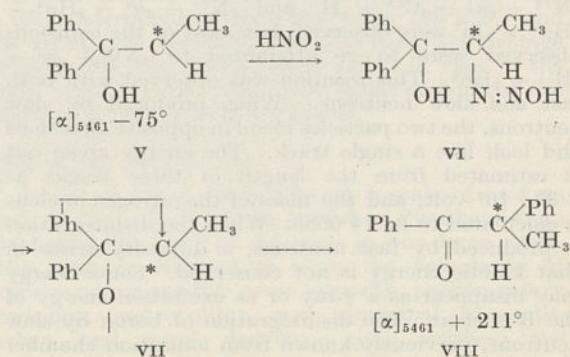
Dr. Mills then briefly described the pictures of valency bonds which are based on quantum mechanics, and in particular referred to the model of a double bond. In this model the shared electrons moving in *s* levels

(that is, levels with serial quantum number $l = 0$) form an electron cloud symmetrical about the line joining the carbon atoms, whilst the electrons in *p* levels (with $l = 1$) may be regarded in the first place as moving in paths for which wave-mechanics gives a roughly dumb-bell-shaped electron cloud normal to the carbon-carbon axis. Interaction between the *p* electrons on adjacent carbon atoms constrains these dumb-bell-shaped figures to remain parallel to one another as shown in III, and thus accounts for the lack of free rotation about a double bond. In the allene derivatives, as IV shows, the central carbon atom is associated with two sets of *p* electron clouds at right angles to one another; these by interaction with the *p* clouds on the terminal carbon atoms lock the valency bonds of these atoms into definite space directions.

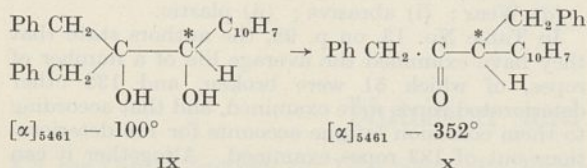


Another application of wave-mechanics to a stereochemical problem concerns derivatives of triphenylmethyl. On the theory developed by Hückel (1933), the stability of a free radical of the type CR_3 depends upon wave-mechanical resonance between three aryl radicals arranged at angles of 120° in the plane around the central carbon atom. Such an arrangement is obviously incompatible with the existence of an optically active free radical, even if three different aryl groups are attached to the central carbon atom. In accordance with this model, Wallis and Adam (1933) have found that whilst the ions CR_3^- and CR_3^+ (which contain one electron more or less than the free radical) can exist in optically active forms, the activity is lost when they pass into the free radicals.

Another type of reaction in which an optically active CR_3^+ ion may exist for a short time was discussed by Prof. A. McKenzie. The optically active substance V, when treated with nitrous acid, passes smoothly into the ketone VIII, which is also optically active. The probable course of the reaction is shown by the formulae V to VIII, in which the asymmetric carbon is indicated by an asterisk. When nitrogen and water split off from VI, the intermediate product VII

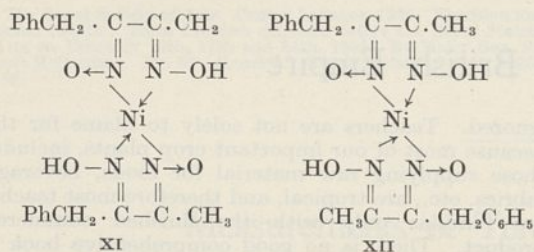


has a positive charge on the carbon atom. This unstable entity passes into VIII by the migration of a phenyl group as shown by the arrow in formula VII. Since the product is strongly active, it is clear that the intermediate carbonium ion in VII cannot possess a planar configuration. Similar migrations of radicals occur when glycols are dehydrated. With some optically active glycols, the ketone produced is also optically active, as in the production of X from IX; in other cases the product is completely inactive.



The valency links which have so far been discussed are described by the quantum theory as compounded of electrons in *s* and *p* levels. An interesting feature of the theory of Pauling (1931) is the configuration deduced for atoms in which *d* levels (with $l=2$) are compounded with *s* and *p* levels to form valency bonds. When one *d* level is used, the theory predicts an arrangement of four bonds at 90° in one plane. Vacant *d* levels with energies comparable with *s* and *p* levels are found in the atoms of transition elements; with certain of these the utilisation of a *d* level to form the valency bond should alter the magnetic moment of the metallic atom. Thus, for example, bivalent nickel, which is paramagnetic in its simple salts, should become diamagnetic in co-ordination compounds in which it has a planar configuration.

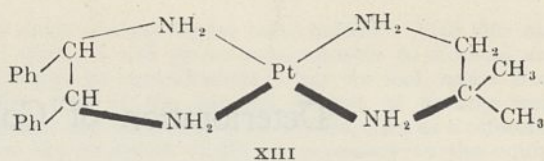
Recent work on compounds of this type was reviewed by Prof. S. Sugden. There are now three main lines of evidence in favour of a planar configuration of compounds of nickel, palladium and platinum. First there is the occurrence of *cis-trans* isomerides when two unsymmetrical chelate groups are attached to the metallic atom. As an example, the isomeric nickel derivatives of benzylmethylglyoxime (Sugden, 1932) shown in formulae XI and XII may be quoted. Other examples are furnished



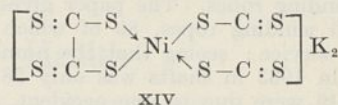
by the isomeric glycine derivatives of platinum (Grünberg and Ptizyn, 1933) and of palladium (Pinkard, Sharrard, Wardlaw, and Cox, 1934).

Evidence from optical activity is provided by the resolution of the compound XIII, which was achieved by Mills and Quibell in 1935. If the links to the platinum atom had a tetrahedral arrangement instead of the planar configuration shown in the formula (XIII), then the planes of the two rings would be at right angles; the molecule would thus possess a plane of symmetry and the substance should not be resolvable.

Finally, X-ray studies by Cox, Wardlaw and others in the last two years have demonstrated a planar

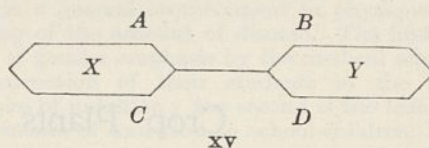


configuration in no less than 14 derivatives of nickel, palladium and platinum. The dithio-oxalate, XIV, is of special interest since the good scattering power of the sulphur atoms enabled the position of all the atoms in the molecule to be determined by X-ray analysis.



There is thus abundant evidence for the frequent occurrence of a planar configuration in four covalent complexes of these three elements. The magnetic evidence is also in accord with Pauling's theory for nickel, which is diamagnetic in all the compounds which have been shown to be planar but paramagnetic in other simple and complex salts. Since all the compounds of palladium and platinum, whether simple or complex, are found to be diamagnetic, no change in magnetism can be observed, but the diamagnetism of the planar derivatives is in accord with Pauling's views. A real discrepancy appears, however, with cupric compounds. Cox and Webster (1935) have found from X-ray studies that the cupric derivatives of certain β -diketones have a planar configuration. These compounds are paramagnetic, and there is not a vacant $3d$ level in the cupric ion. Similar difficulties arise in the interpretation of the magnetic data for some octahedral complexes in which Pauling postulates the use of two *d* levels.

Finally, Dr. E. E. Turner gave a comprehensive survey of the stereochemistry which arises from restricted rotation about a *single* bond. In diphenyl derivatives of the type XV,



the substituents *A*, *B*, *C*, *D*, if they are large enough, may block the free rotation of the benzene rings *X* and *Y* so that they cannot pass through a coplanar configuration. The molecule may then have no plane or centre of symmetry and should be resolvable. This explanation of the optical activity of diphenyl derivatives was given by Mills in 1926; since then a large number of investigations has been concerned with the number and size of the substituent groups necessary to give optical activity, the relation between rate of racemisation and the size of the obstacles, etc. If the substituent groups are large enough, only two or even one substituent is necessary, since it cannot clear the corner of the benzene ring when the two rings are rotated. Another interesting point which was discussed is the part played by the rotation of groups of the type $-\text{N}(\text{CH}_3)_2$ about the bond joining them to the benzene ring; this rotation enhances the power of such a group to form an obstacle to the free rotation of the two benzene rings.

S. S.

Deterioration of Colliery Winding Ropes*

THE Safety in Mines Research Board has recently issued Paper No. 94 on "The Deterioration of Colliery Winding Ropes in Service", which includes the revision of a former paper, No. 50, of the same title. This is a very valuable production, and should be carefully studied by everybody responsible for colliery winding ropes. The paper gives reports on nearly 250 winding ropes, 85 of which have been broken in service; seeing that the number of fatal accidents in 1933 in shafts was only 28 altogether, of which 16 were due to one accident, the subject may be thought unimportant; but nevertheless it deserves study, because the saving of even one life underground is worth while. The authors, Prof. S. M. Dixon, M. A. Hogan and S. L. Robertson, put down the accidents as mainly due to what they have entitled "corrosion fatigue", which term they use "to describe the phenomenon exhibited by materials subjected to the simultaneous action of corrosion and repeated stressing", and have entirely neglected the possibility of the phenomenon known as "acid brittleness" occurring, although they point out (p. 43) that it is quite possible for these ropes to be attacked by acids, or by salts, etc. The authors refer in passing to the B.S.I. tests and point out that torsion tests, a favourite test in Great Britain, are not used on the Continent.

The causes of accidents are grouped as follows:

(a) Fatigue, unaccompanied by corrosion.

(b) Corrosion-fatigue: (i) unaccompanied by obvious deterioration; (ii) with marked internal corrosion;

* Mines Department: Safety in Mines Research Board. Paper No. 94: The Deterioration of Colliery Winding Ropes in Service (Including a Revision of Paper No. 50). By S. M. Dixon, M. A. Hogan and S. L. Robertson. Pp. iv+108+8 plates. (London: H.M. Stationery Office, 1936.) 2s. net.

(iii) with marked external corrosion; (iv) with marked internal wear; (v) with marked external wear.

(c) Corrosion, unaccompanied by fatigue: (i) internal; (ii) external.

(d) Wear: (i) abrasive; (ii) plastic.

In Table No. 13, on p. 98, the authors state that they have examined the average life of a number of ropes, of which 51 were broken, and 132 other deteriorated ropes were examined, and that according to them corrosion fatigue accounts for 116 deteriorations out of 183 ropes examined. Altogether it can be said that, whilst deterioration is carefully examined, and instructions are given for finding out the causes of deterioration, omitting of course the cause of the possibility, under certain conditions, of the formation of a brittle alloy of hydrogen and iron¹, there are but few hints as to the means of avoiding breakages. The authors lay great stress on shock absorbers (pp. 35-38) and also recommend that testing should be carefully carried out, and that ropes which show any sign of wear of either the rope as a whole, or of the wires composing it, should at once be taken off. They also apparently pin their faith on galvanising wires, and pay but little attention to the brittle alloy of zinc and iron which always forms in hot galvanising.

Whilst we have been careful to point out the various directions in which the Safety in Mines Research Board authorities might improve this paper, we nevertheless hold it to be a most valuable one, and one which should be in the hands of everybody in any way responsible for the safety of men in colliery shafts.

¹ V. E. Hillman, *Foundry Trade J.*, 22, 854 (November 1922).

Crop Plants of the British Empire

THE recent issue of the *Kew Bulletin of Miscellaneous Information* is a compilation dealing with cultivated crop plants of the British Empire and the Anglo-Egyptian Sudan (*Bull. Mis. Information*, Royal Botanic Gdns., Kew. Additional Series, 12. H.M. Stationery Office, 6s. 6d. net). The list has been brought together by Mr. H. C. Sampson, economic botanist at the Royal Botanic Gardens, and is based on information which has been supplied by the Departments of Agriculture concerned. This is the first attempt to furnish information about tropical and subtropical plants, and is a very successful one.

According to Sir Arthur Hill, in a foreword, it is hoped that this brochure will stimulate the trial of new crops. We venture to say that it will without doubt do this, but it will actually have a much wider use even than that. In the study of botany, whether at the elementary stage in schools or at the advanced stage in universities, very little economic botany finds a place, and the practical, everyday application of this important branch of science is almost completely

ignored. Teachers are not solely to blame for this, because most of our important crop plants, including those supplying raw material for foods, beverages, fabrics, etc., are tropical, and therefore most teachers are familiar only with the finished commercial product. There is no good comprehensive book on the subject, but such information as there is, is dotted about in various books, encyclopædias, reports, etc. This brochure now gives teachers and students the essential basis for further information. Nothing of importance need now be missed. Reference to the list will give basic information concerning each crop plant, and then further detailed information can easily be gleaned elsewhere.

The crop plants are listed under their generic names. So many as 450 genera are listed alphabetically. Then under each genus are given various species of economic importance together with their geographical distribution, including, where possible, country of origin, common and vernacular names and other important information. For example,

under the genus *Citrus* are listed eleven species and varieties together with certain 'unspecified' species. Following this list, which occupies 180 pages, are 68 pages of useful crop notes on certain species.

The authorities at the Royal Botanic Gardens, Kew, especially Sir Arthur Hill and Mr. H. C. Sampson, are to be congratulated on this very praiseworthy effort to "stimulate the trials of new crops, and more especially the trial of other varieties

of crops already under cultivation". With this aim in view, it will prove indispensable to tropical and subtropical agriculturists; but we feel, apart from this, that if the general subject of botany were taught and studied as it should be, then as a reference list the brochure would be necessary to the equipment of every 'academic' botanist, for as a source of information and guide to further study it will prove invaluable to him.

Nutrition and National Health

IN the Cantor Lectures for 1936 before the Royal Society of Arts*, Sir Robert McCarrison presented a strong case for the fuller recognition of the importance of nutrition in determining the health and efficiency of human beings, as it has long been recognised in the case of domestic animals. Observations on the dietary habits of different races of men in India have convinced him that the kind of food habitually eaten is responsible not only for striking differences in physique, vitality and endurance, but also for equally striking differences in their susceptibility to diseases of various kinds. His numerous experiments in the laboratory have amply confirmed the field observations and have demonstrated the poor physique and increased liability to disease of animals reared on faulty diets similar in composition to those consumed by large sections of the populations both of India and of Western countries.

The analysis of the dietary factors concerned in the maintenance of good nutrition is proceeding rapidly, and new light is being shed on the origin of a great number of common human diseases and disorders. Insufficient supplies of mineral elements and vitamins have been shown not only to lead directly to the deficiency diseases, but also to be important predisposing causes to other diseases of infective or metabolic origin. Deficiency of one or more of the factors calcium, phosphorus and vitamin

D, which dominate the calcifying processes of the body, is one of the commonest faults in Great Britain. Iron deficiency is responsible for a great deal of ill-health both among infants and among women of the child-bearing period of life. In parts of the world, iodine deficiency is concerned with the appearance of endemic goitre and its associated cretinism and deaf-mutism.

Though but few diseases caused directly by gross deficiency of specific food elements are commonly met with in Western countries, lesser degrees of dietary deficiencies are of great importance in determining the onset of some of the common illnesses of mankind. The geographical distribution of such diseases as tuberculosis, gastric and duodenal ulcer, rheumatism, nephritis and heart-disease in India suggest that nutrition plays an important part in their causation. There is no reason for supposing that nutrition is not an equally important factor in determining the susceptibility of individuals in Western countries to similar diseases.

There is increasing evidence that in Great Britain faulty nutrition is by no means a rarity and is not confined to the poorest classes of society. Two measures are strongly recommended to bring about that raising of the standard of nutrition which should result in a general improvement in physique and a lessening of the amount of disease. The first is the laying of greater emphasis by the medical schools on the instruction of their students in the general principles of nutrition; the second is the teaching of the elements of nutrition to school-children.

* The Royal Society of Arts. Cantor Lectures, 1936. Nutrition and National Health: Three Lectures delivered before the Royal Society of Arts on February 10th, 17th and 24th, 1936. By Major Gen. Sir Robert McCarrison. Pp. 56. (London: Royal Society of Arts, 1936.) 2s. 6d.

Measurements of Temperature at Great Heights

PROFESSIONAL Note No. 67 of the Meteorological Office, Air Ministry, by L. H. G. Dines, entitled "The Rates of Ascent and Descent of Free Balloons and the Effects of Radiation on Records of Temperature in the Upper Air", deals with two problems in connexion with the measurement of temperature at great heights in the atmosphere that are more closely related than they appear to be at first sight.

The records of upper air temperature with which the writer is concerned are those obtained at meteorological stations in Great Britain with the aid of the simple mechanism known as the Dines balloon meteorograph, that has been in use with only slight modifications for twenty-seven years.

This apparatus will only indicate air temperature provided that it is not heated directly by solar radiation, or radiation from any other source, and is not chilled by the loss of its own heat by radiation, and, further, provided that the air with which it comes in contact has not been warmed or chilled by contact with any of the auxiliary apparatus—such as the balloon. When an ascent is made during the daytime, the balloon may become strongly heated by the intense solar radiation encountered at very high altitudes above cloud-level, but the meteorograph is suspended 40 metres below the balloon and therefore should not be affected; it is itself shielded from the sun by being mounted inside a polished metal cylinder, open at its ends, the ascent of the

apparatus providing automatically a ventilating current of air past the walls of the cylinder, similar to that produced artificially in the well-known Assman psychrometer.

The first part of the paper is concerned with the rates of ascent of balloons of various sizes and also with the rates of fall of the apparatus after the balloon has reached its greatest height and has burst; in the second part an estimate is made of the probable errors in the measurement of temperature at heights greater than 13 km. due to imperfect protection against direct solar radiation, arising from the fact that the diminished density of the air at such heights reduces the ventilating effect of a given air current. In this last problem the required result has been obtained by studying statistically the differences found between the temperatures recorded when the apparatus is ascending and descending, in relation to the time of day. It appears that the error due to solar radiation in soundings made during the day is serious, and may be more than 3° C. at a height of 20 km. The need for some more effective protection than is provided by a single metal cylinder therefore appears to be established, if reliable figures are to be obtained during the daytime in regions of very low air density; it is observed that the construction of such a screen is no simple matter, which doubtless accounts for the almost universal use of the inadequate metal cylinder.

Educational Topics and Events

CAMBRIDGE.—The professor of chemistry has, with the consent of the Vice-Chancellor, appointed F. S. Bridson Jones, of Clare College, to be his assistant.

EDINBURGH.—The *Senatus Academicus* has resolved to offer the degree of LL.D. to the following among others: Sir Thomas Hudson Beare, regius professor of engineering and dean of the Faculty of Science in the University; Dr. Mervyn Henry Gordon, consulting bacteriologist; Sir William McKechnie, permanent secretary, Scottish Educational Department; Prof. E. L. Thorndike, director of psychological research in Columbia University, New York.

LEEDS.—Prof. J. K. Jamieson has resigned from the chair of anatomy after serving on the Council, the Senate and the Medical School during the long period of forty-one years, in the course of which he has been dean of the medical faculty and a member of the University Council continuously for eighteen years.

The following appointments have been made: D. J. Cork, to be lecturer in dental pathology and bacteriology; D. S. Hendrie, to be district lecturer in agriculture; J. C. Gillies, to be honorary demonstrator in anatomy.

Easter Holiday courses of lectures on history and archaeology, law, astronomy and physics will be given in the University on April 15–17. Lectures on history and archaeology will be given by A. H. Dainton and Miss Mary Kitson Clark; on physics by Prof. R. Whiddington, Dr. E. C. Stoner, Dr. G. W. Brindley and J. McDougall. Two lectures on "Modern Developments of Astronomy" will be delivered by Prof. S. Brodetsky. Further information can be obtained from the Registrar.

LONDON.—Sir Denison Ross, who has reached the age of retirement, has accepted the invitation of the Governing Body of the School of Oriental Studies to remain as director of the School for another year. Prof. R. L. Turner, University Professor of Sanskrit, has been appointed to succeed Sir Denison as director after the end of the session 1936–37.

OXFORD.—D. A. Jackson, of Balliol College, has been granted the degree of D.Sc. for his work on the hyperfine structure of spectral lines.

MR. J. R. BLOCKEY has been appointed principal of the Leathersellers' Technical College, Tower Bridge Road, S.E.1, to succeed Mr. M. C. Lamb, who is retiring at the end of the current session. Mr. Blockey, who has been works manager of Messrs. Harold Nickols, Ltd., of Leeds, since 1930, was educated at the University of Leeds, where he obtained his B.Sc. degree with first-class honours in 1908, and was awarded the M.Sc. degree in the following year. From 1909 until 1913 he was on the staff of the Leathersellers' College as lecturer in the applied science of leather manufacture.

THE seventh World Conference of the New Education Fellowship will be held in Cheltenham during the first fortnight in August. The subject of the Conference will be "Education and a Free Society". Delegates to the Conference have been appointed by the Board of Education and the Scottish Education Department, and Government representatives have also been appointed by Northern Ireland, Denmark and France. The Conference will be open to the public. Further information can be obtained from Mr. A. B. Paterson, 29 South Street, St. Andrews, Fife.

A LIBRARY Consultant Service established four years ago in Teachers' College, Columbia University, exemplifies, in the course of its development, certain widespread movements in the United States involving a convergence of the methods of the librarian and those of the teacher, especially the university teacher. So long ago as 1928, Dean Russell of Teachers' College and Dr. Suzzallo, formerly president of the Carnegie Foundation for the Advancement of Teaching, foretold the consummation of these tendencies in the merging of the best features of the library and the school in an entirely new type of educational institution consisting of three elements: "a lot of books, an earnest student and someone who knows them both and can bring them into thoughtful accord". The library consultant at Teachers' College provides advisory services of four types: first, helping students individually, at their request, to find in books and journals just the information they need; secondly, general lectures, open to the entire student body, explaining the organisation of the library and use of the card catalogues and periodical indexes; thirdly, meetings with classes for demonstrating the use of the reference and bibliographic tools appropriate for the subjects in question; and fourthly, group meetings with teachers of various subjects to present the reference and supplementary materials useful in teaching those subjects, thereby demonstrating the potential value of a good school library. It is the mission of such services to stimulate the student to seek a wider basis of knowledge than lecture notes and, to that end, to acquire such a modicum of library technique as will obviate much waste of time and energy.

Science News a Century Ago

Mitchell's Exploration of Eastern Australia

AMONG the many explorers of the interior of Australia was Major (afterwards Sir) Thomas Livingstone Mitchell (1792-1855), who in 1828 became Surveyor-General to New South Wales. In the third of his expeditions, he proved the junction of the River Murray with the Darling, and struck the Glenelg, which he followed to the sea. A report written from a camp "West of Harvey's Range", dated September 4, 1835, to the Colonial Secretary, was read at a meeting of the Royal Geographical Society on March 28, 1836. This described a journey of some 300 miles down the left bank of the Darling. His party met with considerable difficulty owing to the opposition of the natives, and in one passage he wrote: "The conduct of these tribes was very extraordinary. To conciliate them was quite hopeless, but not from any apprehensions on their part. On the contrary, the more we endeavoured to supply their real wants, and show good will towards them, the more they seemed to covet what was utterly useless to them, and the more they plotted our destruction. Some of their ceremonies were different from those of any other aboriginal tribes near the Colony, such as waving the green bough, first setting it on fire, with furious gestures at us; throwing dust at us *with their toes*, and spitting at our men. They behaved thus just after they had received presents, and while we endeavoured by sitting in the dust, to conform to their manners and customs." During the four winter months just past, said Mitchell, "no clouds gathered to any particular point of the horizon, no rain has fallen, neither has there been any dew, and the winds from the west and north west, hot and parching, seemed to blow over a region in which no humidity remained".

Death of the Chimpanzee at the Zoo

ON March 31, 1836, *The Times* said: "On Saturday morning last the Zoological Gardens lost their chief attraction for the season by the death of the chimpanzee. For four hours preceding the death of this singular link in the animal kingdom, he would not be separated from the keeper's wife, for whom he had formed an attachment as nearly approaching to the filial as expression can define. A gentleman who was present until within a very short period of the creature's death describes all the changes that took place, and the exhibitions of apprehension and lamentation made by him as but scarcely differing from the sufferings and sorrowings of a human being."

The *Beagle* at the Keeling or Cocos Islands

ON April 1, 1836, the *Beagle* arrived at the Keeling or Cocos Islands, where she remained until April 12. With Captain FitzRoy, Darwin visited several of the islands, and his "Journal" contains a sketch of the natural history of them. On April 6 he described a visit to an island at the head of the lagoon. "When we arrived at the head of the lagoon, we crossed a narrow islet, and found a great surf breaking on the windward coast. . . . The ocean throwing its waters over the broad reef appears an invincible, all-powerful enemy; yet we see it resisted, and even conquered, by means which at first seem most weak and inefficient. . . . It is impossible to behold these waves without feeling a conviction that an island, though

built of the hardest rock, let it be porphyry, granite, or quartz, would ultimately yield and be demolished by such an irresistible power. Yet these low, insignificant coral-islets stand and are victorious: for here another power, as an antagonist, takes part in the contest. The organic forces separate the atoms of carbonate of lime, one by one, from the foaming breakers, and unite them into a symmetrical structure. Let the hurricane tear up its thousand huge fragments; yet what will that tell against the accumulated labour of myriads of architects at work night and day, month after month? Thus do we see the soft and gelatinous body of a polypus, through the agency of the vital laws, conquering the great mechanical power of the waves of an ocean which neither the art of man nor the inanimate works of nature could successfully resist."

The Cornwall Polytechnic Society

IN its notes "Our Library Table", the *Athenæum* of April 2, 1836, says: "Report of the Cornwall Polytechnic Society 1835.—The report is ably drawn up, and the accompanying papers very creditable. We are of opinion that some valuable hints might be gathered from this work, by the Directors of many local Societies."

Societies and Academies

LONDON

Royal Society, March 19. D. F. MARTYN and O. O. PULLEY: The temperatures and constituents of the upper atmosphere. Radio measurements of the heights and electron densities of the ionised regions indicate considerable cooling of the upper atmosphere during the night. The absolute temperatures between the *E* and *F* regions of the ionosphere are found, from consideration of the electron collision frequencies, to reach values of the order 1,000° K. in both summer and winter daytime. From the observed rate of cooling at night, considerable water vapour is present in the ionosphere, an average concentration being one part in 6,000 by volume. The high temperatures found are attributed mainly to ozone, in concentration of 1 part in 10⁴. The ionisation densities in the *E* and *F* regions are correlated directly, and the height of the *F* region indirectly, with the barometric pressure at the ground. This correlation is attributed to the temperature changes in the ionosphere occasioned by changes in ozone concentration. The attachment of electrons to neutral particles is the main process by which free electrons are removed from the ionised regions. As regards temperatures below 100 km., a maximum is found at 60 km., and a minimum of 160° K., at 82 km. Noctilucent clouds are found to be formed of ice crystals. P. I. DEE and C. W. GILBERT: The disintegration of boron into three α -particles. The common mode of disintegration is into two particles which proceed at angles of 150° to 180° relatively to one another, the third particle receiving little energy. A theoretical picture of the process, involving the existence of an unstable $\frac{10}{4}\text{Be}$ nucleus, of very short life, explains the main features of the distribution of energy among the particles emitted in this process and also in the similar three-body disintegration of boron under deuteron bombardment. The value $8.7 \pm 0.2 \times 10^6$ e.v. was obtained for the total energy release in the first reaction.

EDINBURGH

Royal Society, March 2. KATHLEEN B. BLACKBURN : A reinvestigation of the alga *Botryococcus braunii*, Kützing. The alga was studied in search of an explanation of its preservation as boghead and in peats. The cellulose walls, green chloroplasts and starch production reveal it as a member of the Chlorophyceæ with affinity near Dictyosphaeriaceæ. The general matrix of the colony is gradually secreted through cup-like cutinous outer cell membranes, and is of a fatty nature. This is a mixture of fatty acids, fats, etc., which becomes gradually more insoluble and is thus preserved in fossil form. A thin outer sheath of pectic mucilage is secreted by the non-cutinised exterior part of the cells. B. N. TEMPERLEY : A critical study of the problem of boghead coals and of the organisms involved. A description is given of the morphology of the 'yellow bodies' which form the essential constituents of the boghead coals. The composition of parrot coals and oil shales is also discussed. Their structure is shown to agree in all significant features with that of the living oil-bearing alga *Botryococcus braunii*, Kützing, and there is similar polymorphism of the colonies, together with other apparent variations caused by varying states of preservation. The views of Edgeworth David (1888) and Bertrand and Renault (1892) as to the algal nature of these coals is thus confirmed. Zalessky (1914) first made the correlation with *Botryococcus*, but did not supply adequate details. Thiessen (1925) also described the alga which is now forming similar deposits (coorongite) in Australia, but failed to identify the organism as *Botryococcus*. J. ALLEN : Some experiments having particular reference to the flow of water along short capillary tubes connecting two reservoirs with free surfaces. The paper describes experiments made with capillary tubes of various ratios of outside to inside diameters between 1.59 and 4.31, and various ratios between 28.8(7) and 155.2. An empirical formula is given for tubes having sharp ends and for conditions within a wide range of Reynolds number, R , defined in the paper. This formula is of the type

$$\frac{2gh}{v^2} = \alpha + \beta \frac{l}{d} \cdot \frac{1}{R},$$

where α and β are functions of l/d . The losses of energy may be reduced somewhat by grinding the ends to a bell-mouthed shape.

PARIS

Academy of Sciences, February 17 (*C.R.*, 202, 525-600). ALFRED LACROIX : The mineralogical composition of the volcanic rocks of Easter Island. ERNEST ESCLANGON : Talking clocks and the diffusion of the time. An account of the results obtained by connecting the telephone system of Paris with an automatic apparatus giving the exact time. JEAN TILHO : Extract from a letter concerning the expedition to French Equatorial Africa. LUCIEN DANIEL : The appearance again of *Pirocydonia Danieli*. CHARLES CAMICHEL was elected a non-resident member, in succession to the late Charles Flahault. ARNAUD DENJOY : A formula of Gauss. GUSTAVE JUVET : A decomposition of d'Alembert's equation. PAUL LÉVY : Integrals with independent uncertain elements and stable laws with n variables. E. BATICLE : The problem of dice and its application to the theory of means. GEORGES TZITZÉICA : A deformation of higher order. SERGE FINIKOFF : The transformations of Calapso. AL. PANTAZI : Certain networks of Terracini. JULIUS WOLFF : The general-

isation of a theorem of Carleman on a series of rational fractions. LUCIEN BULL and PIERRE GIRARD : A new cinematographic arrangement for recording very rapid phenomena. An application of the principle suggested by Henriot and Huguenard, in which the rotating part, without axis, is driven and supported by compressed air. 50,000 images per second have been obtained and are perfectly clear and distinct. EDMOND BRUN and ROBERT LECARDONNEL : The heating of a body placed in a rapid current of air. GUSTAVE ANDRÉ MOKRZYCKI : Coefficients of longitudinal equilibrium in aeroplanes. JULES GÉHÉNAU : The true mass of the photon and the electromagnetic tensor. W. H. BENEDICTUS : The photonic interpretation of the Maxwellian field. Mlle. ARLETTE TOURNAIRE and ETIENNE VASSY : Comparison of the continuous molecular spectra of hydrogen and deuterium. The deviation between the intensities of the two spectra is negligible for the shortest waves studied, increases as the visible spectrum is approached, passes through a maximum at about 4100 Å. and then diminishes slightly. JEAN WEIGLE : The width of the $K_{\alpha 1}$ line of molybdenum. BERNARD KWAL and Mlle. ANNE RIEDBERGER : The periods of natural and artificial radioactive bodies, the existence of layers and the classification of atomic nuclei. ROBERT CASTAGNÉ and Mlle. DOROTHY OSBORNE : The radioactivity of the mineral springs of the Cachat d'Evian group. PIERRE DAURE, ALFRED KASTLER and HENRI BERRY : The Raman effect in ammonia. ANDRÉ MORETTE : The constitution of vanadium carbide. By reducing vanadium pentoxide with an excess of carbon at a high temperature, the vanadium carbide produced has the composition C_3V_4 . Mlle. ELLEN GLEDITSCH and TH. F. EGIDIUS : The mercurous amides. Mlle. M. PERNOT : The system mercuric iodide, caesium iodide, water. ALFRED LEMAN : Comparative acetylation of the naphthols. In acetic acid solution the hydroxyl of β -naphthol is more reactive than that of α -naphthol : in pyridine solution the reverse is the case. GILBERT MATHIEU : The application of the law of posthumous folds to the dislocations of Poitou. Some relations between the primary massifs of Vendée and of Limousin. MME. LOUISE NOUVEL : A mode of regeneration of locomotive appendages peculiar to *Crangon crangon*. PAUL CHABANAUD : The special situation of the nadiral nasal organ of the unsymmetrical teleosts of the family Achiridae. Mlle. CLAUDETTE RAPHAËL : The localisation of hæmoglobin and its derivatives in some Aphroditians. JEAN RÉGNIER, RAYMOND DELANGE and ROBERT DAVID : The influence of the acid combined with the base on the anæsthetic power of different salts of p -aminobenzoyldiethylaminoethanol (the base of novocaine). Novocaine resembles cocaine in that its activity as an anæsthetic varies considerably with the nature of the acid with which the base is combined : some acids increase the action, others destroy it. The phenylpropionate and isobutyrate are found to possess the following advantages : good anæsthetic properties, preservation of its activity after sterilising and keeping, slight toxic action, absence of irritating action on the tissues, good solubility in water. YVES LE GRAND : Vision in directed light. LOUIS MAILLARD and JEAN ETTORI : The estimation of titanium in the organism by extraction and photometry. The method described is capable of determining titanium with an accuracy of 0.0001 mgm. Titanium has been found in the muscle of man and other mammals and in blood. AUGUSTIN BOUTARIC and JEAN A. GAUTIER :

The antoxigen properties of medicines used as febrifuges. Most febrifuges used in medicine behave generally as negative catalysts with regard to oxidations produced by free oxygen. FERNAND ARLOING, ALBERT MOREL and ANDRÉ JOSSEMAND: New researches on the soluble organo-metallic complex compounds of dehydrascorbic acid. Increase of their effects on cancers by varying the metal.

VIENNA

Academy of Sciences, January 23. J. JURISIĆ: Glandular hairs on the adventitious roots of *kalanchoë*. GÜNTHER LOCK and GÜNTHER NOTTES: Some halogen derivatives of metaoxybenzaldehyde. ALOIS WAGNER: Differences in the counting of protons by electrical and scintillation methods. Simultaneous records of counts by tube and scintillation methods showed that many observers found a 60-70 per cent excess of scintillations with respect to the electrically recorded particles. This can only be explained on physiological and psychological grounds. W. WIRTINGER: A special result in potential theory. W. J. MÜLLER and E. LÖW: Theory of the *Sperrschicht* in aluminium. The behaviour of passive aluminium electrodes of great purity in a saturated solution of sodium bicarbonate is discussed.

January 30. A. WAGNER: Theory of diurnal changes of the winds. Discussion of variations in force and direction. OTTO REDLICH and WALTER STRICKS: Raman spectrum of deuterobromoform. ERNST SPÄTH and ALEXANDER F. J. SIMON: The root of *Heracleum sphondylium*, L.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 22, 1-80, Jan. 15). A. J. WATERMAN: Experiments on young chick embryos cultured *in vitro*. Chick blastoderms from an early primitive streak to the head process stages, and a medium consisting of agar, serum and chick embryo extract were used. A median sagittal cut from the anterior part of the streak to the germ wall led to duplication of notochord, brain, etc., even at this late stage. A certain amount of differentiation occurred after removal of Henson's node. Thyroid and a pituitary extract did not affect development. FROELICH G. RAINEY: A new prehistoric culture in Haiti. Five aboriginal dwelling sites in north Haiti contained flint and other tools, but no pottery, and represent a culture as yet unrelated to others in the West Indies. Six other sites produced abundant pottery, two types of decoration being represented at different sites, stone and shell tools, but no flint implements. A tentative sequence of culture horizons in the West Indies in relation to those of Puerto Rico is drawn up. HARLOW SHAPLEY: Summary of investigations of variable stars. The topics discussed include the distribution of a thousand new variables in the Small Magellanic Cloud, periods of super-giant Cepheids in the Cloud, new faint Milky Way variables and high latitude variables in relation to the thickness of the galaxy. F. L. WHIPPLE, T. E. STERNE and D. NORMAN: Prismatic deviation as a function of cosmical observation. A rigidly constructed 2-prism astronomical spectrograph was mounted with its optical plane parallel to a horizontal turntable. Between the light source (a mercury arc) and the slit was a mirror with six clear spaces 0.5 mm. in width and 1 mm. apart which could be shifted 0.5 mm. parallel to the slit. An exposure with the 'grating' up gives six segments of a spectral 'line';

another exposure with the 'grating' down gives six complementary segments. Any change of refractive index of the system between the two exposures, due to rotation and observation at various sidereal times, would be shown by displacement of the complementary 'lines'. The refractive index was found to be constant to 5×10^{-8} . ALEXANDER HOLLAENDER and B. M. DUGGAR: Irradiation of plant viruses and of micro-organisms with monochromatic light. (3) Resistance of the virus of typical tobacco mosaic and *Escherichia coli* to radiation from $\lambda 3000$ to $\lambda 2250$ Å. The destruction spectra are compared: at $\lambda 2250$ Å. the energy required to destroy half the virus in 1 c.c. is one fifth of that required at $\lambda 2600$ Å., whereas for inactivation of the bacteria more energy is required at the shorter wave-length. H. C. SHERMAN: Calcium as a factor in the nutritional improvement of health. Moderate increases of calcium intake for rats on an adequate diet hasten growth and development, induce higher vitality and improve the expectation of life of adult and young. These results seem to be paralleled, at least in part, in children. JACK SCHULTZ: Variegation in *Drosophila* and the inert chromosome regions. Variegations are associated with abnormal configurations of salivary gland chromosomes caused by aggregation of inert regions to a chromocentre; the addition of Y-chromosomes seems to decrease the frequency of variegation. W. T. MARTIN: Special regions of regularity of functions of several complex variables. MAX ZORN: Discontinuous groups and allied topics (1 and 2). W. V. QUINE: Concepts of negative degree. H. M. MACNEILLE: Extensions of partially ordered sets. DENIS L. FOX: Further studies of the carotenoids of two Pacific marine fishes, *Fundulus parvipinnis* [Pacific killifish] and *Hypsypops rubicunda* [garibaldi or goldfish], and of a marine annelid, *Thoracophelia* sp. The annelid contains exclusively carotenes; the 'goldfish' has a single pigment of the xanthophyll group; and the killifish, whether fed on either of these, stores only a xanthophyll similar to, or the same as, that in the 'goldfish'. G. H. PARKER: Colour changes in Elasmobranchs. Whereas in the smooth dogfish, *Mustelus canis*, cutting the nerves at the base of the fins or faradic stimulation causes contraction of melanophores and therefore blanching of the parts of the fish affected, neither operation had any certain effect on the small shark, *Squalus acanthias*. Pituitrin, pituitary extracts and also blood from dark specimens of this shark, however, caused blanching, showing that melanophore pigment in *Squalus* is dispersed by a blood-borne pituitary neurohumour. DAVID I. MACHT: Experimental and clinical study of cobra venom as an analgesic. Cobra venom in physiological saline produces death in the cat by paralysis of a vital centre in the hind brain (medulla). Solutions of venom were standardised in mouse units; an average therapeutic dose (5 mouse units) produced very favourable results in 65 per cent of 115 clinical cases so far as relief of pain was concerned, and had the further advantage that increasing doses were not required as with morphine, etc. This pain-relieving effect seems to be due to action in the cerebrum. With the dilute solutions used, it does not have a local anaesthetic effect. ERNST CLOOS and H. GARLAND HERSHEY: Structural age determination of Piedmont intrusives in Maryland. Measurement of cleavage planes in the area, and examination of thin sections of inclusions within the intrusives, lead to the view that the intrusives are of Palaeozoic age rather than pre-Cambrian, as hitherto believed.

Forthcoming Events

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

Tuesday, March 31

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP), at 7.—Prof. H. Freundlich: "Weigert's Phenomenon and its Importance in Photography".

ENGINEERS' STUDY GROUP AND ASSOCIATION OF SCIENTIFIC WORKERS (Joint Meeting), at Royal Society of Arts, at 7.45.—Discussion: "The Design of a Family Budget", to be opened by Sir John Orr.*

Thursday, April 2

ROYAL ASIATIC SOCIETY, at 4.30.—Lieut.-Colonel D. L. R. Lorimer: "The Burusho of Hunza in the Karakoram".

CHADWICK PUBLIC LECTURE, at 8.15.—(at the Royal Institute of British Architects, 66 Portland Place, W.1).—L. G. Pearson: "Modern Hospital Construction".*

Friday, April 3

PALÆONTOGRAPHICAL SOCIETY, at 4.—Annual Meeting to be held in the apartments of the Geological Society.

ROYAL INSTITUTION, at 9.—The Right Hon. Lord Rutherford, O.M., F.R.S.: "The Electric Arc and its Applications".

INSTITUTION OF NAVAL ARCHITECTS, April 1-3.—Seventy-seventh Annual Meeting to be held at the Royal Society of Arts.

Official Publications Received

Great Britain and Ireland

England and Wales. Map of the London Area: showing the City of London and Metropolitan Boroughs, County, Parliamentary and Municipal Boroughs, Parliamentary County Divisions, Urban and Rural Districts, Civil Parishes, London Passenger Transport Area, and Catchment Area Boundaries. Scale: Half-Inch to one Statute Mile. 42in. x 33in. (Southampton: Ordnance Survey Office.) 3s. 6d. net. [43]

University of London: University College. Annual Report, February 1935-February 1936. Pp. ii+164. (London: Taylor and Francis.) 93

Reports of the Progress of Applied Chemistry. (Issued by the Society of Chemical Industry.) Vol. 20, 1935. Pp. 819. (London: Society of Chemical Industry.) 93

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1934-1935. (Cmd. 5079.) Pp. 183. (London: H.M. Stationery Office.) 3s. net. [113]

The Physical Society. Reports on Progress in Physics, Vol. 2. General Editor: Allan Ferguson. Pp. iv+371. (London: Physical Society.) 21s. net. [113]

Transactions of the Royal Society of Edinburgh. Vol. 58, Part 3, No. 25: The Zonal Distribution of the Non-Marine Lamellibranchs in the Coal Measures of Scotland. By Dr. John Weir and Duncan Leitch. Pp. 697-751. (Edinburgh: Robert Grant and Son, Ltd.: London: Williams and Norgate, Ltd.) 7s. [123]

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, Additional Series 12: Cultivated Crop Plants of the British Empire and the Anglo-Egyptian Sudan (Tropical and Sub-Tropical). By H. C. Sampson. Pp. viii+251. (London: H.M. Stationery Office.) 6s. 6d. net. [123]

Journal of the English Folk Dance and Song Society. Vol. 2: International Festival Number. Pp. viii+162. (London: English Folk Dance and Song Society.) [123]

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1666 (T. 3462): Full Scale Tests on Longitudinal Control of a Low-Wing Monoplane with Special Reference to Wing Wake. By J. E. Serby and R. P. Alston. Pp. 12+21 plates. 2s. net. No. 1673 (T. 3592): Wind Tunnel Tests of High Pitch Airscrews, Part 1. By C. N. H. Lock, H. Bateman and H. L. Nixon. Pp. 29+9 plates. 2s. net. (London: H.M. Stationery Office.) [133]

The Iron and Steel Institute. Special Report No. 11: The Work of the Corrosion Committee: being a Review of the Work to December 31, 1935, compiled at the request of the Committee by Dr. W. H. Hatfield. Pp. v+27+4 plates. (London: Iron and Steel Institute.) [133]

Armstrong College: Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending July 31st, 1935. (Third Series, No. 3.) Pp. 59+7 plates. (Newcastle-on-Tyne: Armstrong College.) 5s. [133]

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Guide to the Bird Exhibits. By Colin Matheson. Pp. 14. (Cardiff: National Museum of Wales.) 2d. [163]

Other Countries

Division of Fish and Game of California: Bureau of Commercial Fisheries. Fish Bulletin No. 45: The Sharks and Rays of California. By Lionel A. Walford. (Contribution No. 117 from the California State Fisheries Laboratory.) Pp. 66. Fish Bulletin No. 46: A Contribution towards the Life Histories of Two California Shrimps, *Crago franciscorum* (Stimpson) and *Crago nigricauda* (Stimpson). By Hugh R. Israel. Pp. 28. (Sacramento, Calif.: California State Fisheries Laboratory.) 93

Dominion of Canada. Annual Report of the Department of Indian Affairs for the Year ended March 31, 1935. Pp. 55. (Ottawa: King's Printer.) 25 cents. 93

U.S. Department of Agriculture. Circular No. 369: Industrial Fumigation against Insects. By E. A. Back and R. T. Cotton. Pp. 52. (Washington, D.C.: Government Printing Office.) 5 cents. 93

South Australia. Annual Report of the Director of Mines and Government Geologist for 1934. Pp. 8. (Adelaide: Government Printer.) 93

South Australia: Department of Mines. Mining Review for the Half-Year ended 30th June 1935. (No. 62.) Pp. 85+6 plates. (Adelaide: Government Printer.) 93

Western Australia. Annual Progress Report of the Geological Survey for the Year 1934. Pp. 27. (Perth: Government Printer.) 93

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 28: Technological Reports on Standard Indian Cottons, 1935. By Dr. Nazir Ahmad. Pp. iii+103. (Bombay: Indian Central Cotton Committee.) 1.8 rupees. 93

City of Durban: Durban Museum and Art Gallery. Annual Report for Municipal Year 1934-35. Pp. 12. (Durban: Durban Museum and Art Gallery.) 103

Astrophysica Norvegica. Vol. 1, No. 6: On the Theory of Cyclone Formation at Extra-Tropical Fronts. By J. Bjerkes and C. L. Godske. Pp. 199-236. Vol. 1, No. 7: Über die freien Schwingungen einer homogenen Flüssigkeitsschicht auf der rotierenden Erde, I. Von H. Solberg. Pp. 237-340. (Oslo: Jacob Dybwad.) 103

Ministerio da Educação e Saude Publica: Observatorio Nacional do Rio de Janeiro: Taboas das marés para o anno de 1936 nos portos do Rio de Janeiro, Belém, S. Luiz, Amaração, Camocim, Fortaleza, Natal, Cabedello, Tambahú, Recife, Aracajú, Bahia, Ilhéos, Victoria, Santos, Paranaçu e Itajaí. Pp. 210. Anuario publicado pelo Observatorio Nacional do Rio de Janeiro para o anno de 1936. (Anno 52.) Pp. xiii+482. (Rio de Janeiro: Observatorio Nacional.) 103

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 15, No. 1: Über eine neue Südafrikanische Lucernariide, *Depastromorpha africana*, n.gen.n.sp., nebst Bemerkungen über den Bau und die Systematik dieser Tiergruppe. Von Oskar Carlgren. Pp. 24. Serien 3, Band 15, No. 2: Revision der australischen Acridiiden, 2: Monographie. Von Yngve Stöstedt. Pp. 191+2 plates. Serien 3, Band 15, No. 3: Additional Cretaceous Plants from Western Greenland. By A. C. Seward and Verona Conway. Pp. 41+6 plates. (Stockholm: Almqvist and Wiksells Boktryckeri A.-B.) 103

U.S. Department of Agriculture. Technical Bulletin No. 523: Biology of the Primary Screw Worm Fly, *Cochliomyia americana*, and a Comparison of its Stages with those of *C. macellaria*. By E. W. Laake, Emory C. Cushing and H. E. Parish. Pp. 24. (Washington, D.C.: Government Printing Office.) 10 cents. [123]

Bulletin of the Bingham Oceanographic Collection. Vol. 2, Art. 3: Scientific Results of the Second Oceanographic Expedition of the *Pauwée*, 1926—Heterosomata to Pediculi from Panama to Lower California. By C. M. Breder, Jr. Pp. 56. Vol. 5, Art. 2: The Aristæinae, Solenocerinae and Pelagic Pempseis of the Bingham Oceanographic Collection—Materials for a Revision of the Oceanic Pempseis. By Martin D. Burkenroad. Pp. 151. Vol. 5, Art. 3: Notes on Pennatulacea and Holothuroidea collected by the First and Second Bingham Oceanographic Expeditions 1925-1926. By Elisabeth Deichmann. Pp. 11. (New Haven, Conn.: Yale University.) [123]

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