NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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SOCIAL MEDICINE

THE conception of social medicine, which has been the subject of several recent addresses by leading medical men, was, as Prof. Major Greenwood has pointed out in a Chadwick Lecture (*Lancet*, March 13, 1943, pp. 325–328), inherent in the teaching of Hippocrates. In those early days the training of the medical student was a much more personal matter than it is to-day. The student studied with his master, much as he did in the days of our grandfathers ; he learned, as medical students of a century ago still did, much about the mode of life of his patients ; and medical opinion is nowadays rediscovering the value of this method of approach. It is coming into line with the similar recent movement among biologists, who have learnt that the organisms which they study cannot be fully understood unless they are studied as beings which are inseparable from the surroundings in which they live. It is being recognized by medical men that the individual human patient must indeed be studied as an individual ; sympathetic insight into his peculiarities is as important as, and sometimes more important than, knowledge of the malady from which he is suffering ; but the group to which he belongs must also be studied, and also all the conditions which civilization imposes upon both the individual and the group. It is the task of social medicine to study such problems as these. Their variety and importance have recently been emphasized by Prof. J. A. Ryle (*Brit. Med. J.*, Nov. 20, 1943, p. 633), who is professor of social medicine at Oxford and head of the first Institute of Social Medicine to be established in Great Britain. A similar department has recently been created by the University of Birmingham, and it would appear that the University of Edinburgh is moving in the same direction with the appointment of Prof. F. A. E. Crew to the chair of public health (see NATURE, March 25, 1944, p. 371).

Social medicine is not, in the opinion of Prof. Ryle, just another name for preventive medicine, and it is not socialized State medicine. It embodies the idea of medicine applied to the service of man and of the community, and seeks to lower the incidence of preventable diseases and to raise the general level of fitness. It lays emphasis on those causes of disease which are rooted in the environment, and so is directly related to social work of all kinds.

How much has already been done in this direction has been indicated by Sir Wilson Jameson, chief medical officer to the Ministry of Health, in his Harveian Oration to the Royal College of Physicians (*Lancet*, Oct. 24, 1942, p. 475). He showed there how profoundly the development of medicine has been influenced by the great social changes which have occurred since the Industrial Revolution, and also how great has been the stimulus given to this development by war. The beneficent work begun by Florence Nightingale has led us far beyond the betterment of the lot of the fighting men. The pages of the medical journals show how much has been

done for the people in general by such means as mass radiography, industrial health schemes and, during the present War especially, by the national food policy, which is based upon recent discoveries in the science of nutrition.

That much more can be done no reasonable man will doubt. Prof. Sargant Florence (NATURE, March 25, 1944, p. 363) has put forward some valuable suggestions for the study of variations in human health and efficiency with living and working conditions. Prof. Ryle tells us something of what is already being done at Oxford. He urges us to get away from the specialism and reliance on technical procedures which have been so marked a feature of medicine during the last quarter of a century. As the *British Medical Journal* (Nov. 20, 1943, p. 648) points out, we have taught medical students to think too much about how men die and too little about how they live. We should consider the patient more as an individual inseparable from such environmental factors as the anxieties of a job and a home, economic insecurity, the fear of poverty, and from ignorance of how to live a healthy life and how to use leisure. The importance of such root causes of disease as these has been emphasized by Dr. Geoffrey Bourne in a Penguin Special, "Health of the Future" (1942). Dr. Pemberton (*Brit. Med. J.*, Dec. 11, 1943, p. 754) and Dr. Lloyd-Davies (*Lancet*, Feb. 12, 1944, p. 223) discuss the same theme. Since the War began, Scotland has, with the aid of the Emergency Medical Service hospitals, tried experiments in social medicine. These are described in "Health and Industrial Efficiency: Scottish Experiments in Social Medicine" (London: H.M. Stationery Office, 1943. 1*s*.). These social causes of disease are, as Prof. Ryle points out, being studied in the United States, India, the British Dominions and in the U.S.S.R., and we can learn much from these countries. There is certainly no lack of material for such beneficent work.

Tuberculosis, venereal disease, cancer, rheumatism, influenza, typhoid and other fevers and the blindness which afflicts, as Prof. A. Sorsby points out, some fifteen million people in the world (*Brit. Med. Bull.*, 1, No. 9; 1943; see NATURE, March 25, 1944, p. 383) all come within the scope of social medicine. Nor must we think that, when the causes of disease lie in the environment, it is always the ugly and distressing features of that environment that are responsible. Disease may arise, as endemic goitre does, from some feature of the most delightful rural surroundings. The Goitre Sub-committee of the Medical Research Council, in its memorandum on this particular disease (*Lancet*, Jan. 22, 1944, p. 107), recommends, as a national policy, the addition of one part of potassium iodide to one hundred thousand parts of common salt, as a prophylactic, comparable to our national measures against deficiencies of proteins, vitamins and other essential elements in our diet. There are, further, the diseases which do not always kill, but cause incalculable disability, unhappiness and economic loss. An example of these is gastric ulcer, which is increasing greatly; it affects all social groups; it attacks certain temperamental and physical types more than others; it is, in Prof. Ryle's words, a disease of our era of money-getting and money-lack, of occupational and domestic anxiety, of restless living, snack meals and excessive tobacco consumption. It could become as rare as it used to be, if its root causes, which are largely economic, were so fully understood that they could be removed.

It is clear, therefore, that social medicine has a great part to play in social reconstruction after the War. It is clear, also, that the medical student, as well as the qualified medical man, will have to take an active part in this work.

The report of the Royal College of Physicians on social and preventive medicine (see *Brit. Med. J.*, Oct. 30, 1943, p. 553) lays down the lines of a possible future development of social medicine. This report avoids the addition of social medicine as merely another special study tacked on to the existing curriculum. It suggests a modernized course in social and preventive medicine, which should be founded, as the clinical subjects are, on the basic sciences, and should grow and expand through the three clinical years. It should, moreover, be a practical course, operated by a Department of Social and Preventive Medicine in every medical school and should replace the present courses in public health; it should also bring the student into close touch with the active social organizations in the community concerned, especially with the health services provided by the local authorities and with the hospital almoner's department. All medical schools should recognize the importance of problems of industrial medicine; student health services should be available in every medical school and should be used as the instruments of teaching. All hospitals should employ properly trained almoners and psychiatric social workers for the teaching of students as well as for the care of patients; and the Royal College of Physicians should take an active interest in the organization of the teaching of social and preventive medicine, not only to medical students but also to nurses and medical social workers.

The adoption of these admirable recommendations would mean that medical students would learn in a practical way the social and industrial factors which contribute to disease; they would learn methods of social investigation; they would learn all about existing social organizations; they would be able to undertake that admirable mission which Prof. Ryle prescribes for them, the mission of helping, with the aid of their scientific associates and of social workers, to expose social evils and to devise means of removing them. In this way the medical practitioner of the future would fulfil, in a wide and modern sense, the traditions of a profession which was, to the fathers whom we remember, the noble calling of friend and counsellor as well as mender of physical and mental ills. Such a calling will require and will attract the best type of woman and of man. Its teaching and research facilities should be endowed and assisted to the fullest limit of our capacities, so that they may be intensified and expanded to meet the manifold requirements of the post-war world.

INTRODUCTION TO GEOLOGY

Geology for Everyman

By the late Sir Albert Charles Seward. Pp. xi+312+8 plates. (Cambridge : At the University Press, 1943.) 10*s*. 6*d*. net.

BOTANIST, geologist and lover of Nature and of his fellow-men, Sir Albert Seward finished writing this book three days before his sudden death. It was evidently a labour of love—this endeavour to transmit to others his enthusiasm for the only real open-air science. Not only is the book an appeal to folk to take up geology as a hobby, but also it sets out "to present a case for the inclusion of an intelligent interest in" the subject "as part of that intellectual equipment we call culture, culture that has been defined as what remains after we have forgotten all we learnt at school". His descriptions "are not intended to serve as an elementary text-book" ; his "hope is that they may be used as stepping stones to something higher and more scientific".

Such a book has long been needed, for geology has receded from the position it held a century ago as part of the natural equipment of an educated person. To-day its principles are little understood, and its discoveries and their implications are ignored. Perhaps people are put off by the scientific jargon which prevails in geology to an undue degree ; but Seward's book proceeds in the first few chapters with many delightful personal touches to arouse an interest in the basic principles of the science with a minimal use of technical terms, though he pleads that "some of the technical terms in common use by geologists should find a place in the vocabulary of all educated people". It is perhaps questionable whether the bare minimum of principles given here will by itself provide a complete novice with sufficient knowledge to take the fullest advantage of the main part of the book which follows. This is devoted to the record that the rocks provide of an ever-changing geography brought about through the slow grinding away of land, and the growth of deltas, plains and mountains through the ceaseless movement of the crust and the equally inexorable changes of climate. Throughout, Seward uses the changing geographical scene as the background to organic evolution.

It is natural that the author of "Plant Life throughout the Ages" and of the standard text on "Fossil Plants" makes evolution one of the main themes of his book, with particular emphasis on the changes in plant life from age to age. As this is an aspect of the stratigraphical record to which Seward had devoted his life, and one that rarely receives adequate recognition in geological text-books, the treatment is rightly developed on a fuller and more satisfying scale than that accorded to the animals, though their palæontological record is not neglected. General readers for whom the book is intended will be attracted to the study of fossils through the clear way in which their significance is brought out.

The method adopted in this book of treating the geological periods from the newest to the oldest has the sanction of authority in that it was used by Lyell ; but it inevitably leads to repetitions, some of which are irritating and tend to distract from the sequence of the events. But in this book each chapter is an exposition of one or two major principles or important incidents rather than a description of an ordered cavalcade of events. Doubtless Seward intended to excite interest in some particular part of the geological record and to show what sort of things can be deduced from it, and for this purpose was not over-concerned with its dating. Here are some of his themes : Britain under the arctic conditions of the Ice Age, post-Glacial climatic changes and their effects on the vegetation, de Geer's system of geochronology, the changing floras of the Tertiary and their interpretation in terms of climate, the building of the Alpine chain, the break in mid-Cretaceous times between ancient and modern types of plants, the salt lakes and deserts of the New Red Sandstone, the origin of coal, the value of careful fossil collecting and the contribution to science that it can make even in the hands of amateurs.

The chapters relating to the Cretaceous, Tertiary and Glacial periods are very interesting and attractively written, and so are the ones on fossils ("Medals of Creation") and on the "Procession of Life" ; but strangely enough the one on the origin of coal is disappointing and surprisingly misleading over the composition of that much-analysed substance. Naturally the older formations are more difficult to deal with ; but a sense of their influence on scenery, their antiquity and of the strangeness of the forms of life that they contain, is vividly conveyed. "The world, to our limited vision, appears to be almost static ; mountains we have thought of as symbols of eternity, seen through geological spectacles, take their place as episodes in a series of events which have moulded the changing features of the earth's face. The rocky covering of the world viewed by geologists, 'foreshortened in the tract of time', reveals itself as a dynamic mobile crust responding from age to age to constructive and destructive forces which have operated since the earth's early youth."

This is a book so full of wisdom, wit and learning that it cannot fail to convey to its readers the author's lifelong enthusiasm. For this reason alone it is particularly welcome to-day, for it will take an honoured place among the instruments designed for that wider education of young people and adults which we all look forward to after the War. It will find its most appropriate niche in the school library and on the bookshelves of students' hostels, clubs and unions ; but it should also make a strong appeal to lovers of the country and to the not inconsiderable number of persons who like 'to go geologizing'.

L. J. WILLS.

PLANT GEOGRAPHY OF THE MEDITERRANEAN REGION

Das Pflanzenkleid der Mittelmeerländer

Von Prof. Dr. M. Rikli. Lieferung 3. Pp. 241–352+13 plates. Lieferung 4. Pp. 353–436+14 plates. (Bern : Hans Huber, 1943.) 9 Schw. francs each.

THE publication of another two serial parts of Dr. Rikli's book on the plant cover of the Mediterranean region completes volume 1 of this work (for an account of the first two parts see NATURE, 152, 117 ; 1943). Part 4 includes the title-page and list of contents of the volume, together with a short preface by the author. In the latter it is noted that the large number of maps showing the geographic distribution of numerous different species in the region have been prepared on the basis of the classical floristic works and partly in consultation with specialists on certain parts of the Mediterranean basin. The advantage of these maps is the rapidity with

which a general impression of the distribution of a species may be obtained; but on the other hand, they tend to imply a completeness of knowledge which is not actually existent, and gaps within the total area of distribution are as a rule disregarded. Their primary object is to serve as a stimulus for the collection of further data, so that in a later edition the maps may be supplemented or corrected as is found necessary, and communications on this subject are invited by the author.

The seventh chapter, dealing with the natural land of the cultivable belt, is now completed, and the eighth chapter, which studies the distribution by altitude of the various formations discussed, brings the first volume to a close. A note at the end of the seventh chapter states that the cultivated land is to be treated in Chapter 10. The normal disadvantage of any such serial publication, namely, that some illustrations to which allusion is made or pertinent references to the literature have not yet appeared, although it certainly exists in the present case, is not so serious as to be of any significant hindrance to the use of the work.

The natural formations described in the remainder of the seventh chapter comprise large-shrub formations, the xerophilous small-shrub formations, tracts of herbaceous growth and of tall herbaceous, large-leaved plants, and sea-shore, dune, lakeside, marsh and cliff formations of various kinds. Under the first-named the section on the pseudo-maquis is terminated, and the sibljak formation is described. The sibljak is a sub-Mediterranean association of summer deciduous therophytic shrubs or shrub-like trees which are able to bear—in addition to a dry, hot summer—a fairly severe winter with occasional low temperatures, cold winds, and often also a long covering of snow. It is never found near the coast, but principally in the more continental part of the eastern Mediterranean, although it is recorded also for the west, for example, the centre of the Iberian peninsula. Some fifteen to twenty species participate in the structure of this formation, which is generally seen above the evergreen level and is considered in many localities, such as steep rocky slopes, scree on slopes, etc., to be an original association, the area of which has become greatly enlarged, however, through the destruction of forest.

The xerophilous small-shrub formations described are the steppe of succulents and thorn bush limited to southern Morocco, the ericaceous heaths—in the Mediterranean a type of vegetation principally of the submontane level, and in the Iberian peninsula of unusual richness—and the garigues. The name 'garigue' is of Provençal origin, and is applied to a more or less open association of small shrubs, seldom higher than 1–1·5 metres and often rich in ethereal oils. Between maquis and garigue all manner of transitional formations exist. Sixteen different types of garigue are distinguished and described. Their use for grazing is generally very intensive, as a result of which many plant species become eliminated in the course of time, while others, such as certain thorn bushes and especially poisonous plants (*Peganum Harmala*), become dominant. Where the humus-deficient soil of the garigues becomes still shallower and dries up more rapidly, even the small shrub growth is endangered, and its place is gradually taken by an ephemeral growth of therophytes and by geophytes. This formation is described as 'herbaceous razings (rock grazings)', the word 'Trift', which means a pasture or grazing, being used in preference to 'Heide' or 'heath' in order to avoid confusion with the ericaceous formation. The word indicates, too, the only use—periodic grazing—to which these lands are put. Typical of the formation is its great abundance of species and their magnificent colouring when in flower. A different type of vegetation is seen in the association of tall, large-leaved herbaceous plants, 1–2 metres and more in height, found in moister, better soils of (*a*) forest regions and (*b*) in open association in dry regions.

In the consideration of the strand and marsh formations there are treated successively the submerged associations; the sparse vegetation of the strand itself; the vigorous plant-growth found amid heaps of large rocks, which is quite different from that of similar rock groups in the mountains; the vegetation of the littoral shifting-sand zone and of the littoral dunes respectively; that of the salt marshes, the freshwater marshes, of ponds (depressions only periodically flooded and dry for practically the greater part of the year), lake- and river-sides; and finally, the cliff and strand rock flora affected by surf and spray. Dunes are found on all the flat coasts of the region, but especially along the Atlantic coasts of the Iberian peninsula and Morocco (Agadir and Mogador) and on the shores of the Sirte region in northern Libya. Successful efforts at the stabilization of dunes between Tripoli and Lebidah (also named Leptis Magna or Neapolis) are described. In regard to the river- and lake-side flora, it is noted that boreal species form the main contingent of the plants present; specifically Mediterranean elements are rare, and it is almost the papyrus alone that is of definitely southern origin.

The classification of the Mediterranean plant cover in accordance with altitude is impeded by the fact that the various levels are not so sharply defined as in central Europe, and the actual elevation at which associations or their components are found varies very considerably with the region. This is discussed with particular reference to the evergreen, Mediterranean culture belt as found in the Iberian peninsula, Corsica, the Apennine peninsula, the northern part of the Balkan peninsula, Greece, the Near East, and the Atlas lands respectively, and it is concluded that, generally speaking, the limit of the altitude line or belt becomes higher from north to south and lower from west to east. Allowance being made for variation of this nature, three more or less clearly defined altitude lines or vegetation belts ('Höhenstufen') are distinguished, namely, (1) the evergreen, Mediterranean culture belt (also described as the olive girdle or, from its most important formation, the maquis girdle); (2) the Mediterranean mountain belt, embracing the region from the upper limit of the evergreen belt to the upper forest- and tree-line; and (3) the orophytia belt. Of the first, the natural land formations have already been described in the seventh chapter, and reference is made to Chapter 10 (not yet published) for those of the cultivated land. A description of the second belt occupies the major part of the eighth chapter, and discussion of the third is reserved for a further section.

Originally the Mediterranean mountain belt consisted for the most part of forest, but the spoliation of centuries has led to far-advanced deforestation in many parts, where the place of the woods has been taken by impoverished, grazed garigues. In other parts, however, the woods remain and present a constantly changing landscape made up of different kinds of trees. The influence of the forester is as yet

insignificant. The woods are composed either of deciduous trees, especially *Castanea sativa* and *Fagus silvatica*, occasionally also *Quercus Ilex*, or of a large number of conifers of the genera Picea, Pinus, Abies, Juniperus, Cedrus and Cypressus. The distribution and nature of these woods and their components are described in considerable detail.

Finally, there are described the formations which have possessed themselves of the areas denuded of forest. Of these the most important is the garigue, the capacity of which for establishing itself on such lands exceeds that of any other formation. Not only does it occupy wide tracts of the former woodland girdle, but also it often reaches far above the upper limit of the Mediterranean forest- and tree-line.

G. M. ROSEVEARE.

A SURVEY OF PLANT DISEASE

Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1933–1942

(Ministry of Agriculture and Fisheries, Bulletin No. 126.) Pp. iv+100+8 plates. (London: H.M. Stationery Office, 1943.) 2*s*. net.

IT is sometimes a little difficult to attain true perspective in a science like plant pathology, where facts are accumulated in a manner necessarily fragmentary and sporadic. Diseases never occur in standard measure, either of space or time, and Pasteur's dictum that chance favours only the mind that is prepared applies with special emphasis to the study of plant pathology. It is very appropriate that a periodical review be made of the occurrence of all diseases, and Mr. Moore, who is mycologist to the Ministry of Agriculture and Fisheries, has gathered together such information for England and Wales. He has had numerous collaborators, and the review follows an earlier bulletin (No. 79) which covered the five years, 1928–32.

One of the outstanding indications of the bulletin is the increasing number of plant maladies which are now recognized. This is, in all probability, due to the fact that cultivators are now more aware of diseases than formerly. We are separated by little more than half a century from the time when blights upon crops were regarded as 'acts of God', as little amenable to control as the whirlwind. The increasing tempo of plant cultivation since the outbreak of war has brought the plant pathologist much extra work, but has also given him a further harvest of scientific facts. Moreover, such glances as are vouchsafed into what might be called the archæology of plant pathology show that diseases were often present on fragments of plant material preserved from bygone times. Greater awareness of disease is also shown by the increasing number of deficiency troubles which are included in the bulletin under review. The work of the pathologist here merges with the activities of the physiologist, with ultimate advantage to both.

The bulletin arranges the diseases of each host according to the nature of their causal agents, and in the order fungi, bacteria, viruses and non-parasitic. Pathology of ornamental plants, of hop, mushroom and flax, and of fruit and vegetables is recorded, in addition to the maladies of all farm crops. An indication of the thoroughness of compilation is given by the mention of Pythium root rot and a mosaic virus on watercress, the notice of *Ovularia Nymphœrum* on water-lily, and a description of soft shell of the walnut; and diseases of the more usual crops receive no less encyclopædic treatment. Symptoms of the more recently discovered troubles are given in sufficient detail for field diagnosis, and some are illustrated in the eighteen excellent half-tone figures. Common names are in accordance with those recommended in the "List of Common Plant Diseases" of the British Mycological Society. The review certainly achieves the purpose of keeping the plant pathologist up to date.

Some effort has been made to correlate the incidence of disease with climate. Synopses of the weather in each of the ten years are given, and in some cases broad conclusions are possible. The general effect of weather on potato blight has been recognized for some time. Hot, dry summers in 1921, 1929, 1933–35 and 1940 rendered blight of little economic significance as a foliage disease. Wet and sunless periods between June and September in 1926, 1931, 1936 and 1942 brought very severe attacks of blight. A wet May seems to portend a bad year for apple scab, and abnormal rainfall in July and August renders the downy mildew of hops very destructive. Chocolate spot of broad beans can assume epidemic proportions in periods of dull, showery weather between April and July. Mr. Moore very rightly points out the need for more extensive and intimate studies of the 'micro-climate' within an infected crop. Closely connected with climatic survey is the question of estimation of disease intensity, and here the excellent pioneer work of the British Mycological Society is incorporated in the bulletin.

The incidence of wart disease is interesting. Its spread during the last twenty years has been greatly reduced by the operation of the Wart Disease of Potatoes Orders. Outbreaks since 1933 have averaged about 87 per year, and this figure has not been exceeded by the average for the war years. Onion smut, another disease subject to legislation, appears to be increasing, though it is probable that most of the new cases represent long-standing infection; they were discovered during an intensive survey by the Ministry's inspectors. The problem is complicated by the length of time the fungus can remain infective in the soil—at least seventeen years. A slight decrease in the amounts of severe mosaic and leaf roll is recorded in potato crops raised from new Scotch or Irish seed during the war years. There is also less virus infection in crops raised from once-grown seed. The bacterial disease mentioned most frequently is crown gall (*Bacterium tumefaciens*). It occurs upon such widely varying hosts as dahlia, raspberry, apple, vegetable marrow, tomato, mangold, chrysanthemum and many others. Of deficiency diseases, that of potassium appears to be most frequent, and most cases are reported in the war years. Magnesium, boron, manganese and calcium may also cause their respective deficiency symptoms. One type of injury likely to be recognized more widely in the future is that due to acid soil. Plants growing at the lower limit of their *p*H range frequently exhibit characteristic symptoms, and their tabulation is one of the future tasks for the joint efforts of plant pathologists and physiologists.

The bulletin is far more than a list of plant diseases. It is an informative conspectus of the intelligence section of phytopathology. Mr. Moore frequently uses a somewhat conversational blend of history and etiology, so that his descriptions are not merely arid records, and his pages often indicate the direction which future investigation should take.

JOHN GRAINGER.

BIOLOGICAL CONTROL AS A SUPPLEMENT TO CHEMICAL CONTROL OF INSECT PESTS

By DR. W. E. RIPPER
Pest Control Ltd., Cambridge

WHILE chemical control is in general the most effective method of pest control known and therefore the most generally used, an increasing amount of experimental proof has accumulated during recent years showing that this method has a very serious limitation. Repeated applications of chemical control result in an unintended artificial selection of those mutants within the pest population which happen to be resistant to the poison used. The progeny of these surviving mutants develop races of the pest which are more difficult to control than the general population.

This disturbing phenomenon was first noticed by Melander in 1914 on San José scale, *Aspidiotus perniciosus* (Comst.)[1]. Fifty years after the importation of this pest into the United States it was found that, after several treatments with lime sulphur had been carried out every year in the State of Washington for twenty-five years, this scale insect had become much more resistant to lime sulphur.

Next, Quayle in 1916[2] showed that a strain of the red scale, *Aonidiella aurantii* (Mask.), at Corona in California, was more resistant to cyanide fumigation than the general population of this pest elsewhere. Since the introduction of tree fumigation in 1886, prussic acid has given unusually effective control over a large part of the red scale infested area of California, but in certain districts, an increased resistance was found a few years previous to Quayle's publication in 1916. For more than thirty years the increase of the distribution of the resistant strain has been observed and the phenomenon extensively investigated by Quayle during 1916[2] and 1938[3] and Woglum in 1925[4], who established that the survival in areas where the non-resistant strain abounds was of the order of 1 per cent, while in the area where the resistant strain had developed it was 20 per cent. As the red scale has under present spraying schedules at least three generations to one treatment, such a difference in survival was of high economic significance, and the difference in susceptibility was noticed by the fumigation contractors operating in that area. Environmental influences were excluded by rearing sixty generations of colonies of the resistant and non-resistant races under identical conditions, when it was found that the same differences in susceptibility towards cyanide persisted.

Dickson in 1940[5] was able to show that the factor of resistance is inherited and situated in the *X*-chromosome and is therefore sex-linked.

From the general aspect of chemical control, it is important that the resistant strain of the red scale was also found to be less susceptible to two other fumigants, methyl bromide and ethylene dioxide.

Increased resistance to prussic acid was established for two further citrus scales, namely, the black scale, *Saissetia oleae* (Bern.)[2], and the citricola scale, *Coccus pseudomagnoliarum* (Kuw.)[3]. The spread of the resistant strain of the latter scale was dramatic in its rapidity; the resistant strain was first noticed in *one* orchard in 1936; but in the next three or four years the area of its distribution extended over most of the region infested by the citricola scale in Southern California. As natural barriers cross this area, the selection of this resistant strain must have occurred simultaneously from independent mutants. Thus in a very short period the effect of chemical control had changed from satisfactory to very unsatisfactory results.

Race segregation resulting from the application of insecticides is not confined to scale-insects but has also been found in the codlin moth, following treatments with arsenate of lead. The discovery of resistant strains as a result of chemical control on so different a type of insect first attracted attention to the general character of this sequel to chemical control. The most resistant strain was found in Colorado, where codlin moth had appeared in 1891, and spraying with arsenate of lead had been started three or four years later. In 1900 two sprays were necessary to obtain a satisfactory control, and by 1930 eight, ten or twelve.

This resistant strain was investigated by Hough[6,7,8], who took a stock of the codlin moth from Colorado to his laboratory in Virginia and studied it there in comparison with the endemic codlin moth population. It was found that the Colorado strain was not only able to enter apples sprayed with arsenate more successfully than the Virginian strain, but also showed the same superiority in its resistance to other spray residues, such as cryolite, barium fluosilicate, rotenone, nicotine, cuprous cyanide. The Colorado strain was also significantly resistant to cyanide fumigation in the incubated-egg stage and in the larva stage.

Hough was further able to demonstrate that a strain with similar characteristics to the Colorado strain can be bred from the Virginian codlin moth populations by artificial selection. He held the opinion that mutants of the same higher resistance existed in all codlin moth populations.

On a very different type of insect, the larva of the primary screw worm, *Cochliomyia americana*, Knipling[9] was able to demonstrate that a greater resistance against phenothiazine could be acquired and inherited.

Increased resistance against tartar emetic sucrose bait has been noticed in the Citrus thrips[10]. An interesting feature of this case is the development of a resistant strain after this spray chemical had been used for three or four years only. Resistance developed in a fairly big area over a space of about a hundred miles with big stretches of uncultivated land and mountain barriers between, so that it would seem that mutants may have arisen at several foci simultaneously.

Thus, in the life-time of one entomologist at least seven species of injurious insects have evolved races which are more resistant to certain insecticides than the ordinary populations or any of the populations of twenty-five years ago.

In some cases the resistance is not specific towards one chemical but results in the pest being more difficult to kill by a whole range of chemicals, so that it seems that the segregation of these new resistant races is a problem of rapidly increasing importance and far-reaching effect on our conceptions of chemical control. If it is remembered that, as the above described facts show, this increasing resistance can be acquired in a period of repeated applications of chemicals varying from three or four to thirty years, it is not difficult to appreciate the concern of the entomological profession over this man-bred segregation which renders the pests more and more inaccessible to our control measures.

The position has been admirably surveyed by Harry

Smith[11] and Quayle[12] in its genetic, entomological and economic aspects, and Smith concluded that the segregation of resistant races "is an obstacle to the practical usefulness of entomology, the surmounting of which will require not only all our ingenuity, but all our capacity to organise and ability to enlist the active co-operation and interests of geneticists, physiologists, ecologists, and taxonomists. It is my firm conviction that recognition of the practical significance of the effect of man's activities on the racial composition of insect populations, followed, of course, by group attack for solution of the problems arising from it, will become a milestone in the progress of both the science and the art of applied entomology".

As the segregation of resistant races is caused by the survival of resistant individuals, it seems expedient to direct our attack against these surviving resistant mutants. As shown by Hough[8] and Yust[13], the latter may possess a higher resistance against a variety of chemicals; it seems, therefore, obvious that the reduction of these survivals must be attempted by a totally different method, for example, by biological control. For this purpose, we require an insecticide which would kill a much greater proportion of the pests than of the predators and parasites of the pest. Such an insecticide is referred to in the following as a *selective insecticide*. In such a case the surviving beneficial insects should clear up the resistant mutants of the pest before the latter can propagate and develop a resistant strain. In other words, we are searching for a type of insecticide capable of effecting a shift of the oscillatory equilibrium between the population of the pest and the population of parasites and predators in such a direction that the latter outnumber the former, either immediately or in a short interval after spraying, and lead to a complete annihilation of the pest population in the treated biotope.

The development of selectively poisonous chemicals would not only enable us to prevent segregation of resistant strains, but would also be desirable for economic reasons. Many treatments with insecticides lead only to relief from the pests for the time being, because immediately after treatment the pest population builds up quickly and necessitates a repetition of the treatment, often, during the growing season, within ten days or a fortnight.

In many cases it has been observed that the reinfestation after chemical treatment builds up more quickly than the original infestation. The theory underlying this phenomenon was described by Volterra[14] in his consideration of the variations and fluctuations of the number of individuals in two animal species living together, one species preying on the other, and was communicated in what he called the "Law of the Disturbance of Averages": "If an attempt is made to destroy the individuals of two species uniformly and in proportion to their numbers, the average of the number of individuals of the species that is eaten increases and that of the individuals feeding upon the other diminishes". Hence the destruction of a whole section of the population of hosts, predators and parasites may result in a subsequent relative increase of the host and relative decrease of the parasite, a phenomenon only too familiar to all entomologists engaged in pest control operations, as a frequent sequel to chemical control. Such deleterious effects of spray treatments on the parasites of the pests has often been recorded (Driggus & Pepper[15]; Driggus & O'Neil[16]; Boyce[17]).

If the chemical control necessitates a repetition of the treatment, it is obvious that the application of the method will only be an economic proposition on higher paying crops. The use of selective insecticides, apart from preventing the segregation of resistant strains, will also reduce the number of spray operations necessary and thus bring pest control methods within reach of growers of cheaper, that is, farm, crops.

All these limitations of chemical control as practised to-day make the introduction of selective methods of pest control highly desirable.

Some attempt has been made to develop such selective insecticides by utilizing the differences in the physiology of the phytophagous insects on one hand and the carnivorous or parasitic insects on the other hand. For this purpose, stomach poisons were prepared, the individual particles of which were coated with substances digestible only by certain groups of phytophagous insects. By this means the poison was rendered indigestible to adult Hymenoptera and certain other insects and therefore harmless to parasites and certain predators[18].

Another attempt towards selective eradication of pests was based on the difference in toxicity of nicotine vapour to aphides and parasites or predators. It can be shown that short exposures of 40 sec.–1 min. to nicotine vapour at a temperature of 60°–80° F. and of a concentration of 0·8 mgm. per litre, proves fatal to 80–99 per cent of certain aphides, but does not seriously affect coccinellids, syrphids or the larvæ of the Braconid aphid parasite Aphidius, which lives and pupates in the aphides.

These beneficial insects surviving the nicotine vapour treatment outnumber the surviving aphides and decimate the latter in the weeks following the treatment, so that after an initial high percentage of kill, the infestation is further reduced. Thus, this method gives the best control of aphides hitherto demonstrated on farm and market garden crops in Great Britain, and has therefore been used on a large commercial scale during the past four years. It is called field fumigation or gassing.

The method fulfils all requirements postulated earlier for a selective insecticide, and a quantitative study of changes in the population of the pest and its natural enemies caused by the selective action of insecticide is therefore of general interest in ascertaining the mechanism of the combined action of chemical and biological control, and more especially to determine whether the limitations of chemical control as generally practised are overcome.

While the destruction by parasites and predators of those aphides surviving the fumigation has also been observed on infestations of black-fly, *Aphis fabae* (Scop.) and the potato aphis, *Myzus persicae* (Sulz.), none is more suitable for a quantitative study of the phenomenon than the cabbage aphis, *Brevicoryne brassica* (L.).

The biotope of the Brussels sprout field lends itself particularly well to population studies, because the number of Brussels sprouts plants per acre is small, and under Bedfordshire cropping conditions constant (4,840). The plants are set at intervals and the infestation by cabbage aphis lasts for many months, May–November. The cabbage aphis has a fair number of predators—coccinellids, *Coccinella 7-punctata* (L.), and *Adalia bi-punctata* (L.): the larvæ of syrphids, *Syrphus ribesii* (L.), *S. balteatus* (De G.), and *Catabomba pyrastri* (L.); and the larvæ of cecidomids, *Phaenobremia* sp. (Petherbridge &

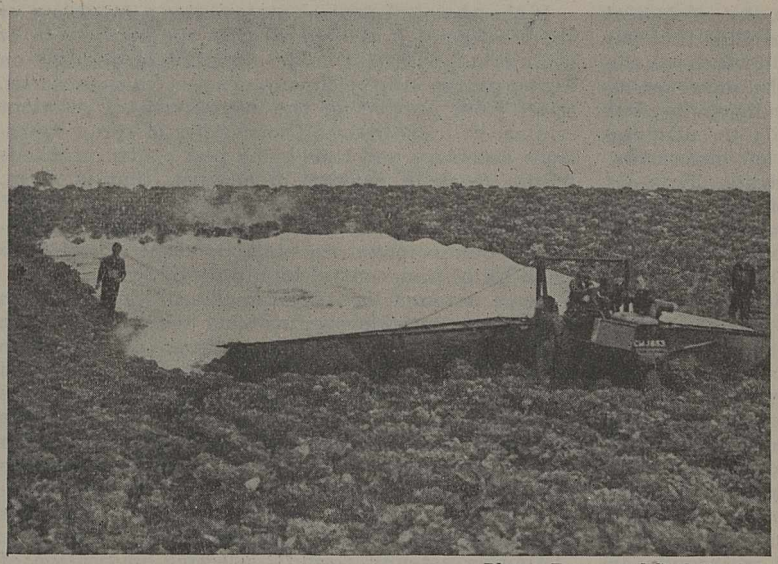

Photo: Farmer and Stock-Breeder.

FIG. 1. FIELD FUMIGATION CARRIED OUT WITH TRACTOR-MOUNTED GASSING MACHINE, VAPOURIZING 95 PER CENT NICOTINE.

Wright[19]; and one important parasite—*Aphidius brassicæ* (Marsch). In a normal year these beneficial insects live with their host in a state of equilibrium for the greater part of the year, resulting in a severe infestation of the plants by the aphides, which cause a good deal of damage. At the beginning of the autumn, parasitism increases and the pest, having spoilt the crop, is often overwhelmed by its natural enemies at the end of the growing season.

This is in agreement with the results of the work of Ullyett[20], who has shown that, despite the higher biotic potential of the parasite, the latter is at a disadvantage compared with the aphis because (1) of super-parasitism, (2) some of the parasitized aphides are able to reproduce before the parasites kill them, and (3) every individual aphid is reproducing.

In order to prevent damage it has become the practice to gas the Brussels sprouts in the middle of August or in September, vapourizing up to 3¼ lb. of 95 per cent nicotine per acre. All the cabbage aphides are exposed to toxic fumes for 60 sec. under a gas-proof drag sheet which provides a movable fumigation chamber fitted to a gassing machine moving at a speed of one mile per hour (see Fig. 1).

To study the population changes of aphides and their enemies, a method of measuring the population before and at regular intervals after treatment was developed. As the population of aphides per plant shows great variety in size, plants were sampled at random and grouped in three classes according to the various degrees of infestation. Representative samples were then taken of several plants in the three classes. These plants were then analysed by counting (1) predators, (2) live aphides showing no signs of advanced parasitism, (3) aphides killed by parasites. Figures thus obtained for 'parasitized' aphides refer only to those in advanced stages of parasitism, when the aphides are dead and show a change in colour. This simplified the counting by avoiding dissections and introduced a constant error which does not obscure the phenomenon. For counting, a gravimetric method was used. It was possible for one full-time worker to ascertain the population of a field in two to three full days' work. Population counts were taken by this method before gassing and immediately after treatment, and at intervals later to show the after-effects of the selective insecticide on the aphis population.

As fumigated aphides drop off the plants, the mortality achieved by the direct effect of gassing was ascertained by fixing black cloths under a number of plants before the treatment and counting the live and dead insects remaining on the plants and those collected on the cloths. 'Parasitized' aphides were then transferred to test tubes and the parasites reared.

The results obtained from this survey by the above method follow a general pattern, which will be described, using as an example data relating to the field of Messrs. Bates Bros., of Roxton, Beds (see Fig. 2).

The infestation on the Brussels sprouts in the field to be treated (*B*) and equally in the adjacent control (*A*) was severe, 98,000,000 and 22,000,000 aphides per acre respectively. On both fields the parasitism, as expressed as percentage of dead aphides parasitized by *Aphidius brassicæ*, was low, 3·0 per cent and 3·1 per cent. The number of aphides per one syrphid larva was 101 and 103. There was no infestation by *Entomophtora aphidis* and there were no predators except syrphid larvæ. The weather was dry and hot.

The field *B* was fumigated by two commercial tractor-mounted gassing machines of Pest Control Ltd., Model 1942, on July 28 between 1 and 5 p.m.: the temperature was 78° F. and the drop-off of the dead aphides instantaneous. The first counts were taken on July 31, showing a kill of aphides of 99·9 per cent.

Gassed 'parasitized' aphides were collected and the parasites reared in comparison with 'parasitized' aphides, from untreated fields. 100 per cent emergence was recorded in both cases.

On the treated fields the aphis population on July 31, three days after gassing, was found to be only one-thousandth part of the population before gassing. After a further three days a fourfold increase in the number of living aphides was counted, but this was again reduced to less than a quarter sixteen days after treatment. The infestation was then still of the order of a thousandth part of the initial population, and three weeks after gassing no living aphid could be found on the field. All aphides which survived the gassing had been killed by parasites or predators irrespective of whether they were mutants more resistant to nicotine, aphides which escaped merely because they were in a particularly protected position, or chance arrivals migrating to the field after the treatment. On August 18, three weeks after the treatment, on the whole field no living and only a few parasitized aphides could be found.

With a non-selective insecticide, we should expect the pest population to build up again immediately after the treatment during the summer months, particularly in cases such as the cabbage aphis, which migrates continually. This migration, incidentally, is probably responsible for the increase of the aphides between the third and sixth days after gassing.

The treated field remained free from aphides until the end of the fourth week after the treatment, and only then the infestation built up until, fifty days after treatment, the population reached again a serious infestation.

It is obvious that practical control would be carried out in such a way as to prevent reinfestation. Therefore, either the treatment would be deferred to such a date as would ensure that the period during which the parasites keep the newly arriving migrants in check extends over the migrating period, or the treatment would be repeated when the protecting effect had reached its end.

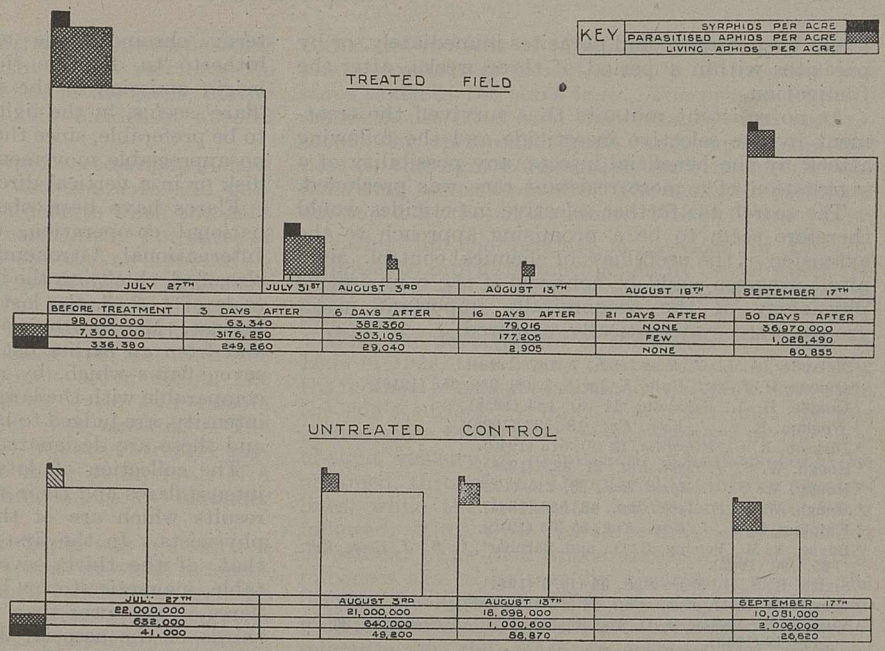

FIG. 2. EFFECT OF CHEMICAL AND BIOLOGICAL CONTROL ON THE POPULATION DENSITY OF CABBAGE APHIS AND ITS PRINCIPAL ENEMIES, THROUGH TREATMENT WITH A SELECTIVE INSECTICIDE.

If we compare the densities of the aphis populations on the treated and untreated field, we see that the population on the untreated field remained almost stationary through the summer and decreased towards mid-September to about half its magnitude on July 28, the date when the first field was gassed.

If we look at the number of parasitized aphides per acre we observe a great change in the proportion of parasitized aphides to living aphides, before and after treatment. While the number of aphides is reduced to one thousandth of its original figure, the number of parasitized aphides is only reduced by a half. Thus the superiority in the number of parasitized aphides over living aphides became paramount until, after three weeks, the parasites had completely wiped out the living aphides. At that time, as mentioned before, *no* living aphid could be found—merely a few dead parasitized ones.

Adult parasites feed normally on the honey dew excreted by aphides, and as the aphides had disappeared and no substitute food had been provided, the Aphidius adults emerging from the parasitized aphides three weeks after treatment were left to starve, the newly arriving cabbage aphis migrants being unable to support them. Thus most of the parasites died of starvation and a new big infestation was therefore built up.

It is worth noting that the parasites which, after treatment, outnumbered the cabbage aphis, remained in this overwhelming majority until the aphides were wiped out, while the hover fly larvæ which, three days after treatment, were only slightly fewer than before treatment, had almost disappeared so early as six days after treatment. Most Syrphid larvæ pupated, and female hover flies were not sufficiently induced by the small number of aphides left after treatment to lay their eggs, so that the population of hover fly larvæ decreased rapidly. Hover fly larvæ disappeared completely three weeks after treatment, showing that they can be relied upon to help in the cleaning-up of the pests *immediately* after treatment by vapourized nicotine. But as their superiority in number soon disappears, the population of hover fly larvæ, though a powerful factor, is a short-lived one in the biological control of the pest following the application of a selective insecticide.

In the untreated field the populations of parasites and hover fly larvæ remained fairly constant for four weeks after the date of treatment of the gassed field, but towards mid-September the percentage of parasitized aphides had significantly increased in accordance with the usual trend.

That the results described are typical was shown by the close agreement of further data obtained by quantitative analyses of aphis population counts after gassing on other fields. The mortality varied with the temperature at the time of treatment, but even when it was so low as 87 per cent, the after-effects of the treatment followed the same general pattern, provided that there was an initial parasitism and an initial population of predators before the field was treated.

Treatment with a selective insecticide should not be carried out at too early a stage of the infestation before the beneficial insects are established.

Summing up, it has been shown that chemical control is greatly limited by the development of resistant races of pests through artificial selection caused by the insecticide, and it is proposed to overcome this limitation by a combination of chemical and biological control through use of selective insecticides.

To demonstrate the latter effect field fumigation of aphis infestations by nicotine vapours in short exposures was used. At a dosage of 3¼ lb. nicotine (95 per cent pure) per acre, and an exposure of one minute, a mortality of the cabbage aphides at the rate of 85–99·9 per cent was obtained at temperatures above 60° F., while Coccinellids, their larvæ and pupæ, and the larvæ and pupæ of Syrphids and of the Braconid parasite Aphidius, showed no mortality. Cabbage aphides surviving the nicotine treatment, whether more resistant to nicotine or not, were all

killed by predators and parasites immediately, or by parasites within a period of three weeks, after the fumigation.

As no resistant mutants thus survived the treatment by the selective insecticide and the following attack by the beneficial insects, any possibility of a segregation of a more resistant race was precluded.

The search for further selective insecticides would therefore seem to be a promising approach to the extension of the usefulness of chemical control. More rapid progress could be achieved if the comparative physiology of the economically important insect groups were systematically explored.

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SOLAR PHENOMENA AND GEOMAGNETISM

A DISCUSSION on "Solar Phenomena and Some Allied Geophysical Effects" was held at a meeting of the Royal Astronomical Society on March 10. The president of the Society, Prof. E. A. Milne, was in the chair, and the discussion was based upon four papers contributed during the recess by the following authors: Mr. H. W. Newton, of the Royal Observatory, Greenwich ("Solar Flares and Magnetic Storms": second paper); Dr. C. W. Allen, of the Solar Observatory, Canberra ("Relation between Magnetic Storms and Solar Activity"); Mr. M. A. Ellison ("Sunspot Prominences: some Comparisons between Limb and Disk Appearances"); and Dr. H. A. Brück, of the Solar Physics Observatory, Cambridge ("On the Distribution of Intensity within the Solar Corona"). Others who spoke during the discussion were Prof. H. H. Plaskett, Prof. W. H. McCrea, Dr. T. G. Cowling and Dr. A. Hunter.

Solar Activity and Magnetic Storms

Opening the discussion, Mr. Newton referred briefly to the findings of his earlier paper, entitled "Solar Flares and Magnetic Storms", recently published by the Society. A solar flare may be described as a small area of the sun's surface which shows the hydrogen line (Hα) in strong emission instead of absorption; many other lines show reversals, but observations are normally made by Hα light with the spectrohelioscope—Hale's instrument, which has contributed more than any other to our knowledge of these phenomena during the last solar cycle. The term 'chromospheric eruption' has been in use hitherto to describe these sudden appearances of bright emission in the sunspot areas, but the term 'flare' seems, in the light of our present knowledge, to be preferable, since the bright emission itself shows no appreciable movement either laterally across the disk or in a vertical direction.

Flares have been observed since 1934 by international co-operation, under the auspices of the International Astronomical Union, and have been classified, chiefly on the basis of area, on a qualitative scale of 1, 2, 3, the last being the largest and most intense. Mr. Newton now selects from these records and from an earlier list by Hale, a total of thirty-seven flares which, by reason of great extent (area comparable with the largest spot-groups), duration or intensity, are judged to be of outstanding importance, and these are designated 3 +.

The collection of data relating to these specially intense flares and their subsequent discussion lead to results which are of the greatest interest to geophysicists. In the first place, it is very significant that, of the thirty-seven flares listed in Newton's table, magnetic storms began within 2·0 days of the flares in no fewer than twenty-seven cases, and two thirds of the associated storms are 'great' storms, having a range at Greenwich in $D \geqslant 1°$, or in H or $V \geqslant 300\,\gamma$. Since, even at solar maximum, great storms are rare events (about 3·2 per year), the total number of chance coincidences of a flare day occurring within 2·0 days of the commencement day of a great storm can be shown to be just *one* for the twenty-eight flares in the central zone of the disk. Actually seventeen such coincidences were discovered. The time interval (storm begins *minus* flare first observed) given by the data is $25{\cdot}7 \pm 1{\cdot}5^{h}$; but the largest five of the great storms give $20{\cdot}3 \pm 0{\cdot}9^{h}$, and this difference is considered to be real in view of the probable errors.

The distribution of intense flares over the sun's disk prior to great magnetic storms was next considered, each flare being regarded as a source-point for corpuscular emission. Dividing the flares into 'central zone' (0°–45°) and 'outer zone' (45°–90°) flares, and analysing the data by the 'superposed epoch method', there emerges a much closer association between the central zone flares and magnetic storms than is the case for those in the outer zone. Furthermore, since the magnetic records are necessarily more complete than the solar flare records, it is possible to extend the available data by working back from the records of great storms and postulating intense flares on the sun's disk about one day earlier to account for them: these flares would most probably be located near the largest or most active spot-group present on the disk at the time. Maunder and others have, of course, shown that there is a statistical relationship between the central zone passage of great spot-groups and the greatest magnetic storms. These 'deduced' flares, like the observed flares associated with great storms, are found to favour the central regions of the disk.

The whole body of evidence is consistent with the following general hypothesis: (1) an intense solar flare emits ultra-violet radiation, reaching the ionosphere at the same moment as the Hα emission seen with the spectrohelioscope, and gives rise to the synchronous wireless fade-out and magnetic 'crotchet'; (2) there is a newly formed, cone-shaped corpuscular stream ejected at the time and place of the flare, having a semi-vertical angle as large as 40°, or

occasionally larger ; (3) the arrival of this corpuscular stream about twenty-six hours later, reaching the earth in a 'head-on' encounter, is the cause of the great magnetic storm with its incidental auroral effects.

The general results of Newton's second paper show that the close relationship between flare and geomagnetic storm is much less definite when the next intensity class (3) of flare is considered. For flares of medium intensity (2) there appears no appreciable connexion between the dual phenomena. Although it seems that a further step has been made in tracing the solar origin of the more intense magnetic storms, Newton has himself emphasized the fact that the smaller magnetic storms which occur during the minimum of the 11-year solar cycle still remain unrelated generally to visible disk markings. The solar origin of these storms is, however, strongly suggested by their tendency to recur at intervals of a solar synodic rotation, as first shown by Maunder forty years ago.

In Dr. Allen's absence, his paper was summarized by Dr. H. A. Brück. Allen's work provides independent confirmation of Newton's conclusions and the well-established association between great magnetic storms and solar flares. Its main importance appears, however, to lie in the attempt to study the cause of those smaller magnetic storms and disturbances the solar origin of which is betrayed by their 27-day recurrence tendency, but which do not show any correlation with observable solar phenomena. Grouping magnetic disturbances observed over a period of thirty-six years according to their recurrence tendency, Allen seeks correlations between the occurrence of the different types of disturbance and the observation of large sunspot groups. For a shorter period of about four years he has also investigated possible correlations between magnetic disturbances grouped according to their recurrence tendency, intensity and sudden commencement and the observation of solar flares or radio fade-outs produced by such flares.

The results of his investigation lead Allen to the conclusion that the influence of the *M*-regions on the sun (in which the origin of the minor magnetic disturbances is to be sought) is affected by the presence of sunspots in their neighbourhood. When these are within 40° of the *M*-region, they seem to deflect the emitted particles in very much the same way in which streamers in the solar corona are deflected by regions around sunspots. This, and the particular persistence of the *M*-regions or recurrent disturbances one or two years before sunspot minimum when the equatorial coronal streamers have their greatest extension, suggests according to Allen that *M*-regions are identical with coronal streamers. Their base appears to cover an extended region on the sun from which the corpuscular emission is constrained to move in limited streams by forces in the solar atmosphere. Allen's *M*-regions are therefore rather different from the relatively small *C*-regions of abnormal emission in the coronal line λ 5303 found by Waldmeier (1942) and identified by him with the *M*-regions. Further studies of the recurrent disturbances during the present solar minimum might possibly bring a decision in favour of one or other of the two hypotheses.

Prominence Motions

Describing his paper on sunspot prominences, Mr. Ellison remarked that, hitherto, our knowledge of the forms and motions of prominences had been drawn almost exclusively from the study of *elevation* pictures taken at the sun's limb. The principal instruments in use have been the visual eye-end spectroscope, the spectroheliograph, and, within the last decade, the Lyot coronagraph and the interference polarizing monochromator. The monochromator, as developed by Pettit at Mount Wilson Observatory, following up the original suggestions of Öhman, promises to prove the most generally useful where the study of rapid motions in prominence features is concerned.

With the development of the spectrohelioscope by Hale in 1926, there arose the possibility of studying the motions of sunspot prominences in *plan* view upon the sun's surface by light of the Hα line. It was immediately found that direct readings of the line-of-sight velocity of prominence streamers could be obtained, through the Doppler shifts of the spectral lines, while the horizontal movements were being followed. Thus arose the three-dimensional method of attack. The disk appearances, when these prominences are to be seen by absorption against the brighter background of the chromosphere, also provide fuller and more continuous records, with special reference to the state of activity and stage of development of the parent spot-group. The precise location of the prominence filaments and arches in relation to the spots is likewise of considerable importance in any discussion of the causes of their rapid movements. Observations of this kind made during the past 11-year cycle of solar activity have been contributed mainly by the observatories at Greenwich, Zurich and Sherborne, and Mr. Ellison explained that the present paper was intended to summarize these findings and to provide a correlation with the corresponding types of limb prominence.

Most frequent in occurrence are the inflowing filaments of short life which originate in the surrounding chromosphere or in 'coronal clouds' formed above the spot area, move along curved trajectories and finally terminate near the boundary of the penumbra with a mean velocity of inflow of 48 km./sec. Their mean projected length is 61,000 km. and their movements are found to be independent of the magnetic polarity of the attracting sunspots. These filaments are now regarded as being identical with the 'Fleckenkronen', described by Fényi (1891) from limb observations, and with the "Jets and Rockets" of Evershed's memoir of 1917 : they are therefore placed under Type III*a* of the Pettit classification (1943).

Complex formations of loops and arches over sunspots are rare, but single and double arches are frequently seen, with the spectrohelioscope, connecting adjacent sunspots of the same group. The direction of motion of the gases is upwards on one side and downwards on the other side of the arch, only one case in thirty-one having been observed where matter was clearly in descent on both sides of the same arch. Because of their Doppler displacements, such objects cannot be recorded in their entirety with the spectroheliograph. The mean distance between the legs of the arches is 43,000 km., and the mean velocities of inflow and outflow are found to be 39 km./sec. and 28 km./sec. respectively. Such prominences are identified with the arches of Type III*b* in Pettit's limb classification, and the directions of motion are again independent of the magnetic polarities of the associated sunspots.

A further type of great interest is the flanking prominence (Type III*c*), often of great dimensions,

the form, growth and decay of which is intimately connected with the life-history of the adjacent spot-group. These exhibit much internal activity, as well as forming external streamers which leave the tops of the prominences to flow horizontally inwards and downwards into the spot area.

Mr. Ellison emphasized that the slender trajectories, perhaps 100,000 km. in length and no more than 5,000 km. thick, have not received any satisfactory explanation or likely parallel in terrestrial physics. They give one the remarkable impression of being semi-permanent conducting paths along which bright condensations follow one another at frequent intervals over a period of several hours. Such motions were first studied in the cinematograph films taken by McMath. In the horizontal trajectories it would seem that gravity must be compensated by radiation pressure, and that the motive force along the trajectory may be of an electrostatic nature. This, however, introduces a difficulty, for the highly conducting properties of the hot solar gases would appear to prevent the collection of electrostatic charges.

Photometry of the Corona

Dealing with his investigation of the intensity distribution within the inner corona, Dr. Brück mentioned that Waldmeier had recently published a paper on the same subject in which he found signs of a connexion between intensity gradients and the structure of the corona. Dr. Brück's photometric work confirms Waldmeier's suggestions in greater detail. It has been based upon a plate which was obtained by the late Prof. H. F. Newall during the eclipse of August 30, 1905, in Algiers, and at the same time as the plate from which Waldmeier's conclusions had been derived.

The distribution of intensity has been determined from records made with a microphotometer along seventy-two solar radii equally spaced in position angle, and the results have been represented by a series of isophotes covering an intensity ratio of mag. 2·5. These are sensibly circular, as is to be expected for an eclipse near sunspot maximum, but show considerable local variations corresponding to the structure of the corona on the original negative. Intensity gradients, when derived for a region extending from a distance of about 2′ to a distance of about 5′ from the solar limb, show systematic variations with position angle in the sense that intensities, and therewith densities of scattering electrons, seem to decrease less rapidly with increasing distance from the sun when measured along rays than in 'normal' regions in between. The opposite effect has been observed by von Klüber for streamers in the outer corona, which extend from about 6′ to about 70′ from the limb.

As a consequence of his own work, Waldmeier believes that the inner corona is composed of a spherical shell of electrons, atoms and ions. The electrons, by scattering light from the photosphere, give rise to the continuous spectrum of the corona. Over the sunspot zones, where the ultra-violet and corpuscular radiations are assumed to be most intense, the atoms are ionized to a very high degree, losing as many as fifteen electrons, and are left in metastable states from which emission of the forbidden coronal lines takes place in accordance with Edlén's remarkable hypothesis. The increased ionization leads in turn to a greater electron density, with the consequent brightening of the continuous spectrum which has been observed in these regions.

KILIMANJARO: AN ACTIVE VOLCANO

By DR. P. E. KENT

IT is nearly a century since Kilimanjaro was discovered, a snow-capped mountain 200 miles south of the equator, and the highest point in Africa. Until recently it was thought to be quite extinct, but expeditions during the last few years have produced evidence of a recrudescence of activity in the broad Kibo crater which forms the more easterly of the twin summits.

Meyer[1], the first explorer to climb the mountain, observed that in 1889 the crater floor was almost entirely covered with weathered ice, commenting "the volcanic activity of Kilimanjaro is now a thing of the past; there is no trace even of fumaroles". He recognized, however, that the local emergence of the rock floor indicated a relic of internal heat.

From the time of the first discovery, however, the amount of ice has been diminishing. In 1889 the crater basin discharged ice through a gap in the western side, but in 1906 discharge had ceased, and there has been no connexion between the crater ice and the glaciers of the mountain slopes since that time. A detailed map by Klute[2] dating from 1912 showed large isolated masses of ice and snow on the crater floor, including a mass practically in the centre, and in 1921 Gillman[3] was able to detail considerable reductions in the ice masses, which he thought might be due to climatic fluctuation. In the next few years further evidence of the reduction was obtained[4], and Mittelholzer[5] published a series of air photographs taken early in 1928 which showed the crater floor mantled with only a thin and patchy covering of snow, and showed a perfectly preserved central crater pit (located where Klute had mapped an "Eisburg") which had apparently not been seen before. Subsequent air photographs show that snow conditions were virtually unchanged in 1932, but that there was a temporary increase in quantity in 1937[6] and that in mid-1942 the greater part of the rock floor was clear[7]. There was thus a rapid decrease in the snow cap in the period preceding 1928, fluctuation during 1928–37, and subsequent further reduction.

H. W. Tilman[8] climbed the mountain in 1930 and 1933. He found the snow on the outer slopes much reduced between the two visits, and in 1933 observed sulphurous fumes and pieces of sulphur in the crater —the first signs of the gas emission which has since greatly increased.

Two years ago, fresh evidence was obtained. J. J. Richard ascended the mountain in the autumn of 1942 and saw several well-developed fumaroles surrounded by sulphur deposits, and found that the rocks were warm in several places[9]. Early in 1943, he climbed the mountain again in company with Mr. Spink of the Meteorological Department of East Africa[10], and found that the number of fumaroles had increased from about six to twenty, and that sulphurous fumes could be detected at some distance. Reports from the western side of the mountain described underground rumbling noises and earth tremors.

Spink[11] has since reported a visit to the crater on July 18, 1943, and a detailed account of the phe-

nomena observed has been published in East Africa[12]. Activity was most strongly developed on the western and southern sides of the crater area, where almost continuous parallel lines of fumaroles were found associated with extensive beds of crystalline sulphur. Emission of sulphurous and acrid-smelling gases was so copious that they could be detected a considerable distance away. The temperature of the fumaroles varied from 52° to 78° F. It was found that parts of the ground were warm and soft, so that the mountaineer frequently sank to his knees: the broken surface gassed freely, and it was clear that the gas emission was by no means confined to the obvious vents.

It is evident from these observations that the fumarole activity is increasing to a considerable volume, and there can be no doubt that the mountain should not be classified as extinct. The central pit in the crater first photographed by Mittelholzer is one of the most perfectly preserved vents in Africa, comparable with the pits in the craters of some of the active Mufumbiro volcanoes in Uganda. It may well have been formed within the last few hundred years, although the presence of a permanent ice cap may have had a protecting effect and the fresh appearance may be somewhat deceptive.

The presence of active volcanoes in East Africa makes one wonder whether there will ever be a recurrence of the great eruptions when enormous areas of the highlands were flooded with lava and covered with layers of volcanic ash. The active volcanoes occur in three widely separated areas: west of Kilimanjaro, the mountain Doinyo Ngai has erupted at intervals during the last fifty years; far to the north in Kenya, Teleki's and Andrew's volcanoes at the southern end of Lake Rudolf have been occasionally active; and in Uganda, Nyamlagira of the active Mufumbiro group discharged a lava flow into Lake Kivu in 1938. In the intervening areas hot springs are known in many places, for example along the shores of Lakes Hannington, Magadi, Natron and Manyara (most commonly on the western shores, for some unexplained reason), and steam jets at Eburru in the Njorowa gorge and in the volcanoes Longonot and Meru show that underground temperatures are still high over a wide area.

It is usually supposed that the localized activity of the volcanoes is a last dying glow, the remnant of the great eruptions which produced the plateau lavas. But there is much geological evidence to show that lavas were produced during two separate periods which were separated by a time of quiescence probably as marked as that of the present day. There may, in fact, be a third upwelling of the lava from below over the highlands of East Africa. If there is, one can be sure that it will develop gradually and—if it happens at all—it is not to be expected until many centuries have passed.

[1] Meyer, H., "Across East African Glaciers" (1891).
[2] Krenkel, E., "Geologie Afrikas", Teil 1, 244 (1925).
[3] *Geog. J.*, **61**, 1 (1923).
[4] Mosterz, H., *Z. Vulkanol.*, **12**, 299 (1929–30).
[5] Mittelholzer, W., "Kilimandjaro Flug" (1930), pl. 104–109.
[6] Light, R. U., "Focus on Africa" (1941).
[7] *Illust. Lond. News*, 80–81 (Jan. 16, 1943).
[8] Tilman, H. W., "Snow on the Equator" (1937), 175.
[9] Sinclair, P. J., *The Times* (Dec. 24, 1942).
[10] Sinclair, P. J., *The Times* (May 5, 1943).
[11] Spink, P. C., *The Times* (Aug. 18, 1943).
[12] *East African Standard* (Oct. 8, 1943).

OBITUARIES

Prof. H. F. Newall, F.R.S.

THERE passed away peacefully at Cambridge on February 22, at the age of eighty-six, an astrophysicist of real distinction, who by his personal work in stellar and solar spectroscopic observations and in the design of spectrographs, by his discoveries and by his fine character had a marked influence on astrophysics at Cambridge, both in establishing it as a university study and in attracting younger workers into the field in which he himself had been so notable a pioneer. The first professor of astrophysics at Cambridge, he was a true natural philosopher, who had survived into an era of specialists from a more gracious and spacious age, in which he could study, unhurried, the whole world of Nature and of art.

Hugh Frank Newall was born at Gateshead-on-Tyne on June 21, 1857, a son of Robert Stirling Newall, F.R.S. His mother was the daughter of Hugh Lee Pattinson, F.R.S. R. S. Newall (born at Dundee in 1812) was the head of a considerable firm engaged in the manufacture of wire ropes, which he had himself invented; this firm made the first Atlantic cable, laid by the *Great Eastern*. Pattinson, likewise, had invented a commercial process—the desilverization of lead. R. S. Newall saw two rough disks of crown and flint glass exhibited at the Exhibition of 1862, acquired them and had them made into a lens of 25-in. aperture, which he caused to be erected at Gateshead as part of an equatorial refracting telescope, of focal length 29 ft. Here it was visited by the great and learned of the day. In March 1889—the year in which he died—he offered the telescope to the University of Cambridge.

His son, Hugh Frank, had been educated at Rugby (1872–76) and Trinity College, Cambridge (1876–80) and had then gone as an assistant master to Wellington College (1881–83). The next three years he spent partly abroad, and while he was at Perugia in 1886 an invitation came from the then Cavendish Professor (J. J. Thomson) to become his assistant and demonstrator at the Cavendish Laboratory. This offer coincided with Newall's natural tastes and inclinations and he occupied the post thus offered from 1886 until 1890.

The University of Cambridge was at first not eager to accept R. S. Newall's offer of the big telescope, partly on grounds of expense, partly because of want of a suitably qualified person to take charge. H. F. Newall's own desires were for a career in pure physics, more particularly in spectroscopy—he was much attracted by the inquiries suggested by J. J. Thomson's discovery of the electrodeless discharge through rarefied gases—but he sacrificed those desires and resigned his post at the Cavendish in order to supervise and indeed operate the Newall telescope. It was more than a sacrifice of personal inclination: he not only became henceforward a worker without stipend, but also he paid for the expense of removal of the Newall telescope from Gateshead to Cambridge out of his own share of the family patrimony. From 1891 onwards he was the Newall Observer, and in 1904 he became assistant director of the Cambridge Observatory under Sir Robert Ball. The first "Report" on the proceedings with the Newall telescope was dated 1892. His first paper in the *Monthly Notices of the Royal Astronomical Society* appeared in 1894, entitled "Notes on some Photographs taken with a Visual Telescope". Papers on astrophysics

followed in a regular stream. He never, however, relinquished his original interest in spectroscopy for spectroscopy's sake, and he had the honour of a paper in the first volume (1895) of the *Astrophysical Journal*, on the spectrum of argon, then newly discovered by Ramsey and Rayleigh.

Newall's first thoughts, on being put in charge of the Newall telescope, were to adapt it for photographing and measuring the spectra of the stars. He began by constructing a one-prism spectrograph (the Bruce Spectrograph) for attachment to the eye-end. This, it is interesting to recall, was named after an American benefactor who gave funds for such instruments. It was in action in 1895. Newall also added a correcting lens to the 25-in., to obtain an improved colour curve in the photographic region. The description of the Bruce Spectrograph was published in the *Monthly Notices* of 1896, and reprinted in the *Astrophysical Journal* (Vol. 3) for the same year. With this, and more especially a later four-prism spectrograph which he also designed and put into use in 1899 (though he did not formally describe it until 1905), Newall began systematic observations on the radial velocities of the stars, through the Doppler effects in their spectra. For the accurate determination of wave-lengths in stellar spectra, an iron arc comparison spectrum was used. To astrophysicists of the present generation, this may seem a routine matter. But anyone who reads W. W. Campbell's "Stellar Motions" will appreciate the difficulties that dogged the footsteps of the early measurers of stellar wave-lengths, when striving for an accuracy sufficient to give an error of only a few km. per sec. in the line of sight velocity. There were difficulties due to flexure of the tubes of telescopes when heavy spectroscopic apparatus was clamped on to them—apparatus for which they had not been designed. There were difficulties due to temperature variations. There were difficulties with the production of a comparison spectrum which had to be formed from the same slit, and to be derived from the same spectroscopic train, as the light from the star. There were difficulties even in viewing the stellar image sufficiently clearly to afford accurate guiding. All these, Newall with his own unaided instrumental good sense and sound principles of optical design, and his consummate skill with his hands, triumphantly overcame. He deserves the greatest possible credit for his pioneer work in this field. Newall showed that high-precision stellar spectroscopy was possible, and possible in Great Britain. Without Newall's devotion to a subject not of his own choosing, without his sacrifice of the career in physics which was opening before him, Great Britain would have lagged behind the work then being done by Vogel at Potsdam and Campbell at Lick.

The fruits of this work appeared in 1899 when Newall announced (*Mon. Not.*, **60**, 2; 1899) his discovery that the star α Aurigæ (Capella) was a spectroscopic binary; the same discovery was made simultaneously and independently by W. W. Campbell at Lick. Newall's substantive paper "On the Binary System of Capella" appeared in 1900 (*Mon. Not.*, **60**, 418; 1900).

Meanwhile Newall had been gaining experience as a solar observer. He took part in an expedition (with E. H. Hills) to Pulgaon, India, to observe the total solar eclipse of Jan. 22, 1898; and in an expedition to Algiers for the eclipse of May 28, 1900. There was also the expedition to Sumatra for the eclipse of May 17–18, 1901; and we may mention here the expedition to Guelma (Algeria) for the eclipse of Aug. 30, 1905, at which he obtained a splendid photograph of the solar corona (a slide of which, by an apt coincidence, was thrown on the screen in the course of a discussion at the same meeting of the Royal Astronomical Society as that at which his death was announced; see p. 454 of this issue). His later expeditions, to the Crimea (eclipse of Aug. 20–21, 1914) and to Norway (June 29, 1927), were frustrated by weather.

Newall's work was recognized by his election to the Royal Society in 1902. During 1905–7 solar instruments were purchased out of the Frank McClean Bequest, and added as an annexe to the Newall dome. These included a 16-in. cœlostat and a 14-ft. plane-grating spectrograph of Littrow type, producing a 6-in. solar image. Again, in 1908 the Royal Society offered the Huggins telescopes from Tulse Hill (a 15-in. refractor and an 18-in. reflector on the same mounting) to the University of Cambridge, and these came under Newall's care in 1909. He was president of the Royal Astronomical Society during 1907–9.

This period of Newall's most intense activity was fittingly crowned by his appointment in 1909 as professor of astrophysics at Cambridge (without stipend) and his election as a fellow of Trinity. In 1911, on the retirement of Sir Norman Lockyer from the directorship of the Solar Physics Observatory at South Kensington, it was decided to transfer that observatory to Cambridge; and in April 1913 the move was effected. Henceforward the old Solar Physics Observatory was fused with the Astrophysics Department and the Newall telescope, and, under Newall as director, the combined Solar Physics Observatory left the control of the University Observatory. Newall held the posts of professor of astrophysics and director of the Solar Physics Observatory until 1928, when he retired and was succeeded by Prof. F. J. M. Stratton, who had been formerly one of his assistant directors. It is understood that the chair was endowed through the generosity of Newall.

Newall observed the spectrum of Nova Aquilæ in 1918. In 1916 he had identified (with F. E. Baxandall and C. P. Butler) the *G*-band in the solar spectrum with a band due to hydrocarbons. Later he occupied himself with problems of solar rotation and the relations between successive spot-cycles, and he devised a promising method for obtaining differentially the departures of the law of rotation of the sun from that of a rigid body.

Newall was an honorary D.Sc. of Durham, a foreign member of the Spectroscopisti Italiani, and a collaborator on the editorial board of the *Astrophysical Journal*. In 1925, he was a vice-president of the International Astronomical Union for its Cambridge meeting.

Newall married, first, in 1881, Margaret, daughter of the Rev. A. T. Arnold, a house-master of Rugby. Mrs. Newall was an experienced eclipse-observer, accompanying Newall on all his expeditions. She died in 1930. He married, secondly, in 1931, Dame Bertha Surtees Phillpotts, sometime head of Westfield College and mistress of Girton. She died in 1932.

Newall was something very much more than the sum of his published papers, or the bare record of his activities. All who came in contact with him recognized him as a man for whom science stood for something large and gracious, a mistress to receive court, to be adorned in lovely garments, not to be soiled by grim contacts with grim workaday life, to hold converse with at leisure, to be reverenced with

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

THE ROYAL INSTITUTE of CHEMISTRY of GT. BRITAIN & IRELAND

(Founded 1877)
(Incorporated by Royal Charter, 1885)

APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates and Senior Registered Students), who are available for appointments or who are seeking to improve their position, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology. A list of Laboratory Assistants is also available.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to the Registrar.

All communications to be addressed to The Registrar, the Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

SOMERSET COUNTY COUNCIL

AGRICULTURAL INSTRUCTION

APPOINTMENT OF TEMPORARY INSTRUCTOR IN BEEKEEPING

Applications are invited for the above named post on the Agricultural Instruction Staff of the County Council.

Applicants for the post, which is a temporary one, must have had experience in and possess practical and scientific knowledge of all aspects of beekeeping and diseases of bees.

The person appointed will be required to organize and give lectures and demonstrations in beekeeping and must own and be able to drive a motor car.

Commencing salary £260, rising by annual increments of £10 to £300 a year with war bonus in addition (at present 17s. 6d. a week). A motor car allowance on the appropriate County scale will be payable. Subsistence allowance will also be payable when necessary.

Particulars and Conditions of Appointment and forms of application may be obtained from the undersigned, to whom completed applications should be forwarded so as to be received not later than April 24, 1944.

County Hall, Taunton. April 5, 1944.

HAROLD KING,
Clerk of the County Council.

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

NOTICE is hereby given that an ELECTION of JUNIOR FELLOWS to begin work on October 1 will take place in July, 1944. Junior Fellowships are normally of the annual value of £400 for three years; but candidates, younger than those usually elected or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £300 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a Degree in a Faculty of a University in the British Empire or a Medical Diploma registrable in the United Kingdom. Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in Mental Diseases and in the general allotment of Fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates should be received by May 14, though late entries will be accepted up to June 1.

Owing to the disturbance caused by the War, it is necessary for candidates to submit evidence that they could be given accommodation in the departments where they propose to work.

Forms of application and all information may be obtained by letter only addressed to: Dr. A. N. Dury, F.R.S., Acting Secretary, Beit Memorial Fellowships for Medical Research, The Lister Institute, Chelsea Bridge Road, London, S.W.1.

THE UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY

Applications are invited for the above appointment. The duties of the post are concerned principally with Ferrous and Physical Metallurgy, and previous experience in these branches is therefore essential. Some industrial experience will be considered an advantage.

Assumption of Duties.—January 1, 1945, or as soon as possible thereafter.

Salary.—£650 per annum, rising by annual increments of £25 to £800 per annum, provided that an officer who has already served as a University Lecturer, or who has acquired special experience suitable for his duties, may be appointed above the initial salary. The salary is subject to 6 per cent deduction for Provident Fund contributions, Government and University together contributing an equal amount. Half salary will be paid from date of embarkation to date of assumption of duties in Johannesburg. At present a temporary cost of living allowance, amounting to £51 15s. per annum if married, and £28 12s. per annum if single, is paid.

Transport.—£60 will be contributed towards the cost of passage, and first class rail fare will be refunded for the journey from Cape Town.

Applications in duplicate must be lodged not later than July 31, 1944, with Dr. W. Cullen, 4 Broad Street Place, London, E.C.2, from whom further information may be obtained.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Chemistry. Stipend £350 per annum. Applicants should possess special qualifications in Physical Chemistry. Applications to be sent not later than April 25, 1944, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained.

Experienced Metallurgist-chemist required for research on corrosion, protection, and allied problems on magnesium-base light alloys in scheduled Industrial Laboratories in the Manchester district. Will have small staff of assistants and must be able to initiate and carry through research programmes without detailed direction. Sound knowledge of modern theory essential, together with ability to utilize this knowledge in practical applications.—Apply stating age, experience and salary required to Box 175, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist required for light alloy research in Industrial Laboratories in Manchester area scheduled under E.W.O. Must be able to carry out research programmes with minimum supervision; sound basic knowledge of Physical Metallurgy necessary. Knowledge of German advantageous.—Apply stating age, experience and salary required to Box 176, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist-chemist required for research on melting and fluxing problems on magnesium base light alloys in scheduled Industrial Laboratories in the Manchester district. Must have sound basic knowledge of Inorganic Chemistry; some experience in metallurgical work preferred. Apply stating age, experience and salary required to Box 177, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Laboratory vacuum pump to give at least 10^{-4} mm. Hg.—Box 178, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp.—Chards, Microscope Specialists, Forest Hill, S.E. 23.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

Limited supplies of marine biological material are still available, but orders should be placed well in advance.

For prices and detailed information apply to: The Director, The Marine Biological Laboratory, Plymouth.

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serenity. As I have already written and must write again, he was a true natural philosopher, of a kind, I think, more common in the last century than this, to whom curiosity about Nature on the broadest scale was the overmastering motive. In the Newalls' home at Madingley Rise, Cambridge, one heard science talked about in a queenly way, as an intrinsic part of the good life, in partnership with art and music. Sooner or later one met at the Newalls' everyone who counted in astrophysics and the allied parts of physics, and a dinner there was a true meeting of minds, where thoughts could be exchanged on a new phenomenon, a new flower, some development in farming, a Stonehenge discovery or a new star. Newall was the friend of Huggins, Michelson and Hale, and in his knowledge of optical design not their inferior. He was the friend, too, of many younger workers in astrophysics, who received from him hospitality, a captivating welcome and much sound sense as to the directions their energies should take. Withal he was a conservative, loth to embrace modern theories, seeing Nature rather as a complicated spectacle of phenomena than as a stamping-ground for principles. He belonged to the disappearing school which thought that insight into the phenomena apparent in the stars could be gained by consideration of simple laboratory experiments.

Newall was the most modest of men, never referring to his own achievements. Although generally unreserved in his conversation, he clung to reticence about deeper things as to the dress of decency. He was generous in praise of others, and generous and self-sacrificing in all matters of personal conduct. How he would have hated the thought of this his obituary being written! His distinguished personal appearance was the index of a true distinction of mind. We shall long mourn one of the fathers of astrophysics in Great Britain. E. A. MILNE.

Dr. J. McKeen Cattell

DR. J. MCKEEN CATTELL, for the past fifty years editor of *Science*, the weekly journal of the American Association for the Advancement of Science, died in January, aged eighty-three, at Lancaster, Pennsylvania. He was long known as the "dean of American science", although his own subject strictly was psychology. In concurrently editing various periodicals his industry was immense; but he won renown no less as teacher, research worker, and compiler of scientific reference books.

Son of the president of Lafayette College, also in Pennsylvania, Cattell after taking his degree there in 1880 went to study in Göttingen, Leipzig, Paris and Geneva, then returned to Leipzig to gain his Ph.D. in 1886. Two years thereafter he was lecturing in Cambridge, during which time he married Miss Josephine Owen, of London. Psychology as a separate study was in those days in its early development in the United States under Prof. William James of Harvard, and when Dr. Cattell received a call from Philadelphia, to fill a similar chair in the University of Pennsylvania, he went home to his career. In 1891 he proceeded to Columbia University, New York, where for twenty-six years he taught both pupils and teachers, engaging at the same time in researches upon measurement of behaviour, individual and group differences, measurement of psychophysical time, intensity and extensity, perception, fatigue, memory, and association of ideas.

Within about ten years after assuming the editorship of *Science*, Cattell began to edit also *The American Naturalist*, devoted to the biological sciences, and compiled the first edition of his "American Men of Science", a "Who's Who" of research workers. (This book, now grown to 28,000 names, unfortunately and surprisingly lacks a subject-index, and the same is true of its companion volume, "Leaders in Education", first published in 1932.)

Cattell was always a man who pertinaciously stuck to causes or views which he believed in, regardless of what might happen to himself therefrom. In October 1917, six months after the United States had entered the War of 1914–18, he wrote to various members of Congress "not to require drafted men to fight in Europe against their will". For this he was dismissed from his professorship at Columbia. Was such dismissal, when the United States was at war, a violation of academic freedom? Eminent colleagues of Cattell's, Prof. John Dewey the philosopher, and Profs. James Harvey Robinson and Charles A. Beard the historians, protested furiously, and Prof. Beard resigned. Cattell later explained that he meant his letter to apply to conscientious objectors only; but he was not reinstated. Having been a member of the staff for a quarter of a century, Cattell then applied for his pension. It was refused him. Whereupon he sued the University for 150,000 dollars. The case was settled out of court by the award to Cattell of 45,000 dollars.

But by this time Cattell was so deeply occupied in editing his various publications that the loss of his post made little difference to him except to give him several additional hours per week to edit still others. Even while the last War was being fought out he began, from an office in the high tower of Grand Central Terminal, New York, to edit *School and Society*, which in the twenty-five years of his direction grew to be perhaps the leading educational journal in America. Longer still—forty years—was his tenure of the editorial chair of *The Scientific Monthly*, and during a critical period he presided also over *Popular Science Monthly*. In these multitudinous activities two of Cattell's four sons ably assisted him, and survive to carry on a considerable proportion of his work.

If, as some have said, there is in the United States no such thing as a school-leaving age, the gospel of unlimited educational opportunity owes much to the preaching of it by Cattell. But, completely enveloped in science as he was, he tended to attribute to it all the blessings of America and none of the difficulties. "The industrial applications of science," he said in one of his prefaces, "have quadrupled the productivity of labour, abolished slavery, the subjection of women, and child labour, and have made possible universal education even to the age of 18 or 20."

In his long career Cattell was chosen president of many learned societies, including the American Association for the Advancement of Science, nor did his stand in the War of 1914–18 deter the French from electing him a Commander of the Legion of Honour. WILLARD CONNELY.

WE regret to announce the following deaths:

Prof. Karl Schuchhardt, formerly director of the Prehistoric Department of the Folk-Lore Museum in Berlin, aged eighty-four.

Dr. C. H. Townsend, director during 1902–37 of the New York Aquarium, on January 28, aged eighty-four.

NEWS and VIEWS

Committee on Technical Education

MR. BUTLER, President of the Board of Education, has announced in a Parliamentary written answer that the following have been appointed members of a departmental committee to report on higher technological education in England and Wales: Lord Eustace Percy (*chairman*), Dr. D. S. Anderson, Sir Lawrence Bragg, Mr. W. H. S. Chance, Sir Charles Darwin, Dr. E. V. Evans, Mr. B. Mouat Jones, Mr. S. C. Laws, Dr. H. Lowery, Mr. H. S. Magnay, Sir George Nelson, Mr. J. F. Rees, Dr. R. V. Southwell, Mr. H. Fitzherbert Wright, with Mr. Maxwell-Hyslop, Board of Education, as secretary. Officers of the Board of Education will attend meetings of the committee as assessors.

The terms of reference of the Committee are: "Having regard to the requirements of industry, to consider the needs of higher technological education in England and Wales and the respective contributions to be made thereto by universities and technical colleges, and to make recommendations, among other things, as to the means for maintaining appropriate collaboration between universities and technical colleges in this field."

Application of Research in Industry

IN his address "The Application of Research" to the Manchester Chamber of Commerce on March 31, Dr. Andrew McCance said that we should not think of research merely in terms of great laboratories equipped with intricate and expensive apparatus and staffed by scientific wizards aloof from mundane affairs. Valuable information can often be obtained with the simplest equipment, and scientific men are ordinary men whose judgment has been trained to exclude prejudice and to accept only those conclusions which are supported by facts. As example, he referred to investigations on temperature variations in blast furnaces, which have led to a great increase in regularity of output and a corresponding economy in coke consumption. The structure of a research association depends on the organization of the industry. With an industry such as the iron and steel industry, in which the main production comes from a number of large units, each unit can usually make a material contribution to the common cause by undertaking in its own research department a share of the investigations required into a specific problem. Recently, however, this industry has decided to form a new research association, and in future finance for research within the industry in Great Britain will be obtained by a voluntary levy on the ingot production of all producers in the federation. All the work is controlled by a number of committees, dealing with such subjects as blast furnaces, rolling mills, alloy steels, corrosion, etc., and Dr. McCance referred in particular to the work of the Hair Line Crack Committee dealing with the minute cracks which occur in high tensile alloy steel and their prevention, as illustrating the potentialities of co-operative research. This investigation was founded on an effective scheme of co-operation between industrial and university research laboratories.

Research, Dr. McCance emphasized, begins with an attitude of mind, and it is essential first to create the correct attitude of mind in staff and throughout the organization. The research department then becomes an integral part of the production department, planning ahead continually for the creation of new products, new processes and new economies. It is during the initial stage of employing a nucleus of scientifically trained men to create standards for raw materials and products and to investigate faults in manufacture and processes that sympathetic understanding and guidance are most required if antagonism and friction are to be avoided. When the department becomes an accepted part of the organization, additional staff is required to take over the routine work, and the original staff can begin to tackle the more fundamental problems of research-controlled development. Technical control of a business requires the employment of men who have received a technical training. No business can be made more scientific from outside, and Dr. McCance does not believe that a scientific training makes men less practical in their outlook. It is the waste of latent abilities through lack of opportunity or training that should give us more concern, and industry must co-operate in the development and utilization of training facilities if the future supply of competent executives and research workers is to be assured and the enterprise of British industry maintained.

Editorship of *British Birds*

THE place of the late H. F. Witherby, who so successfully conducted *British Birds* through thirty-six volumes, has been taken by Bernard W. Tucker, in accordance, it is understood, with Mr. Witherby's wishes. With Mr. Tucker will be associated in the editing of the journal, Dr. Norman F. Ticehurst and Major A. W. Boyd. *British Birds* has been assiduous in publishing about birds in Britain items of information many of which would otherwise have been lost to record, but it has played a more important part in encouraging scientific observation of bird-life and in suggesting problems and, by example, showing how problems may be tackled. In January 1917, *British Birds* incorporated *The Zoologist*, and thus disappeared after a long and useful history the only magazine which published notes on any aspect of British natural history from any part of Great Britain. The *Scottish Naturalist* performed a similar duty for the northern part of the kingdom, but it is a war casualty. The result is that there is now no magazine available for recording the minor observations of British naturalists on subjects other than birds, so that the cumulative value of the work of that great band of amateur observers, for which Great Britain has long been noted, is being lost. Is it too much to hope that when the War is over a *British Naturalist* will arise, wherein the ordinary student of Nature will be able to put on record field notes of casual interest and articles of connected observations?

Stereoscopic Photographs: 'Polaroid Vectographs'

INFORMATION recently released about the 'Polaroid Vectograph', a system of stereoscopic photography developed by the Polaroid Corporation, reveals that the method is playing an important part in war-time aerial photography. A short account of the underlying principles was given by E. H. Land in 1940 (*J. Opt. Soc. Amer.*, 30, 230; 1940). As in all stereoscopic systems, two photographs of a scene taken from different positions have to be presented to the observer so that the picture taken from the right is seen by the right eye, while that from the left is seen by the left eye. In the 'Vectograph', two very thin polarizing surfaces are located immediately above

an aluminized surface and are oriented so that the vibration directions of the two layers are crossed relative to one another. The light and shade of the 'left' image is controlled by the number of submicroscopic crystals in one of the layers, and that of the 'right' image by the crystal distribution in the other layer. The 'left' image is seen by the left eye through a 'Polaroid' filter placed in front of the eye to act as analyser, the vibration direction of the analyser being crossed with respect to that of the 'left' image. The white areas of the image are thus represented by regions where the polaroid crystals are absent, and the blacks by areas of maximum concentration; further, since the left-eye analyser is parallel relative to the vibration direction of the 'right' image, the presence or absence of crystals in the latter have no effect on the appearance of the 'left' image. A similar viewing arrangement is used to enable the right eye to see the 'right' image.

The result is startlingly effective. The simplicity of the viewing equipment and the approximate superposition of the two images make fusion a matter of no difficulty whatever. When the original photographs are taken from an aircraft, the distance apart at which they are taken can be made large to give the effect of an exaggerated interocular distance. This leads to a greatly enhanced stereoscopic effect which can obviously have very important applications.

Chemical Laboratory Planning

THE design of modern industrial chemical laboratories has been dealt with recently by E. D. Mills (*J. Roy. Inst. Brit. Architects*, 51, No. 2, 27; Dec. 1943). The article, although short, contains some useful details and illustrations, with a short bibliography, and should be useful to those responsible for the erection and equipment of chemical laboratories. Further information about such matters as ventilation (which is quite different from that for normal buildings) would have made it more informative and practical. Many architects have very little idea of what is required, and actual figures are not easy to find.

Ancient Astronomy

A SERIES of articles entitled "Man and His Expanding Universe" is appearing in *Sky and Telescope*, the first of which, in the December issue, deals with Egyptian astronomy. As the life of the Egyptians depended on the overflowing of the Nile, the beginning of which occurred near the time of the summer solstice, the priest-astronomers held a very high position because they knew that the solstice took place about the time of the helical risings of certain stars. Owing to the precession of the equinoxes, the same star could not be used indefinitely, and it is possible to correlate the times of the buildings of some of their temples with our modern calendar, by calculating the times of the helical risings of some of the principal stars. The solar temple of Amen-Ra at Karnak was so oriented that at the summer solstice the setting sun was able to shine through the entire length of the temple and illuminate a golden image in the sanctuary, and the worshippers saw, not the image itself, but "the presence of the god Ra himself in the sanctuary".

The subject is continued in an article in the January issue of *Sky and Telescope* which deals with Chinese and Babylonian astronomy, in so far as a knowledge of the subject was applied to the orientation of temples. Reference is also made to Solomon's Temple, which was so oriented that the rays of the rising sun at the spring and autumn equinoxes penetrated to the Holy of Holies and were reflected by the jewels of the high priest. The basilica of St. Peter's, Rome, is placed due east and west, so that the rays of the rising sun at the vernal equinox can illuminate the high altar at the end of the nave. These articles present many interesting features and explain the orientation of public buildings thousands of years ago when astronomical knowledge was often deliberately concealed from the people, thus enhancing the prestige of the priest-astronomers.

Poliomyelitis in Chile

ACCORDING to a recent official report, only 99 cases of poliomyelitis were observed in Chile during the period 1937–41. 84 of the cases occurred in children less than two years of age, and only one in the age group 5–10 years. No case was observed in persons above ten years of age. Of the 99 cases, 98 showed motor weakness of the lower extremities, and in 11 the paralysis involved the upper extremities also; in one third of the cases the paralysis was bilateral.

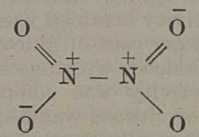
Institute of Physics: Australian Branch

PROF. A. D. ROSS, professor of physics in the University of Western Australia, has been elected president of the Australian Branch of the Institute of Physics. The previous presidents have been Prof. T. H. Laby of Melbourne and Prof. Kerr Grant of Adelaide. Dr. Ross has been local honorary secretary of the Institute in Australia for some twenty years, and he was the first to suggest the formation of a branch of the Institute in Australia. The Branch now includes more than 120 fellows and associates, apart from subscribers and students, and active divisions meet regularly during the year in Melbourne, Perth and Sydney.

Pharmaceutical Scholarships for Chinese Students

THE Pharmaceutical Society of Great Britain announces that five pharmaceutical manufacturers have each agreed to give scholarships to enable pharmaceutical graduates from China to take a two years course at the University of London. They would then return to China to help to train the 50,000 pharmacists required for General Chiang Kai-shek's ten-year plan for public health services. The donors of the scholarships are Messrs. Allen and Hanburys, Ltd., London; Messrs. Boots Pure Drug Co., Ltd., Nottingham; Messrs. Evans, Sons, Lescher and Webb, Ltd., Speke, Liverpool; The Wellcome Foundation, Ltd., London; and Messrs. May and Baker, Ltd., Dagenham. The suggestion for such scholarships came from Mr. A. H. Bentley, a pharmacist who escaped from the Japanese in Hong Kong. It is expected that the cost of each scholarship will be £1,400.

ERRATUM. In the communication by H. C. Longuet-Higgins in NATURE of April 1, p. 408, formula (iii) should read



The term "nitrogen tetroxide" should have been used throughout, instead of "nitrogen peroxide".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Antibiotic from *Aspergillus parasiticus*

RECENTLY we had occasion to examine the possible production of antibacterial materials by about twenty strains of *Aspergillus flavus*, *A. oryzæ*, *A. tamarii* and *A. parasiticus*. The culture fluids showed no significant antibacterial titres when a medium of the Czapek type was used; the test organism was *Staphylococcus aureus* and both the serial dilution method and the plate test[1] were used. When the medium contained bactotryptone or 7–8 per cent of corn-steep liquor together with 4 per cent of glucose and inorganic salts, several of the strains of *A. flavus* and *A. tamarii* produced culture fluids which were weakly antibacterial, being completely inhibitory at dilutions of 1 : 30–80 after 5–14 days incubation at 22–24°. Far superior were the filtrates obtained from four strains of *A. parasiticus*, which gave titres of complete inhibition of 1 : 200–600 after 5–12 days at 24°. A concentrate of the product of one of these four strains was obtained by absorbing the antibacterial principle on charcoal and eluting with aqueous acetone, 50 per cent of the activity being so recovered.

It was later found that in presence of corn-steep liquor additional inorganic salts were unnecessary for the production of antibacterial activity, though copper (1 : 100,000) had a very marked effect on the growth of *A. parasiticus*: with added copper the mould grew luxuriantly with rapid formation of olive-green spores; in its absence, growth was less vigorous and the mycelium remained lemon-yellow for the whole period of growth (up to 14 days). Even added carbohydrate was unnecessary, for the full antibacterial titre developed in 7·5 per cent corn-steep liquor adjusted to *p*H 7 (the sample of liquor contained a small amount of fermentable carbohydrate). Experiments on the length of incubation using varying amounts of glucose in the culture medium threw some light on the probable reason for the apparent superiority of *A. parasiticus* over *A. flavus*. The former grown in 7·5 per cent corn-steep liquor with 0·5 per cent additional glucose produced maximum antibiotic activity in 4–5 days; the antibacterial titre decreased after 7–8 days though appreciable activity was still present after incubation for one month. With two strains of *A. flavus*, however, activity was markedly more transient, and in one case had disappeared on the ninth day of incubation. The glucose content of the medium had a pronounced effect on the *rate* of production of activity by both species. In cultures of *A. parasiticus*, addition of 2 per cent of glucose (compared with 0·5 per cent of glucose) caused a delay of 48 hours in the production of similar activity, the maximum being reached only on the eleventh day. *A. flavus* cultures showed a similar time-lag, and in addition the maximum activity attained was considerably less in 2 per cent or 5 per cent of glucose than in 0·5 per cent of glucose; indeed, with one strain of *A. flavus* appearance of activity was completely suppressed when 5 per cent of glucose was used.

The products from all the strains of *A. parasiticus* grown with or without additional glucose or salts lost all activity on standing at *p*H 2 for 30 min. or at *p*H 11 for 30 min. The active material was extracted by ether, chloroform, or amyl acetate from aqueous solution at *p*H 2–3, and was recovered in aqueous solution by shaking the extract with a suspension of barium carbonate. The antibiotic was approximately as active against *B. fascians* (a Gram-positive plant pathogen) as against *Staph. aureus*, but was inactive against *B. coli*, *B. pyocyaneus*, *B. prodigeosus* and several other Gram-negative bacterial species.

In both chemical and antibacterial properties the new antibiotic resembles penicillin. Antibiotics of similar character have also been obtained from strains of *A. flavus* in surface[2] and submerged[3] culture and from *A. giganteus*[4], so that the production of such materials is evidently more generally possible than has been supposed. The antibacterial titres obtained from at least one strain of *A. parasiticus* are sufficiently high to make its culture of possible practical value. There is insufficient evidence to decide the identity of penicillin or other Aspergillus products with that from *A. parasiticus*, and it is provisionally proposed to designate the new product 'parasiticin'.

We thank Prof. I. M. Heilbron for his encouragement and the Rockefeller Foundation for financial assistance.

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Trypan Blue and Growth of the Adrenal Cortex in Mice

ACCORDING to a recent communication, Calma and Foster[1] have been unable to demonstrate centripetal cell migration in the adrenal gland of the rat by the use of trypan blue. Salmon and Zwemer[2], using the same vital stain, had previously reported inward cell movement. These last-mentioned workers injected the dye subcutaneously and found it taken up first by the cells in the capsule and after varying intervals by cells of the glomerulosa, fasciculata, and reticulosa successively, while the outer layers became dye-free.

More than two years ago, while I was working on the *X*-zone of the mouse, adrenal experiments similar to those of Salmon and Zwemer were started but discontinued with the publication of their report. The appearance of Calma and Foster's letter prompted a re-examination of old slides and a study of more mice. In one experiment five animals received ¼ c.c. of 1 per cent trypan blue for two days, and then left and right adrenals were examined separately after intervals of approximately six days; thus each animal served for two observations. The last adrenal was removed sixty days after the termination of injections.

Inspection of histological preparations of these glands supports the findings of Calma and Foster, namely, that this method yields no evidence of inward cell migration in the adrenal gland. Dye was present in the capsule of every gland, and in greatest amount (to judge by granular size) in the region of the glomerulosa and outer fasciculata.

Goldman[3], in 1909, reported blue granules in the majority of the cortico-adrenal cells of animals receiving excessive amounts of trypan blue. This was clearly demonstrated in one animal sacrificed after 28 successive injections of ¼ c.c. of 1 per cent dye. Granules were found not only in all areas of the cortex but also in the cells of the medulla. Thus it would appear that the capsule, glomerulosa and outer fasciculata preferentially store the stain, but that when an immoderate quantity is supplied to the organ the other cells are called to aid in the storage process.

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Microbiological Assay of Riboflavin

EXPERIMENTS in these laboratories using *Lactobacillus helveticus* for riboflavin assay by the method of Snell and Strong[1] have brought to our notice the importance of the temperature of incubation of the cultures.

Position in Incubator	Front						Middle								Back
Tube No.	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
ml. 0·1 *N* NaOH	3·4	3·55	3·6	3·95	4·05	4·15	4·9	4·45	4·15	3·85	3·75	3·75	3·7	3·65	3·55
Tube No.	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2
ml. 0·1 *N* NaOH	3·5	3·7	4·0	4·0	4·2	4·15	4·55	4·25	4·3	3·85	3·65	3·8	4·05	3·95	3·7

Snell and Strong, and other authors of *L. helveticus* assay methods, advise that the cultures should be incubated at 37° C. We have found, however, that a somewhat higher temperature, in the neighbourhood of 41°–42° C., results in a considerable increase in acid production with a given sub-optimal dose of riboflavin. This is in accordance with Bergey's[2] statement that the optimum temperature for this organism is 40°–42° C. The decreased growth-response resulting from a deviation of 4°–5° C. from this optimum is appreciable and may easily be of the same order of magnitude as that produced by a 25 per cent decrease in riboflavin concentration. (The actual figure depends, of course, on the slope of the dose – response curve in a given experiment, and in cases where this is unusually flat a much higher figure is obtained.)

This observation, which so far as we are aware has not hitherto been reported, is not merely of theoretical interest. Indeed, we have found that the somewhat uneven distribution of temperature in an ordinary bacteriological incubator is sufficient to affect seriously the uniformity of response obtained in a series of identical tubes each containing a sub-optimal dose of riboflavin. The accompanying table shows the titration figures obtained when a series of identical tubes of medium, each containing 0·075 γ riboflavin per 10 ml., was placed in two adjacent rows across the middle of the incubator from front to back; the temperature indicated by the incubator thermometer was 37° C.

It will be seen that the tubes in the middle of each series have, in general, given much higher titration figures than those at the ends. The results are explained by the fact that in this particular incubator the front and back are cooler by some 3°–4° C. than the middle. Similarly, the sides of the incubator are hotter than the middle. The existence of such temperature gradients will not only influence the consistency of replicate tubes, but also the slope of a dose – response curve will obviously be affected by the position of the series in the incubator.

Ideally it is desirable that an incubator for this work should maintain a perfectly even temperature throughout. If this cannot be realized by the use of an internal fan or otherwise, the temperature effect can and should be allowed for in the calculation of the results of assays. Using the latter procedure, the re-calculated results are found to be much more uniform than the uncorrected figures, and the method becomes one of precision. Fiducial limits of 95–106 per cent ($p = 0{\cdot}95$) have been obtained when five tubes were used at each of five levels of standard and four of unknown. On this basis, 83–120 per cent fiducial limits could be obtained with a total of eight tubes (four standard, four unknown).

The basis of these assay methods is that the vitamin under test should alone be the limiting factor influencing growth. It seems, therefore, that unless *either* stringent precautions are taken to ensure uniformity of incubation temperature, *or* appropriate allowances made for non-uniformity, errors of appreciable magnitude may be introduced. On the other hand, the application of statistical treatment appropriate to the conditions renders the method one of high precision.

Further work is in progress and will be reported more fully in due course. We are indebted to Mr. E. C. Fieller for the statistical analysis of our results.

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Mathematics of Biological Assay

D. J. FINNEY observes[1], in effect, that the data of a four-point assay in which the apparent response curves are not parallel do not allow us to distinguish between two conceivable causes of non-parallelism, namely, (1) non-linearity of the fundamental response curve, and (2) real dissimilarity between the response curves of standard and test material; and that while the first does not invalidate the assay[2,3], the second does. To this we may add that the smaller the difference between the overall mean responses to standard and test material the more reason there is to attribute non-parallelism to the second cause. The whole matter is particularly relevant to the vitamin A assay, which employs a non-vitamin A standard and in which there are therefore no "strong *a priori* reasons for believing that the standard and test

preparations have response curves of identical form"[1]. In this laboratory, statistical check is kept on the difference between the constants of slope for standard and test material (which is equivalent to a check on the value of T, as defined by Finney). No significant deviation has, in fact, been found, but it cannot be assumed that this would apply to other regimes.

Finney's formula for the exact fiducial limits of M, the log dose-ratio between standard and test material, is algebraically identical with that recently discussed by Irwin[4], and its importance is perhaps not widely enough realized. May I suggest a version that is fairly simple to handle ?

Adopting Finney's notation, we may write the fundamental formula for M as

$$d\frac{S \pm t_S\varepsilon_S}{R \pm t_R\varepsilon_R}, \quad \ldots \ldots \quad (1)$$

using separate t's and ε's because in practice R and S are often based on different numbers of animals. The limits of error alone may be written, in approximation,

$$\pm d\frac{S}{R}\sqrt{\left(\frac{t_S\varepsilon_S}{S}\right)^2+\left(\frac{t_R\varepsilon_R}{R}\right)^2}. \quad \ldots \quad (2)$$

Now if the standard error of the slope is more than 13 per cent (that is, if $\varepsilon_R/R > 0{\cdot}13$) this approximation is insufficient, and each R in (2) must be replaced by $\sqrt{R^2 - t^2_R\varepsilon^2_R}$. The mid-point of the resultant, wider, error range then shifts to

$$d\frac{S(R^2 - 2t^2_R\varepsilon^2_R)}{R(R^2 - t^2_R\varepsilon^2_R)},$$

although, of course, dS/R still best expresses M.

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Age of the Saline Series in the Salt Range of the Punjab

OF all the debated questions of Indian geology there has been none so baffling as the age of the Saline Series in the Punjab[1]. The selected references cited will give an idea of the controversy that has raged round the question, still by no means closed. Two main theories are now in the field : (*a*) that in the eastern part of the Salt Range the Cambrian sequence, with the Purple Sandstone at its base, lies 'normally' over the Saline Series, which therefore must be Lower Cambrian or pre-Cambrian[2] ; (*b*) that the Saline Series is of early Tertiary age and that its inferior position is due to an immense overthrust of post-Nummulitic date which has pushed the older beds bodily over it[3].

Fossils found in the Saline Series in recent years have repeatedly suggested that the beds are early Tertiary or even younger. But the value of this evidence has been questioned : either the specimens were found on scrutiny to be indeterminable or serious doubts arose as to their having been found *in situ*. It has been rightly argued that in such a highly soluble and plastic substance as the Salt Marl, extraneous material might easily have penetrated through solution holes or have been enveloped during relatively modern earth movements, of which there is ample evidence[4]. In view of these objections, I collected, during a recent visit to Khewra (October 5, 1943) and to Warchha (October 14), some lumps of rock-salt with intercalated thin laminæ of saline earth or 'kallar' from positions deep within the salt mines, with the view of examining the kallar for possible microfossils. Here the kallar lies closely interlaminated with the salt, in beds which run continuously for long distances and which, although often highly tilted, show no other visible signs of disturbance. If, as Christie[5] has shown, these saline deposits are a product of normal sedimentation from salt lakes or lagoons, and if these lakes were exposed to the air at a period when land vegetation existed in any degree of profusion, we might reasonably expect to find, among the dust that blew on to the water's surface or in the material that was washed in, at least some microscopic specks of organic matter giving a clue to the life of the period. Further, as between the Cambrian and Tertiary, it should be easy to clinch the matter over a single such speck found *in situ*, provided only that it could be referred to a known group of land plants.

In quest of such a clue I examined a dozen specimens, some collected, as stated, by myself from different places in the mines (with the kind permission of Mr. C. Phillips of Khewra and Mr. B. S. Lamba of Warchha), others kindly sent me last December by Mr. Lamba from the Warchha mine. The order of thickness of the kallar bands in the specimens examined is indicated by the following examples : 1·5 mm. (thinnest), 9 mm., 12 mm., 22·5 mm. (thickest). There is no question here of any cracks or solution holes, nor of any foliation imposed by thrusting or shearing forces such as Dr. Murray Stuart (*loc. cit.*) advanced in explaining the laminated appearance of these deposits.

The investigation of this material has given results beyond all expectation : the bands of kallar must be teeming with signs of life, for every single piece has yielded microfossils. These specks readily float up to the surface where they can, as a rule, be picked out at once by stabbing the film of water with a needle dipped in safranin, which rapidly spreads out and stains all organic fragments. The great majority are undeterminable as to genus and species, being mainly shreds of angiosperm wood, but there are also gymnosperm tracheids with large round bordered pits, and at least one good, winged, six-legged insect with compound eyes. These facts suffice to prove that the Salt Marl of the Punjab cannot possibly be Cambrian or pre-Cambrian as suggested, among others, by Dr. Murray Stuart, Sir Cyril Fox, and now also by Mr. E. R. Gee, until recently a strong advocate of the Eocene view. So, after all, it turns out that the position of the Saline Series beneath the Palæozoic sequence can only be explained, as was first pointed out by Koken and Noetling more than forty years ago (long before we knew any fossils from the Marl), by postulating an overthrust fault of great magnitude.

The main facts here briefly recorded were discussed in a recent address at Hyderabad Deccan[6], where also some of the fossils found by Mr. B. S. Trivedi and myself were described in a joint paper[7]. We are now examining further material, including the gypsum associated with the salt, and the 'oil shales' underlying the Marl near Warchha. We would

be grateful to geologists for any samples of saline deposits of disputed age from non-Indian sources, especially for authentic *in situ* material from the Iranian saline beds which Boeckh, Lees and Richardson have regarded as Cambrian, but which may be of the same age as the Kohat and Punjab salt.

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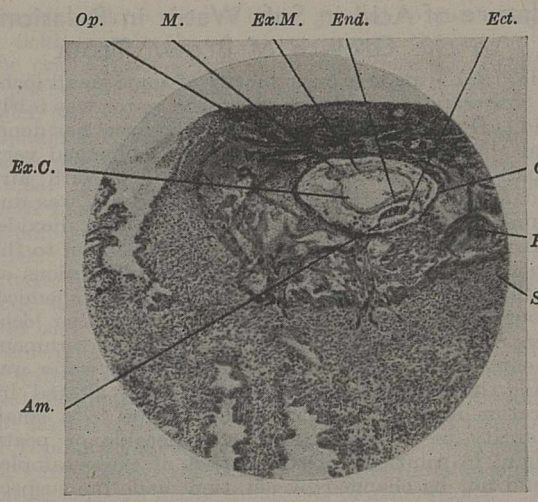
A Human Embryo, Nine to Ten Days Old

A normal previllous human ovum, estimated from both its histological study and the precise menstrual and coital history of the patient to be nine to ten days old, was found in the uterus removed from a young married woman. In its detailed structure it appears to show minor differences from the ovum *Wi*-8004 recently discovered by Rock and Hertig[1] and estimated by them to be 9·5 days old, although the comparison is based solely on a photomicrograph of one section of the latter ovum and the short preliminary report thereon so far published. These two ova represent the earliest specimens of fully implanted human ova yet discovered, and the present specimen shows several features of importance in the early organization of the human embryo.

Heuser and Streeter[2] stressed the precocious formation of the primitive mesoblast in the macaque monkey as compared with other mammals; the present specimen shows that in the human the formation of primitive mesoblast (*M*) is even more precocious. The germ disk has a diameter of 0·117 mm.; that in the 11·5-day Hertig-Rock ovum[3] is 0·138 mm. It consists of a single layer of columnar ectodermal cells (*Ect.*) and a single layer of cubical endodermal cells (*End.*); these two layers have been artificially separated in the process of preparation and no mesoblast penetrates between them. The thin exocoelomic (Heuser's) membrane (*Ex.M.*) is complete, in contrast with that in the 11·5-day Hertig-Rock ovum[3], and, together with the endodermal plate, it encloses the exocoelomic coelom (*Ex.C.*) or primitive yolk-sac. The definitive yolk-sac has not yet developed. The sudden transition of the cubical endodermal cells of the disk to the flattened cells of the exocoelomic membrane favours Heuser's view[4] that, whereas the endoderm is derived from



Section through equatorial region of embryo. (×45.)

the formative cell mass, the membrane is formed from the mesoblast. Likewise the change from the columnar ectodermal cells to the flattened cells of the amnion (*Am.*) support the view of Ramsey[5] and Heuser and Streeter[2] that the amnion is mesoblastic in origin. The amnion is not yet complete and deficiencies in its roof are closed in by cytotrophoblast (*C*); here transition cells are found between cytotrophoblast and amnion. The plasmoditrophoblast (*P*) contains lacunæ in various stages of formation; maternal blood is found only in those lacunæ on the abembryonic (superficial) side of the ovum, elsewhere they contain leucocytes.

In the aborted ova described by Bryce and Teacher[6] and von Möllendorff[7], a zone of necrosis of the endometrium was observed surrounding the ova; consequently the belief was held for some time that implantation of the ovum was normally accomplished by necrosis of the maternal tissue. That this is not the case is indicated in the present specimen by the fact that normal stroma (*S*) abuts on the trophoblast. The operculum (*Op.*), indicating the site of entry of the ovum into the endometrium, consists of a mixture of fibrin and leucocytes permeated by plasmoditrophoblast. Ovulation was deduced to have occurred on the ninth day of the menstrual cycle of twenty-eight days; to this early time of ovulation is attributed the fact that the endometrium is as far advanced in the secretory phase on the twentieth day in the present specimen as that on the twenty-fourth or twenty-fifth day in a number of other specimens examined from women in whom ovulation probably occurred nearer the middle of the cycle.

A full account of this specimen is being published elsewhere.

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Feb. 25.

[1] Rock, J., and Hertig, A. T., *Amer. J. Obstet. Gynecol.*, **44**, 973 (1942).

[2] Heuser, C. H., and Streeter, G. L., *Contrib. Embryol. Carnegie Inst. Wash.*, **29**, No. 180, 15 (1941).

[3] Hertig, A. T., and Rock, J., *Contrib. Embryol. Carnegie Inst. Wash.*, **29**, No. 184, 127 (1941).

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[5] Ramsey, E. M., *Contrib. Embryol. Carnegie Inst. Wash.*, **27**, No. 161, 67 (1938).

[6] Bryce, T. H., and Teacher, J. H., "Contributions to the Study of the Early Development of the Human Ovum" (Glasgow, 1908), 7.

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Nature of Acid in Soft Water in Relation to the Growth of Brown Trout

IN 1937 I made a brief survey of some small lochs in Sutherland, in some of which the water was fairly acid (*p*H 4·5). I found, as Captain Sawyer[1] has done, that the *p*H of these waters could be changed very rapidly towards neutrality by shaking with air; and I concluded, like him, that the acidity was due mainly, if not entirely, to dissolved carbon dioxide.

An account of these observations was given to the British Association in 1937[2], and my deductions as to the cause of the acidity were criticized on chemical grounds. Later, further samples from these lochs were collected and were examined by the Government Chemist. He reported (*in literis*) that the water was acid, that the *p*H was not noticeably altered by aeration and that the acidity was due to a small quantity of a strong acid, of vegetable or peaty origin, in solution. That the *p*H of these samples could not be changed by aeration made me suspect that conditions in these lochs had changed and, by correspondence, I ascertained that this was so. The samples examined by the Government Chemist were taken after a period of heavy rain and were brown in colour, whereas mine were taken after some weeks of drought and were virtually colourless. It was hoped to continue these observations, but a change of programme and then the War have so far made it impracticable.

The conclusion is that Captain Sawyer has produced supporting evidence for the view that the acidity of the waters of these lochs may at times be due to carbon dioxide, but that the presence and importance of 'humic' acids can by no means be ignored.

Whether these factors have any direct bearing on the varying sizes attained by trout in different waters is open to considerable doubt. When Southern[3] produced the hypothesis that the growth of trout was directly related to the composition of the water in which they were living, he started a hare which many of us have followed for varying distances. I now believe that the solution of the problem is to be sought in the relation between the trout population and the food supply. That this line of attack has formerly been found to be unpromising[4,5] is due to over-emphasis of the latter factor and neglect of the former. It happens that, in soft or acid waters, spawning conditions for trout are often ideal, for the rocks are hard and the redds are consequently free from silt. Hence the percentage hatch is large[6] and the survival-rate continues to be high because the predatory fishes such as pike, perch and chub are absent from such waters. The pressure on the available food is accordingly great, and trout, with their extraordinary lability, respond to the conditions by a general decrease in growth.

In waters where the survival-rate is low, owing either to poor spawning ground or to the presence of predators, the trout grow big, whether the water is acid or alkaline[3].

It is hoped, when time permits, to develop this thesis in a paper in *Biological Reviews*.

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[1] Sawyer, R. E., NATURE, **153**, 55 (1944).
[2] Pentelow, F. T. K., *Rep. Brit. Assoc. Adv. Sci.*, 364 (1937).
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[4] Southern, R., *Proc. Roy. Irish Acad.*, **42**, 87 (1934–35).
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[6] Hobbs, D. F., *New Zealand, Marine Dept., Fish. Bull.*, 6 (1937).

Achilles and the Tortoise

PROF. F. G. DONNAN has submitted[1] a very interesting application of the exponential function. I think, however, that his first equation is not altogether accurate. I suggest that the following is rather more realistic.

If y and x are the distances of Achilles and the tortoise from a fixed datum, then

$$\frac{dy}{dt} = 10pe^{-\lambda t};$$

when $t = 0$, $y = 0$ and the constant of integration will be $10p/\lambda$ and

$$y = \frac{10p}{\lambda}(1 - e^{-\lambda t}).$$

$$\frac{dx}{dt} = pe^{-\lambda t};$$

when $t = 0$, $y = d$, their distance apart at the start.

So that the constant of integration is $\frac{p}{\lambda} + d$, and

$$x = d + \frac{p}{\lambda}(1 - e^{-\lambda t}).$$

If D is their distance apart after time t,

$$D = x - y = d - \frac{9p}{\lambda}(1 - e^{-\lambda t});$$

when $t = \infty$, $D = d - \frac{9p}{\lambda}$.

So D may be positive, negative or zero, which rather disproves Zeno's paradox.

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[1] NATURE, **153**, 142 (1944).

THE statement of Group-Captain G. S. Roberts, that the first equation in my letter to NATURE to which he refers "is not altogether accurate", would appear to mean that it does not cover the general case of a tortoise with any possible start. It was made clear in my letter, however, that this equation applies only to the case of a tortoise with a *specified* start, namely, 10 units of distance. In this particular case I showed how it was possible, by a special adjustment of the ratio p/λ, to secure the result that Achilles would overtake this *particular* tortoise only in an infinite time. Given this particular (adjusted) value of p/λ, it follows that, for tortoises travelling according to the same law of speed, those with a start of less than 10 will be overtaken in a finite time, whereas those with a start of greater than 10 would not be overtaken by Achilles even in an infinite time.

It is, of course, a very simple matter to give a general algebraic statement valid for tortoises with all possible starts, but I did not consider that the interest of the problem warranted any further elaboration. It was, however, amusing to note that by a suitable adjustment of p/λ one could always make a 'cut' in the infinite set (of tortoises). This point has been well taken in an interesting letter which I have received from Mr. W. J. Chater of Northampton.

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RESEARCH ITEMS

Promin Treatment of Leprosy

IN a recent paper (*Public Health Rep.*, 58, 1729; 1943) G. H. Paget, R. C. Pogge, F. A. Johansen, J. F. Dinan, B. M. Prejean and C. G. Eccles of the United States Marine Hospital (National Leprosarium), Carville, La., record their observations on the treatment of leprosy by promin, the sodium salt of *p.p.*diamino-diphenyl-sulphone-*n.n.*didœstrose sulphonate in a paper based on the study of forty-six cases. Their conclusions are as follow. (1) Promin is the sulphonamide drug which so far seems to possess to the greatest extent some chemotherapeutic properties against leprosy. (2) While no direct evidence of a specific bacteriostatic or bactericidal action against *M. leprœ* has been demonstrated, it has been observed that promin seems capable of inhibiting the progress of leprosy in a considerable number of cases. (3) Promin can be safely administered intravenously for prolonged periods provided the blood and urine are examined frequently. Toxic manifestations, of which hæmolysis is the most important, are relatively few and mild. (4) Further experimental and clinical studies on the treatment of leprosy with promin are required before more definite conclusions can be drawn.

Blennioid Fishes

EARL D. REID has published a review of the genera of blennioid fishes related to Ophioblennius (*J. Washington Acad. Sci.*, 33, No. 12; Dec. 1943). The work is based on examination of material in the collections of the United States National Museum from the tropical Atlantic and Pacific Oceans. The author recognizes five genera of these fishes, two of which, Leoblennius and Bleniella, are new. Keys are given to the genera and to the ten species referred to Ophioblennius, which is widely distributed in the tropical Atlantic, along the west coast of Africa and from the West Indies to Trinidad. In the Pacific it occurs from the coast of southern California to the Galapagos, Chile to the Marquesas, and the Hawaiian Islands. No species, so far, has been found away from the island or group of islands from which the type was recorded. Most of the species collected have been attracted to an electric light and captured in a dip net used from the ship's side while at anchor.

A Canadian Dinosaur

IN 1924 Dr. Gilmore described as *Troödon validus* a remarkable Canadian Cretaceous Dinosaur which combined a small but greatly thickened skull with a lightly built bipedal body. In 1939 the American Museum of Natural History secured a similar but much larger skull from a higher horizon in Montana. This animal has now been described by Barnum Brown and E. M. Schlackjer (*Bull. Amer. Mus. Nat. Hist.*, 82, Art. 5) as *Pachycephalosaurus grangeri*. This remarkable skull is two feet long—three times the size of Troödon—and the dome-like mass of bone over its cranial cavity is from six to nine inches in thickness, while the ventral parts, the palate, etc., are relatively slender. The greatly thickened parietal and frontal bones are known to be composed of finely cancellar bone with dense laminæ running out to the surface in Troödon, and are no doubt of similar structure in the new form. No suggestion has yet been made to account for this development. It can scarcely be protective, because the lightly built slender neck, body and limbs present so much larger a field for attack. A very similar thickening of the cranial roof is found in the Permian Tapinocephalid Deinocephalia, which are very far removed from the Dinosaurs. Indeed, the skull of Pachycephalosaurus mimics in a remarkable way that of these animals; it is of about the same size, has similar general proportions, and has very small teeth much like those of Mormosaurus; and in Tapinocephalids the parietal may be at least 6 in. thick. But the bodies of the members of the two groups are grotesquely unlike; the Deinocephalian body was a great barrel-like structure supported by four short, immensely massive legs, in contrast to the slender body and limbs of Troödon, and its habit of walking on the hind feet alone. It is, in fact, evident that the great thickening of the skull roof of Troödonts has no direct adaptive significance; it, and also that of Tapinocephalids, must be secondary effects resulting presumably from some endocrine unbalance persisting through many thousands of generations.

Hessian Fly Resistance in Wheat

W. B. NOBLE (*J. Agric. Res.*, 67, 27; 1943) shows that Dawson wheat contains two non-allelomorphic factors for resistance to Hessian fly. The progeny of Dawson × Poso and × Big Club, which are susceptible, have been examined. It was found that the two factors separately confer less resistance to Hessian fly attack than in a combined condition. By scientific breeding using this knowledge, recombinants containing both resistant factors have been produced.

Eye Responses of Drosophila Mutants

H. KALMUS (*J. Genetics*, 45, 206; 1943) has studied the optomotor response of different mutants in Drosophila and shows that wild type females with more ommatidia than males follow striped patterns better, whereas a reduction of ommatidia in the Bar series causes a reduction in the degree of response. Eyeless strains of *D. pseudo-obscura*, with about twelve facets, show no response. Homozygous vestigial winged flies react best of all stocks tested, while yellow, black and ebony mutants were similar to wild type. White-eyed flies, W/w, do not react to the striped pattern while homozygous brown-cinnabar flies and apricot flies and homozygous brown-vermilion flies react less than the wild type.

Ionization and Chromosome Breakage

D. G. Catchside and D. E. Lea (*J. Genetics*, 45, 186; 1943) have continued their work on the effect of X- and other rays upon chromosome breakage. They had previously shown that breakage resulted from a minimum of seventeen ionizations per break. They now compare the effect of ionizations from X-rays of different wave-length. The coefficients of chromatid breakage are highest with $\lambda = 4{\cdot}1$ A. and fall off through $\lambda = 1{\cdot}5$ A. to medium X-rays $\lambda = 0{\cdot}15$ A. to Al*K* radiation $\lambda = 8{\cdot}3$ A., where they are least. This is interpreted to mean that only the densely ionizing tails of the electron track are effective in chromosome breakage and that the tails have a higher efficiency only where they traverse the chromatid. When the radiation is performed respectively on pollen grain divisions and pollen tube divisions of Tradescantia, there is a difference in the coefficient of aberrations. The authors show that there is equal probability of survival of chromatid breaks in both

divisions, but interchange in the pollen tube is reduced by the cylindrical shape as compared with the spherical pollen grain nucleus.

New Plant Diseases

Lilian E. Hawker and B. Singh have described a disease of seedling lilies (*Trans. Brit. Mycol. Soc.*, **26**, Pts. 3 and 4; Dec. 1943). This was caused by the fungus *Fusarium bulbigenum*, which has hitherto been reported as a pathogen of mature bulbs. The fungus can enter unwounded roots of seedlings and of *Lilium regale*, but cannot enter unwounded bulb scales. Infection from pure cultures of the pathogen produced the typical damping-off symptoms. Application of formalin dust to the seed boxes before sowing gave good control. C. J. Hickman and D. Ashworth record, in the same journal, the occurrence of Botrytis spp. on onion leaves. Three species of Botrytis are apparently involved. *B. squamosa*, recorded for the first time in Great Britain, was the predominant organism, and the others were the ubiquitous *B. cinerea* and another form as yet unidentified. Infection was limited to autumn and winter, and plants usually grew away healthy in spring and summer.

Archæan Rocks of South Harris

FOLLOWING up the pioneer work of Craig and Jehu on the geology of the Outer Hebrides, a detailed study of the Archæan gneisses of the Rodil district of South Harris has been made by C. F. Davidson (*Trans. Roy. Soc. Edin.*, **61**, 71; 1943). The oldest rocks are paragneisses representing a series of shallow-water sediments which included impure dolomitic types. These sediments were intruded by a complex of anorthosite and banded gabbro and norite accompanied by small ultrabasic intrusions. High-grade regional metamorphism followed, leading in general to the formation of eclogite and garnetiferous granulites or charnockites, together with calc-silicate rocks and garnet-kyanite-gneisses. Next came a phase of migmatitization due to the passage of a wave of volatiles through the rocks, whereby plagioclase was locally transformed to scapolite, pyroxene to hornblende and garnet to kelyphite. The final phase consisted of the formation of thick sheets and dykes of acid pegmatite. At a much later stage, possibly Caledonian, representatives of all these rocks were involved in a zone of intense shearing and dislocation, mainly along the east coast of the area. Within the shear zone ultracataclastic structures were developed, and on most of the gneisses close to the shear zone there was imprinted the epidote-saussurite facies characteristic of low-temperature alteration. The paper contains several new chemical analyses and is notable for a valuable discussion of the nature and mode of origin of eclogites and charnockites.

Scattering of Light by Small Particles

EXPERIMENTS to elucidate scattering in the sky and in optical instruments have been carried out by H. Zanstra, who has discussed his investigations on the scattering of light by small rock-salt crystals suspended in a saturated solution (*Mon. Not. Roy. Astro. Soc.*, **103**, 5; 1943). Faber produced artificial haloes in the laboratory by using suspensions of small crystals of various salts in their saturated solutions contained in a cell with parallel walls. Zanstra used Faber's method for producing scattering of a central image by small crystals of rock salt, and measured the intensity I of scattered light as a function of the distance r from the centre. A description of the experimental arrangement is given, and this is essentially that of Faber, except for the fact that monochromatic light is not used. For deflexions less than 20′, diffraction may account for the scattering in the given suspension, but for larger deflexions, between 20′ and 5°, the observations cannot be represented by the theoretical formula. In this case an empirical law connects the intensity with the distance r, the intensity varying as $1/r^{\alpha}$, with α equal to 2·28. This law is of the same type as that for long-range scattering about a stellar image, which was observed by Redman; the value of α in this case was 1·70. The main conclusions obtained suggest that the long-range scattering observed in celestial photographs arises from small ice crystals in the sky, such as are responsible for haloes, and it is believed that any kind of small particles in the atmosphere might produce a similar effect. Observations without rock salt show, however, that another part of the long-range scattering in astronomical observations may be due to the instrument, presumably by scattering of light by scratches, dust particles or edges of diaphragms.

Applied Electron Microscopy

IN a paper dealing with electron microscopy, J. H. L. Watson (*Canad. J. Research*, **21**, 89; 1943) points out its advantage when a large depth of focus is desirable. A typical value is 10 μ as compared with 0·4–0·2 μ with optical microscopes. Many electron micrographs are reproduced, covering smokes, mine dusts, paper coatings, and botanical objects (including cutin, which is shown to assume a fibrous nature on older plants). It is suggested that the electron microscope may find application in the study of chromosomes, although it is emphasized that the use of the instrument in botany involves considerable time, experimentation, and skill in suitable preparation. Most of the magnifications shown are of the order of 1,000–1,500, but some (mine dusts) are of 16,100. No details of the electron microscope are given, but a special object holder is described.

Acids and Bases

THERE are two general theories of acidic and basic function. The first, generally known as the Lowry-Brönsted theory, is represented by the scheme $B + H^+ \rightleftharpoons BH^+$, where H^+ is the proton (an acid being defined as a source of protons) and B a base (for example, a weak acid anion, OH^-, an amine, etc.). In the second theory, proposed by G. N. Lewis (1938), a base is a species having a free electron pair which can enter the shell of another atom, and an acid a species which can accept such an electron pair: $A + : B = A : B$. This introduces no new bases but it insists that the proton is only one of many species which can accept an electron pair and so combine with a base, and such molecules as BCl_3 are regarded as acids. G. F. Smith (*J. Chem. Soc.*, 521; 1943) has pointed out that the hydrolysis of the chloroacetate ion, investigated by H. M. Dawson, E. R. Pycock and G. F. Smith (*ibid.*, 517), and of the bromoacetate ion, is subject to general basic catalysis, and the Brönsted catalysis relation holds for a series of basic catalysts, but not for certain cases. In the reactions no proton transfer can be involved, and this is in agreement only with Lewis's definition; the Lowry-Brönsted definition appears to be too narrow.

EDUCATIONAL RECONSTRUCTION IN INDIA

AT the thirty-first Indian Science Congress held in January, the presidential address delivered by Mr. John Sargent before the Section of Psychology and Educational Science deserves more than a passing notice, because of the practical and comprehensive manner in which he dealt with the enormous problem of educational reconstruction in the Indian Empire.

Mr. Sargent began at the very beginning by asserting that the cause of real education has not been helped by "the tendency of woolly-minded philosophers to assume that education with a big E is necessarily a good thing". The totalitarian countries, he points out, have given a timely reminder that education can be as powerful a means of corrupting as of improving the mentality of a nation. But it has always been an instinct of human nature to want to know about things, both to satisfy curiosity and to ensure the preservation of the race by enabling it to assert control over its environment. No free nation which has once had a system of education would submit to be deprived of it. The Indians, of all people, need it, because they now range themselves among the United Nations, pledged to the ideal of democracy, and "democracy, like education, is not necessarily a good thing. It is the sort of democracy that matters." If a little learning in an individual is a dangerous thing, a little learning in a nation is not less dangerous. An India, "85 per cent of whose population are illiterate and liable, as we have seen in recent years, to be stampeded by political or religious excitement, however irrational, constitutes a field for mischief-makers". In other words, India owes it to her allies the world over to overhaul her educational provision thoroughly. "Whatever may satisfy government or big business or all the other vested interests whose vision is oblique or retrospective, the logic of any post-war settlement will demand a drastic change in the present state of things".

Upon such a foundation of principle, Mr. Sargent proceeded to raise a superstructure of Indian education as, in his belief, it ought to be, and in course of time can be. His minimum programme is comprised under a dozen headings, familiar to an English reader. They include compulsory and free schools from five or six to fourteen years of age, a reasonable supply of nursery schools, secondary schools of different types, university education for picked students, technical, commercial and art education, adult education of all kinds and standards, teachers' training institutions, special schools, recreational facilities, employment bureaux, and an efficient system of administration. Judged by the system in Great Britain, this is not an extravagant programme. Mr. Sargent then turned to consider how far the Indian system, as it exists to-day, falls short, and whether it is practicable to build upon it a national system on the lines suggested.

Mr. Sargent takes each item of his minimum programme, and deals with it faithfully. Less than one out of every four children stay long enough at school to attain "permanent literacy", so that the money spent on the others (nearly 80 per cent) may be regarded as wasted. In India, as elsewhere, only a tiny part of the vast army of teachers required enter the profession because they feel called to it; the rest must be attracted by decent prospects of a living, and there India has an immense problem. Of buildings and equipment, at any rate in the lower stages, "the less said the better". There is an obvious need for a youth movement on an All-India scale; and so on through a rather depressing catalogue, which, however, does not prevent Mr. Sargent from courageously facing the problems of finance. There is, he says, reason to hope that "as education spreads among the rural population it may lead to the abandoning of those superstitions and prejudices which for centuries have hung like millstones round the neck of the Indian peasant". A competent observer has estimated that with the removal of these, the standard of living among agriculturists might be raised by as much as 100 per cent. "Given the will and given the funds," concludes Mr. Sargent, "it would in my opinion take at least 35 to 40 years to establish the sort of system outlined in this paper."

The outlook for India, as thus presented, seems by no means depressing. Vast India may be likened to a lot of little Englands put together, and in the England of a century ago illiteracy was nearly as common as it now is in India, and most forms of education did not exist or were struggling for life.

T. RAYMONT.

BASICITIES OF THE AMINOQUINOLINES: COMPARISON WITH THE AMINOACRIDINES AND AMINOPYRIDINES

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IN view of the use that has been made, in recent years, of the aminoquinolines as intermediates in the evolution of new drugs, it is surprising that no measurements of their strengths as bases have been published. Briefly, the history of these drugs is that the antimalarial, pamaquin, introduced in 1926 under the trade-name of 'Plasmoquine', was the first chemotherapeutic substance derived from an aminoquinoline; in 1937 three more aminoquinoline drugs appeared, namely, the wound-antiseptic 'Surfen' and the trypanocides 'Surfen-C' and Bayer 7602, the latter being intended as a specific for *T. cruzi* infections in South America. Later, 'Acaprin', another aminoquinoline drug, became established as a specific for certain piroplasmoses. In Moscow in 1937, Maghidson and Rubstov[1] discovered some malarial schizonticides in this series[2], but the development of new aminoquinoline drugs has taken place mainly in Germany: Iensch[3], even in 1937, was able to review the structure and activity of some hundreds of these compounds, and work of this kind has apparently gone on steadily[4].

The dissociation constants of the seven isomeric aminoquinolines have now been determined and are compared in Table 1 with the dissociation constants of the corresponding aminoacridines and aminopyridines. Because the acridine nucleus is numbered differently from the others, the table has been arranged with analogously substituted compounds opposite one another.

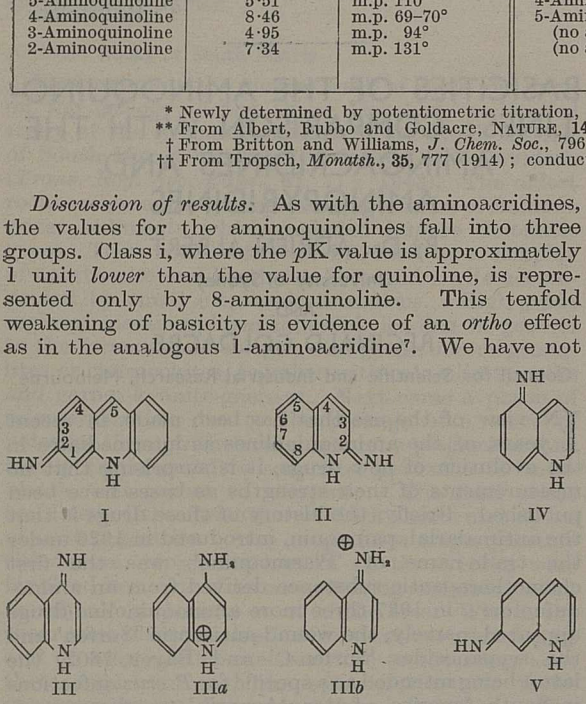
The favourable solubilities of the aminoquinolines has facilitated potentiometric titration of these substances in water (glass electrode; 0·001 gm. mol. in 60 mils). For comparison we reprint our results for the aminoacridines in 67 per cent methanol, since the sparing solubility of these compounds stands in the way of their accurate determination in water. As Mizutani[5] has indicated, *p*K values obtained in methanol of this strength are 0·3–0·9 unit too low, and hence a better approximation to the true values may be had by adding 0·5 unit to the aminoacridine results quoted here than by relying on figures obtained in water under conditions of non-equilibrium[6]. The three aminopyridines are freely soluble in water and we have taken the basicity figures (conductimetric) from the literature.

TABLE 1. FIRST DISSOCIATION CONSTANTS OF SIMPLE HETEROCYCLIC AMINES.
(Expressed as *p*K*a*, the negative logarithm of the acidity constant.)

Quinoline series	*p*K*a* in water at 20° C. *	Criterion of purity	Acridine analogues **	*p*K*a* in 67% methanol; 20° C.	Pyridine analogues	*p*K*a* in water
Quinoline	4·94	b.p. 132°/40 mm.	Acridine	4·54	Pyridine	5·21†
8-Aminoquinoline	3·93	m.p. 65°	1-Aminoacridine	3·68	(no analogue)	
7-Aminoquinoline	6·65	m.p. 94°	2-Aminoacridine	7·60	(no analogue)	
6-Aminoquinoline	5·62	m.p. 117°	3-Aminoacridine	5·30	(no analogue)	
5-Aminoquinoline	5·51	m.p. 110°	4-Aminoacridine	5·74	(no analogue)	
4-Aminoquinoline	8·46	m.p. 69–70°	5-Aminoacridine	9·34	4-Aminopyridine	9·1
3-Aminoquinoline	4·95	m.p. 94°	(no analogue)		3-Aminopyridine	6·6 †††
2-Aminoquinoline	7·34	m.p. 131°	(no analogue)		2-Aminopyridine	7·2
					ditto	6·86*

* Newly determined by potentiometric titration, glass electrode, 20° C.
** From Albert, Rubbo and Goldacre, NATURE, **147**, 332 (1941); glass electrode.
† From Britton and Williams, *J. Chem. Soc.*, 796 (1935); glass electrode, 18° C.
†† From Tropsch, *Monatsh.*, **35**, 777 (1914); conductimetry, 25° C.

Discussion of results. As with the aminoacridines, the values for the aminoquinolines fall into three groups. Class i, where the *p*K value is approximately 1 unit *lower* than the value for quinoline, is represented only by 8-aminoquinoline. This tenfold weakening of basicity is evidence of an *ortho* effect as in the analogous 1-aminoacridine[7]. We have not



yet established in either case whether this *ortho* effect is due to hydrogen-bonding or is simply a steric hindrance to the approach of the hydronium ion. Class ii, where the *p*K is not more than 1 unit *higher* than quinoline, contains the 3-, 5- and 6-isomerides, which are hence considered as the normal amino derivatives of quinoline. Class iii consists of derivatives which are considerably more basic than quinoline, notably 2- and 4-aminoquinolines, the latter being more than three thousand times stronger a base than quinoline. Although 7-aminoquinoline is only fifty times as strong as quinoline, comparison with the analogously constituted 2-aminoacridine indicates that it, too, is rightly placed in class iii.

What is the cause of these exaltations in basicity? In 1941 we suggested tentatively that in the acridine series such exaltations are connected with the fact that the isomerides exhibiting this property can be depicted tautomerically as imines; for example, formula I for 2-aminoacridine. In the quinoline series, only the 2-, 4-, 5- and 7-isomerides can be written in analogous fashion, as has been done in formulæ II, III, IV and V respectively.

A mechanism by which this possibility of tautomerism affects the basicities of the aminoacridines has recently been worked out[6] and is capable of expansion to include the aminoquinolines and aminopyridines.

Briefly, the ion of 4-aminoquinoline may be written as III*a*, which is derived from the normal form of the base, and also as III*b*, which is derived from the tautomeric imine III. The two forms of the *base* differ from one another in the position assigned to an atom of hydrogen, and hence, regardless of whether they can exist apart from one another, they cannot (by definition) be resonant with one another. On the other hand, the *ions* theoretically derived from them differ from one another only in the distribution of electrons and hence, provided that not too much of the unionized base's *nuclear* resonance is destroyed in the process (for example, by converting a benzene ring into an *ortho*quinonoid structure), the ions will exhibit a higher degree of resonance than the unionized base. The larger this 'extra ionic resonance energy' is, the greater will be the basicity of the amine because of the increasing tendency to pass over into the more stable ion. This serves to explain the exaltation of 4-aminoquinoline, which can readily change into the ion, which is a resonance hybrid of both III*a* and III*b*. As is usual where a high degree of ionic resonance is present, the second *p*K is greatly reduced. The exaltation in the analogously constituted 5-aminoacridine and 4-aminopyridine is of the same order.

The ion of 2-aminoquinoline can similarly be considered as a resonance hybrid derived from the normal amine and the tautomeric imine II, which is essentially an amidine. This base is weaker than 4-aminoquinoline because the resonance depends on an *ortho*quinonoid contribution; likewise it is very much weaker than the aliphatic amidines, where the base-strengthening resonance is facilitated by sym-

TABLE 2. 3-AMINOQUINOLINE.

Percentage neutralized	7	13	20	27	33	40	47	53	60	67	73	80	87	93
*p*K*a* value	5·04	5·05	4·96	4·97	4·96	4·94	4·95	4·93	4·92	4·94	4·92	4·94	4·96	5·09

metry and the absence of competition with nuclear resonance[8,9]. In 2-aminopyridine, where all Kekulé-type resonance has been lost in one contributing form, the exaltation is vanishingly small. This diminution in resonance by loss of a benzene ring is seen again in the diminished exaltation of 7-amino-quinoline V, as compared with its analogue, 2-amino-acridine. Finally, no extra ionic resonance is observed in 5-aminoquinoline (corresponding to practically none in 4-aminoacridine). This may well be because an ion derived from the imine IV, in addition to being *ortho*quinonoid (a structure that is relatively unstable and does not readily take part in ionic resonance[10]), must also lose both the Kekulé-type rings of quinoline.

An interesting by-path in these investigations has been the examination of our titration figures for 3-aminoquinoline in order to confirm the existence of the semi-hydrochloride that Mills and Watson[11] postulated on the grounds of colorimetric and cryoscopic anomalies. However, the constancy of the *p*K values obtained on adding one equivalent of hydrochloric acid to the base (Table 2) gives no indication of its formation.

While these simple aminoquinolines do not themselves possess marked chemotherapeutic properties, the main types of basicity discussed here will persist in their active derivatives. For example, pamaquin, a derivative of 8-aminoquinoline and the only aminoquinoline drug yet investigated, has a pK_a of 3·55[12]; similarly, in the acridine series the exaltation seen in 5-aminoacridine persists in its derivatives 'Rivanol' and 'Atebrin'.

Because bases with *p*K values below 6 are less than 10 per cent ionized at *p*H 7, while those with values above 8 are practically completely ionized, a biologically important difference exists between drugs based on different aminoquinolines, and this should not be overlooked in interpreting the action of known drugs and in devising new ones.

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EARTH-FAULT RELAY EQUIPMENT

A PAPER entitled "A Modern Earth-Fault Relay Equipment for use on Systems Protected by Petersen Coils" was read in London recently by L. B. S. Golds and C. L. Lipman before the Institution of Electrical Engineers, and in it the authors dealt with the automatic isolation or indication of earth-faults on such systems. After discussing the operating principle of this type of protection, describing the working of a wattmeter-type relay, and enumerating the electrical constants of the type of system to which the protection is applied, the paper describes the application of the relay to an actual 66-kV. system.

The currents in the feeders are analysed and the problem of accurate current summation is discussed in detail. A comparison is made between current summation by means of a summation transformer and by direct paralleling. Results are given of laboratory tests on current-transformers at currents approximating to the system capacitance currents. Further test figures are given showing the effect of load current in addition to capacitance currents. The design of the relay element, its constructional features and operating characteristics are described.

From experience gained on tests with artificial faults and under actual system earth-fault conditions, the relays were found to be quite reliable in operation, providing the equipment was connected correctly and the current-transformers were sufficiently accurate. When commissioning the gear, an artificial fault is valuable in proving the reliability of the equipment. By observing the operation of the relays at each sub-station with faults at selected points, the complete scheme can be put into operation with a minimum of testing. Preliminary tests are carried out by single- and three-phase injection to ensure that the transformers are balanced and that they comply with the specification.

These relays are being used in conjunction with phase-fault relays to switch-out one faulty line in the event of a double earth-fault, leaving the original fault on the system. The difficulty of extreme sensitivity has been overcome by the use of a resistance in series with the coil, which serves the double purpose of limiting the asymmetric current under healthy conditions and increasing the active component under fault conditions; this has the advantage of making the relay more robust.

FORTHCOMING EVENTS

Monday, April 17

Institution of Electrical Engineers (Cambridge and District Wireless Group) (at the Technical School, Cambridge), at 5.30 p.m.—Mr. B. J. Edwards: "A Survey of the Problems of Post-War Television".

Tuesday, April 18

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. Hans E. Adler: "Life in Soviet Turkestan".

British Society for International Bibliography (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 4.30 p.m.—Mr. H. Thomas: "Co-operative Cataloguing"; Colonel Luxmoore Newcombe: "The Library of Congress Depository Catalogue and Bibliographical Service at the National Central Library".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. D. Caradog Jones: "The Standard of Living".

Illuminating Engineering Society (joint meeting with the Science Masters' Association) (in the Large Physics Lecture Theatre, Imperial College of Science, Imperial Institute Road, South Kensington, London, S.W.7), at 5 p.m.—Following a short introductory Address a series of Experiments illustrating the Production and Nature of Light, Photometry, the Fundamental Principles of Illuminating Engineering, and the Advantages of Good Lighting will be demonstrated and discussed.

Institution of Electrical Engineers (Wireless Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Metals and their Finishes in Radio Construction" (to be opened by Dr. G. L. Sutherland).

Royal Photographic Society (Scientific and Technical Group) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. Y. A. C. Yule: "Unsharp Masks, a New Method of Increasing Definition in Prints".

Wednesday, April 19

Society of Chemical Industry (joint meeting of the Microbiological Panel of the Food Group, the Agriculture Group and the Association of Applied Biologists) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 11 a.m.—Papers on "Soil Sterilization". (Dr. W. F. Bewley: "Some Problems in Soil Sterilization"; Mr. W. J. C. Lawrence: "Soil Sterilization and Seedling Growth"; Mr. A. H. Dodd: "Considerations in Chemical Soil Sterilization"; Mr. H. Lees and Dr. J. H. Quastel, F.R.S.: "A New Technique for the Study of Soil Sterilization" (with Demonstration); Mr. H. Lees and Dr. J. H. Quastel, F.R.S.: "Effects of Chlorate Administration on Soil Nitrification").

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. C. Cameron: "Education To-day and To-morrow", 8: "School Broadcasting".

GEOLOGICAL SOCIETY OF LONDON (joint meeting with the INSTITUTION OF WATER ENGINEERS) (at Burlington House, Piccadilly, London, W.1), at 2 p.m.—Discussion on "Sources of Water in relation to Town and Country Planning".

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Address by the President (Admiral of the Fleet the Rt. Hon. Lord Chatfield, G.C.B., O.M.).

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Discussion on "The Limitations and Uses of the Comparative Method in Medicine", 4: "Neurology and Psychiatry" (to be opened by Dr. Dorothy Russell, Dr. J. R. M. Innes, Dr. W. S. Gordon, Dr. W. H. Andrews and Prof. Samson Wright).

Thursday, April 20

MANCHESTER CHAMBER OF COMMERCE (at Houldsworth Hall, Manchester), at 11.30 a.m.—Sir Edward V. Appleton, K.C.B., F.R.S.: "Fundamental Research—its Practical Importance".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. H. Mills, F.R.S.: "Old and New Views on Some Chemical Problems" (Presidential Address).

INSTITUTE OF THE PLASTICS INDUSTRY (LONDON AND DISTRICT SECTION) (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. D. N. Davies: "Polyvinylchloride".

ELECTRICAL ASSOCIATION FOR WOMEN (joint meeting with the WOMEN'S ENGINEERING SOCIETY) (at 20 Lower Regent Street, London, S.W.1), at 7 p.m.—Conference on "Women in the Building Industry".

Friday, April 21

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. Jacob: "A New Type of Electron-Optical Voltmeter".

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Display of Scientific Films by Mr. N. L. Harris and Mr. M. Michaelis.

Saturday, April 22

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Dr. J. Blair Hartley: "The Future of Radiology in Obstetrics".

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. H. Glaisher, Dr. W. Betteridge and Mr. R. Eborall: "The Mottling of Aluminium Alloy Radiographs".

APPOINTMENTS VACANT

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

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Principal, Harris Institute, Preston (April 20).

LECTURER IN INORGANIC OR PHYSICAL CHEMISTRY to Higher National Certificate or Degree standard—The Principal, Royal Technical College, Salford 5, Lancs. (April 21).

GRADUATE LECTURER IN MECHANICAL ENGINEERING, a GRADUATE LECTURER IN ELECTRICAL ENGINEERING (preferably with experience in RADIO), and a GRADUATE LECTURER IN CHEMISTRY (with subsidiary MATHEMATICS, PHYSICS or BIOLOGY), at the Southend Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (April 22).

SENIOR SPEECH THERAPIST—The Director of Education, Education Offices, Nelson Square, Bolton, Lancs. (April 22).

ASSISTANT MASTER FOR TECHNICAL SUBJECTS in the Municipal Technical College—The Secretary, Education Office, Town Hall, Widnes (April 22).

CHAIRS OF MATHEMATICS, PHILOSOPHY and PHYSICS, tenable at Bedford College for Women—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (April 24).

INSTRUCTOR IN BEEKEEPING (temporary) on the Agricultural Instruction Staff of the Somerset County Council—The Clerk to the Somerset County Council, County Hall, Taunton (April 24).

COMBUSTION ENGINEER to undertake Shift Duties at a large Power Station in London—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2074XA) (April 24).

ASSISTANT ENGINEER by the Great Yarmouth Electricity Undertaking—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.799XA) (April 24).

ASSISTANT MAINS ENGINEER (location, Essex)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.800XA) (April 24).

TEACHER (man) OF MATHEMATICS (with subsidiary SCIENCE) at the Cambridgeshire Technical School—The Education Secretary, Cambridgeshire Education Committee, Cambridge (April 24).

ASSISTANT LECTURER IN CHEMISTRY (with special qualifications in PHYSICAL CHEMISTRY)—The Registrar, The University, Manchester 13 (April 25).

LECTURER IN CHEMISTRY to teach PHYSICAL and INORGANIC CHEMISTRY up to Honours B.Sc. standard, at the Cardiff Technical College—The Director of Education, Education Offices, Cardiff (May 1).

SUPERINTENDENT to take charge of modern factory in South-East Essex producing Soap Products, Glycerine and Fatty Acids—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2091XA) (May 1).

ASSISTANT MASTER to teach MATHEMATICS at any stage up to University Scholarship work at the City of London School—The Town Clerk, 55–61 Moorgate, London, E.C.2 (May 1).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

ENGINEERING INSPECTOR OF MINES (temporary) in a Government Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2088A) (May 17).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

GRADUATE LECTURER IN MECHANICAL ENGINEERING at the Municipal College, Southend-on-Sea—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

JUNIOR CHEMIST for an Iron Ore Mine in Sierra Leone—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 406).

LECTURER FOR BIOLOGY AND HYGIENE—The Principal, St. Katharine's College, Tottenham, at Cary Park, Babbacombe, Torquay.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 62, Part 1, No. 6: Automatic Wave Functions for Ground States of Elements *Li* and *Ne*. By Dr. W. E. Duncanson and Dr. C. A. Coulson. Pp. 37–39. 6*d*. Vol. 62, Part 1, No. 7: Quantum Mechanics of Fields, 1: Pure Fields. By Prof. Max Born and Dr. H. W. Peng. Pp. 40–57. 3*s*. Vol. 62, Part 1, No. 8: A Measurement of the Velocity of Light in Water. By Dr. R. A. Houstoun. Pp. 58–63. 1*s*. (Edinburgh and London: Oliver and Boyd. [133

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 19: The Chemical Constituents of Lichens found in Ireland—*Cladonia sylvatica* (L.) Harm. emend. Sandst. By T. W. Breaden, Dr. J. Keane and Dr. T. J. Nolan. Pp. 197–200. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 6*d*. [143

University of Leeds: Department of Coal Gas and Fuel Industries with Metallurgy. Report of the Livesey Professor for the Session 1942–43. Pp. 16. (Leeds: The University.) [163

Leeds University: University Extension Lectures and Tutorial Classes. Thirty-fourth Annual Report, 1942–43. Pp. 6. (Leeds: The University.) [163

Ollsgoil na h-Éireann: The National University of Ireland. Calendar for the Year 1943. Pp. x+592. (Dublin: National University of Ireland.) [173

Royal Agricultural Society of England. Report of Executive Committee with Statement of Accounts and Balance Sheet for Year ended 31st December 1943. Pp. 24. (London: Royal Agricultural Society of England.) [203

Other Countries

Proceedings of the United States National Museum. Vol. 94, No. 3173: Revisions of Two Genera of Chalcid-Flies belonging to the Family Eupelmidæ from North and South America. By A. B. Gahan. Pp. 339–370. Vol. 94, No. 3174: New Species of American Scolytoid Beetles, mostly Neotropical. By M. W. Blackman. Pp. 371–400+plates 15–17. (Washington, D.C.: Government Printing Office.) [93

Smithsonian Miscellaneous Collections. Vol. 104, No. 2: Cross Sections of New World Prehistory; a Brief Report on the Work of the Institute of Andean Research, 1941–1942. By Prof. Wm. Duncan Strong. (Publication 3739.) Pp. v+46+33 plates. (Washington, D.C.: Government Printing Office.) [93

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1943. (Publication 3740.) Pp. ix+95+2 plates. (Washington, D.C.: Government Printing Office.) 25 cents. [133

U.S. Office of Education: Federal Security Agency. Bulletin 1943, No. 2: Inter-American Education; a Curriculum Guide. By Effie G. Bathurst and Helen K. Mackintosh. Pp. 66. (Washington, D.C.: Government Printing Office.) 15 cents. [133

Pennsylvania State College: School of Agriculture. Bulletin 452: Conditions Affecting the Digestibility and the Metabolizable Energy of Feeds for Cattle. By E. B. Forbes, Prof. R. W. Swift and others. Pp. ii+34. Bulletin 453: Energy Values of a Group of Silages. By E. B. Forbes, Prof. R. W. Swift and John W. Bratzler. Pp. ii+14. (State College, Pa.: Pennsylvania State College.) [133

League of Red Cross Societies. Hygiene, Medicine, Biology: Notes and Abstracts for the Use of National Red Cross Societies. No. 1, July 1943. Pp. iv+47. (Geneva: League of Red Cross Societies.) [133

Anuario del Observatorio Astronómico de Madrid para 1944. Pp. 334. (Madrid: Instituto Geográfico.) [133

Joint Progress Report on Reservoir Efficiency and Well Spacing. By the Committees on Reservoir Development and Operation of the Standard Oil Company (New Jersey) Affiliated Companies and of the Humble Oil and Refining Company. Pp. xix+77. (New York: Standard Oil Development Co.; London: Anglo-American Oil Co., Ltd.) [153

Dominion of Canada. Report of the Department of Mines and Resources including Report of Soldier Settlement of Canada for the Fiscal Year ended March 31, 1943. Pp. 207. (Ottawa: King's Printer.) [203

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