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SCIENCE AND PROGRESS IN INDIA

THE extent to which the welfare, prosperity and, indeed, the very existence of a nation depend on scientific research and on the application of scientific knowledge has been brought home to everyone during the present War. Their supreme importance was fortunately realized in time in Great Britain, and between 1939 and 1941 arrangements were made between the United Kingdom, the Dominions and the United States for close co-operation in scientific research and the full interchange of scientific and technical information in all matters connected with the War. As a consequence, there are now scientific missions or representatives of the Dominions and the United States in London : the United Kingdom has a scientific representative at Ottawa ; and there is at Washington a British Central Scientific Office that acts jointly for the United Kingdom and the Dominions in maintaining a scientific liaison with the United States. In addition, many special missions have been continually at work in all these countries. An attempt in 1941 to bring India into this picture was, however, unfortunately unsuccessful, as the need of this scientific and industrial collaboration was not then recognized in that country.

To help the continuance of such collaboration after the War, when problems of reconstruction and development for the betterment of the life of the people of the world will arise, the Royal Society in 1941 took the opportunity of the presence in London of scientific representatives of the Dominions to set up a British Commonwealth Science Committee to consider how collaboration in scientific matters throughout the Commonwealth and Empire could be made closer ; and in the absence of any Indian men of science in London, the secretary of the Education Department at India House attended. One result of the report of this Committee* is that it is now proposed to call after the War an Imperial Scientific Conference to which scientific representatives of the United Kingdom, India, the Dominions and the Colonies will be invited.

When the Government of India became aware of these activities and of the feeling among British men of science that their Indian colleagues should be taking part, an invitation was sent by the Viceroy, through the Secretary of State for India, to the president of the Royal Society, for Prof. A. V. Hill to go to India as the representative of the Society, in order to discuss the organization of scientific and industrial research as a part of the Indian post-war reconstruction plan, and also current research problems, with visits to universities and other research centres. The Royal Society agreed to the proposal, and Prof. Hill spent from November 1943 to April 1944 in a tour of Indian centres of work connected with science, medicine and technology.

The results of his discussions, visits and contacts with Indian science, industry, medicine and official circles have now been published in a document of

* British Commonwealth Science Committee. (Royal Society, Burlington House, London, W.1. 1943.)

great importance, entitled "Scientific Research in India". A digest of the report, section by section, appears elsewhere in this issue of *Nature* (p. 532). This document, of which the preface is dated August 14, 1944, is all the more important because everywhere he went Prof. Hill was welcomed with the utmost cordiality and given the freest access to information as a representative of the Royal Society and of British science. As a result of his tour, Prof. Hill is convinced that there is no difficulty in the way of full and friendly co-operation between India and Great Britain in the scientific, medical and technical fields. Everywhere the emphatic opinion was expressed that one of the most important needs to-day of Indian science, medicine and technology is better facilities to send the ablest young Indians abroad, particularly to the United Kingdom, for advanced and postgraduate study, for works experience, and for training in research.

In order to understand the implications of this report, it is desirable to know something of the history of the development of the present scientific background in India. This development has followed two parallel lines, official and non-official, each beginning towards the end of the eighteenth century in Calcutta, which was the capital city of the East India Company and later (from 1858) of the Government of India under the Crown, until the removal of the capital to New Delhi in December 1911 as a result of the visit of the King-Emperor to India.

The official line began with the appointment of such officials as the Superintendent of the Botanical Gardens, Sibpur (1788), the Assay Master at the Calcutta Mint (1792), and a Government geologist (1818), and the establishment of the Trigonometrical Survey (1800), and of several astronomical and meteorological observatories (1792–1824); leading ultimately to the formation of the modern survey departments, the Geological Survey (1851), the Meteorological (1875), Survey of India (1878), and the Botanical Survey (1889). This was followed by provision for the applied sciences, mainly in the form of research institutes; for example, agriculture (1885–1903), veterinary (1890–1925), forests (1906), medical (1906), and public health and hygiene (1934). Another phase of official provision has been through the institution of universities, in Bombay, Calcutta and Madras, all dating from 1857, the year of outbreak of the Mutiny, the Punjab (1882), and Allahabad (1887), with several others founded during the present century. The Indian Institute of Science at Bangalore may be conveniently mentioned here, though it owes its inception to the munificence of the Tata family, supplemented by Government aid. Private bequests have, of course, also played a part in the development of the universities of India.

The non-official line of development began with the foundation of the Asiatick Society (now the Royal Asiatic Society of Bengal) by Sir William Jones in 1784. From its activities has sprung the larger part of non-official scientific activity in India (including a portion of the development along the official line), not to mention all its own work for literature, history, archæology and philology. In addition, the Indian Museum, Calcutta (1866) was based originally on the collections of the Asiatic Society; the official Zoological Survey of India (1916) is a descendant of the zoological section of this Museum. The Asiatic Society must also be regarded as the mother of the Indian Science Congress Association, which held its first meeting in 1914, and, as Prof. Hill remarks, the grandmother of the National Institute of Sciences of India, founded by the Indian Science Congress in 1935.

Besides the Royal Asiatic Society, there are now two other academies claiming national scope, namely (*a*) the United Provinces Academy of Sciences, founded at Allahabad in 1930, renamed the National Academy of Sciences, India, in 1936; and (*b*) the Indian Academy of Sciences, founded at Bangalore in 1934.

The growth of scientific activity in India has led also to the formation of a number of specialist all-India societies mainly with their headquarters in Calcutta; for example, mining and geology (1906), mathematics (1907), engineering (1921), botany (1921), chemistry (1924), physics (1934), soil science (1934), and physiology (1934).

From the dates of formation of these non-official academies and specialist societies, it will be realized that during the present century there has been an astonishing efflorescence of science in India as compared with the nineteenth century. This is of course partly due to the growth both in number and stature of the Indian universities, and is best recognized from the wonderful success of the Indian Science Congress, which, with the help of a deputation from the British Association, celebrated its twenty-fifth birthday in 1938. This Congress moves annually from centre to centre on the model of the British Association and is now commonly attended by upwards of a thousand members of all grades; this is all the more surprising in view of the sub-continental size of India and the distances that many of the members must travel in order to attend. This annual assembly of scientific workers is also the venue of the annual meetings of most of the all-India scientific societies, as well as of the National Institute of Sciences of India.

The foregoing summary is but a brief outline of the official and non-official provision for science up to the time of Prof. Hill's visit. It must be remarked, however, that there has been a marked difference in this century between the rates of growth along the official and the non-official lines. Whereas, on the non-official side, growth once it began was on the whole continuously progressive, the same cannot be said of the official side. It is notorious that official science is subject to severe setbacks when official finances become straitened. During this century, there have been two periods of such retrenchment. The first was in 1925, when the Inchcape Committee from Great Britain recommended some measure of retrenchment; and the second was in 1931 when, on the recommendation of an Indian Retrenchment Committee, widespread and disastrous curtailment was effected throughout the Government scientific services. The special selection of science for such slaughter showed how little the Government of India understood or valued such work, and it cannot be denied that in consequence India faced the onset of the present War much worse equipped scientifically than would otherwise have been the case. The change of heart shown by the Government of India in now calling for the help of British science to strengthen Indian science, both academic and applied, is thus all the more to be welcomed. The sad thought is that it has required the impact of war to produce this change.

Although it was not until 1943 that this call for British scientific advice was made, the Government of India had in fact, in 1940, already taken a notable step with the foundation of the Board of Scientific and Industrial Research, which may be regarded as the Indian equivalent of the Department of Scientific and Industrial Research in Britain; and that the Government of India now takes seriously the need for scientific research is shown by the fact that financial provision was made in the Budget of 1944 for fuel research and glass research, and for national laboratories for physics, chemistry and metallurgy. Also the Government of India gladly accepted the invitation of the British Government, sponsored by the Royal Society, to send a deputation of leading Indian men of science to Great Britain in the autumn of the same year. The members of this deputation were given every privilege and facility to enable them to visit centres of scientific and industrial research in Britain and to make contact with the leading industrial enterprises likely to be helpful to India; and afterwards they went to the United States to make similar contacts there.

The above recital of the past and continuing growth of science in India sounds impressive, so long as India is pictured as one country and its scale is forgotten; but it must be remembered that India is nearly as large as the whole of Europe without the U.S.S.R., and that it has a population approaching 400 millions. Against a background of this magnitude, India's scientific provision is, of course, very small indeed, and there is, as Prof. Hill saw, the need in all directions for great expansion in scientific, medical, and industrial research. This is required for three principal reasons: (1) the improvement of the health of the population; (2) the adequate feeding and employment of this enormous population, which is certain to go on expanding rapidly; (3) the provision of adequate defence forces with modern equipment.

Let us consider further the third reason, though only in general terms. Prof. Hill rightly points out that if India wishes to attain national stature, she must be prepared to provide her own defence forces in the future, without reliance on the British Treasury. An inkling of what this may mean has been given by the present War. In the past, when the cost of a portion of the Forces in India has been defrayed by Britain, on the ground that that part was not maintained for purely Indian reasons, the unofficial members of the Indian Legislative Assembly have consistently opposed the provisions of the military section of the Budget for the maintenance of the remainder. This has appeared as a high proportion of the Central Budget, sometimes as much as 40 per cent; but there are also the budgets of some ten provincial Governments, none of which pays a penny towards defence. If the totals of these be added to the central total, the provision for defence is seen to be a much smaller proportion of India's total income. This should be emphasized, for in the future, as Prof. Hill sees it, there must be a greatly increased expenditure on defence, so as to enable the equipment of Indian Forces, land, air and sea, to keep abreast of that of other countries on the modern elaborate and costly scale. In addition, to ensure a high quality for this equipment, it will be necessary to maintain an adequately appointed scientific research organization within or in affiliation with the Defence Department; Prof. Hill proposes a War Research Board for this purpose.

How is all this expansion—medical, agricultural and defence—to be financed? Only by a great expansion and improvement of India's basic industry, agriculture, and by a great growth of her existing industries, with the addition of new industries. The Bombay plan of a group of Indian industrialists was proposed for such purposes, and even though its very magnitude may seem visionary, yet some such plan must be implemented, at least in part. The Government of India has accordingly now taken this task in hand, and, following Prof. Hill's visit, has formed a new Department, that of Planning and Development, with, for its first member, Sir Ardeshir Dalal, former managing director of the Tata Iron and Steel Co. and one of the authors of the Bombay plan.

The greatest weakness in the Government of India in respect of scientific activities is that responsibility for it is scattered instead of concentrated: for example, meteorology is under the Department of Posts and Air; geological survey under Labour; the Survey of India, and the Botanical and Zoological Surveys, under Education, Health and Lands, which also controls medical and agricultural research in part. What is needed is that all these scientific activities should be grouped under one member of Government, for which the new Member for Production and Development seems appropriate.

Prof. Hill's recommendation is, therefore, that there should be a Central Organization for Scientific Research working under the Honorable Member for Planning and Development, divided into six research boards: medical, agricultural, industrial, surveys and natural resources, engineering, and war. He makes suggestions for the constitution of these boards; and for each of these branches of activity he proposes a director of research, who would be secretary and principal administrator of his own board, and a member *ex-officio* of each of the other boards. The responsibility of these six directors would be for directing, organizing, initiating and co-ordinating research, on a nation-wide scale, so far as constitutional considerations allowed, each in his respective field.

Between these boards jointly there would be a Research Grants Committee, and a Research Studentships Committee. There would also be a Scientific Consultative Committee to advise the Member for Planning and Development on general policy in relation to research, consisting of the six directors of research, together with six other distinguished men of science.

In advocating this general principle of bringing research into a single organization, Prof. Hill points out that this would still leave the Departments of the Government of India free to make their own arrangements for applying the results of research to the practical problems they have to face. From this point of view, Prof. Hill regards these other Departments of the Government of India as the 'user' Departments, which, charged with the responsibility of applying the results of research, could set up development or improvement councils, with a liaison with the corresponding research boards. Then, to ensure that development as well as research is co-ordinated at a high level, Prof. Hill would set up under the Member for Planning and Development, as an opposite number to the Scientific Consultative Committee, a Development Consultative Council.

If the Government of India acts on Prof. Hill's report, as there is every reason to suppose it will, then India will be provided with a co-ordinating and initiating organization for research in the six fundamentally important fields outlined by Prof. Hill; an organization that should help materially the improvement of the health of India, the necessary expansion of its agricultural resources, and the expansion of its industries, with a resultant higher level of health and of the employment that is so necessary to produce the greatly increased revenue needed for the general welfare, including the defence of India.

Proposals for the expansion of Indian science and industry cannot, however, be implemented unless men, both in numbers and in quality, are forthcoming to carry them out. India's present educational equipment, including that of the universities, technical colleges, and research institutes, is quite inadequate for the purpose. Consequently, pending a great improvement in educational and technical facilities in India, large numbers of graduate students will have to be sent abroad at Government expense for postgraduate training, both scientific and technical. It is understood that the Government of India is making arrangements for this, and that we may expect a considerable number of such students to arrive in Britain this year. Conversely, it will probably be found necessary, as a temporary measure, for India to import from abroad a considerable number of highly qualified men to help in the reorganization of teaching and training in India. These remarks are made without any reflexion on the professors and other teachers in India, who have done splendid work with the insufficient facilities at their disposal, as must be evident to anyone who contemplates the astonishing success of the Indian Science Congress, of which mention has already been made, or the fact that several Indians have been elected to the fellowship of the Royal Society.

The organization for research proposed by Prof. Hill and outlined above will, of course, if adopted, be an official scheme for the co-ordination of scientific research in India, and when carried out it will have to be regarded as a sudden burgeoning on the official line of development, incidentally co-ordinating, so far as possible, activities on the non-official line of growth. There will, however, remain the non-official activities that find their expression in the specialist scientific societies, in the academies, in the Indian Science Congress Association, and in the National Institute of Sciences of India. These non-official developments must be encouraged by Government and helped financially, while still remaining free. Nevertheless, these non-official activities also need co-ordinating. Prof. Hill refers to the fact that Indian men of science have advocated strongly the formation of a National Research Council, and to the formal resolutions on this matter passed by the National Institute of Sciences in 1944. Without enumerating these resolutions, it may be said that they were designed to give Indian science and Indian scientific men a greater and more appropriate part in national affairs. Prof. Hill holds that his proposals are designed to meet the same needs and difficulties as the proposals of the National Institute, and that they will be acceptable to that body. But although Prof. Hill's proposals may render unnecessary the formation of a National Research Council formally so named, they do not remove the necessity for a co-ordinating organization for Indian non-official scientific bodies. The National Institute of Sciences of India was, of course, formed for this very purpose, as Prof. Hill recognizes, and in fact he expresses the hope that formal recognition may be given to its position by Government, for example, by the grant of a Royal Charter such as the Royal Society and the British Academy have.

Incidentally, Prof. Hill comments on the 'odd' name of the National Institute, recognizing, however, that the name chosen was due to a compromise at the time of foundation. The name is, however, not so odd as it sounds, for the organizing committee, in selecting this name, was influenced by the example of the Institute of France, which is a co-ordinating body for the five French academies, both of sciences and letters, and which in an earlier stage of existence was called the National Institute of Sciences and Arts. As the Indian body was to co-ordinate scientific bodies only, it was named the National Institute of Sciences of India, leaving the field open for the foundation at a later date, for example, by the Royal Asiatic Society of Bengal (which is an academy of both science and letters), of a National Institute of Letters to co-ordinate the activities of academies of letters in India, with perhaps also the formation of a National Institute of Arts co-ordinating the activities of academies of arts in India. Once this has happened, the need may arise for co-ordinating the three national institutes into a National Institute of Arts, Letters and Sciences of India as 'The Institute of India', equivalent to the Institute of France in its comprehensive scope. The foundation of the National Institute of Sciences of India, although on an all-India basis, aroused a certain amount of provincial jealousy at the time of foundation, so that the present location of its office in the building of its 'grandmother', the Royal Asiatic Society of Bengal, is perhaps a disadvantage. If with the grant of a Royal Charter its headquarters is moved to Delhi, this should cause all such jealousies to be dispersed.

In conclusion, it can be emphasized that Prof. Hill's report is a document of the greatest public value, which will provide a first-class stimulus to scientific progress in India. At present few copies are available in England, but it is to be hoped that this deficiency will be rectified later. It is of such importance that it should be studied closely by all who are interested in the welfare of India as conditioned by its scientific progress.

DRY FARMING PROBLEMS

Dry Farming in India
By N. V. Kanitkar. (Imperial Council of Agricultural Research, Scientific Monograph No. 15.) Pp. x+352. (Delhi: Manager of Publications, 1944.) 13.12 rupees; 21*s*. 6*d*.

ON more than one fifth of India's total cultivable area crops have to be grown under conditions of precarious and inadequate rainfall. The area concerned exceeds seventy-seven million acres. A partial crop failure is a serious matter for the sixty million people who live there, and for many others outside who receive their food-grains from the affected areas. The danger has become steadily greater because of the continuous and rapid increase in the total population; not only are there more to be fed, but also the increasing pressure on the land has reduced the average area cultivated by one family on the better lands, and has caused more marginal land to be taken into cultivation and has thus intensified many technical difficulties inherent in the system of husbandry.

During the past ten years, the Imperial Council of Agricultural Research has financed and co-ordinated the work of five special stations set up to examine the scientific and technological problems of dry farming, or crop-growing in low-rainfall areas. The scientific monograph under review is an account of that work. One of the stations, Rohtak, is situated in the north-east Punjab, on the alluvial Indo-Gangetic plain. The other four are in peninsular India and are relatively close together, but cover the two main soil formations. The Sholapur and Bijapur stations in Bombay province are on the Deccan trap, which weathers into the well-known black 'cotton' soils. The remaining two stations are at Hagari in Madras, and Raichur in Hyderabad State. They are on the red and black soils associated with ancient crystalline granite and gneiss.

The monograph contains one or two general chapters, describing the rainfall distribution over India, and the prevalent agricultural practices in dry farming in India and elsewhere, but the greater part deals with the properties of the soils and the behaviour of crops at the five stations. Extensive chemical and physical analyses of the soils were made, but except for easily predictable differences in field behaviour, associated mainly with depth of soil and the degree of heaviness, the results are shown not to have any fundamental bearing on the question whether crop yields can be stabilized or increased. This is to be expected, for the factor that overrides all others in importance is the amount and distribution of the rainfall in any season. The results of the manurial experiments brings out that point. Farmyard and green manures were tried with conflicting results (except possibly on the eroded areas of the peninsular India stations). Thus, the heavier dressing of manure often produced a smaller yield of grain than was obtained with the lighter dressing or no manure at all. The reason was shown to be that the nutrients encourage a greater vegetative growth than the limited moisture supply could bring to maturity. The effect is well known to the cultivators, who say that manure 'dries up' the crops, and are reluctant to use dung as manure, quite apart from their need of it for fuel. The greatest importance, therefore, is attached to the problem of conserving the maximum amount of water in the soil. A great deal of laboratory and field work is discussed, varying from cultivation and run-off experiments to plant transpiration trials. The reduction of run-off water by suitably placed bunds is shown to be of prime importance, and simple methods are described suitable for the cultivators' use. The results of the tillage experiments fall into line with the knowledge now available of the physical factors concerned in the behaviour of soil moisture. Over a period of years deep ploughing is no better, and may be worse, than shallow ploughing, and repeated ploughing is found to be harmful on some soils and ineffective on others. On the other hand, repeated shallow cultivations in the monsoon period do conserve water for the use of the subsequent winter crop, partly through weed destruction and partly by the prevention of deep cracks through which water from the lower levels could escape as vapour.

Developmental studies of the important crop plants were done mainly on the millets that, as sorghum or jowar (*Andropogon sorghum*) and pearl millet or bajra (*Pennisetum typhoideum*), are predominant in these areas. Shallower seeding than the customary is recommended, because the production of the secondary and permanent root system is encouraged; a lower seeding-rate and wider spacing of the rows is also urged, because larger grain yields are obtained, and the wider spacing permits inter-cultivation up to an advanced stage of growth without injury. All this is counter to the usual practice of the cultivator, and it is no criticism of the experimental results to sound a note of caution. There may well be incidental advantages in the customary methods, to be disclosed by experiments covering a longer period of years and a wider variation of climatic conditions. For example, tillering is not desirable in dry farming conditions, and the tendency is discouraged by the close stand of plants given by a heavy seeding-rate. Indeed, an automatic selection of non-tillering types may well have been effected by the practice of close seeding, for it is pointed out in the monograph that the sorghum varieties grown in south India do not usually tiller. Plant-breeding work was outside the scope of the investigation, but promising strains evolved elsewhere were tested against local varieties, with no very significant results, except that early maturity was valuable. It must be recognized that the plant-breeding problems in food crops for dry-farming areas are of peculiar difficulty, not only because of the extreme variation in conditions from season to season, but also because the weight and quality of the stalks and leaves, which are the main fodder supply for the animals, are as important as the yield and quality of the grain.

Another point on which longer trials are needed is the relative value of rotations and the cultivators' practice—by no means confined to India—of sowing mixed crops.

The monograph concludes with an account of the combined agronomic and costings studies in which the yields and costs of the methods worked out in the experiments have been compared, on a farm scale, with the present standard practices of the cultivator. Although each item, such as bunding, inter-cultivation or manuring, gives no significant improvement, their aggregate effect over the seven years 1934–35 to 1940–41 is appreciable. The methods advocated for each of the main tracts are described in detail. The main agronomic and research problems on which further work is needed are also briefly set out. Most of them are clearly important, but the main conclusion gained from a study of the monograph is of the value that resides in the full farm trial (including costings) on a scale within the capacity of the cultivator, of the new methods against the old. It is to be hoped that this feature of the scheme will receive even more attention, for it brings the experimenter and the cultivator together on common ground.

B. A. KEEN.

ABSORPTIOMETRIC METALLURGICAL ANALYSIS

Metallurgical Analysis by means of the Spekker Photo-electric Absorptiometer

By Dr. F. W. Haywood and A. A. R. Wood. Pp. xii+128. (London: Adam Hilger, Ltd., 1944.) 18*s*. net.

WITH the advent of the Hilger 'Spekker' absorptiometer and the pioneer work carried out by E. J. Vaughan in applying this instrument to metallurgical analysis, absorptiometric methods have become widely popular, and this book has been published in order to meet the demand that has arisen for a volume containing a collection of methods which have been devised specially for use with the instrument known as the 'Spekker'.

The first of the two sections into which the book is divided is devoted to a full description of the principles underlying absorptiometric analysis and to the construction and manipulation of the instrument. In the second part are collected twenty-six methods describing procedures for the determination of the commonly occurring constituents of commercial ferrous, aluminium, copper and magnesium-rich alloys. Composite schemes of analysis are included for each class of alloy, whereby several constituents may be determined on one initially weighed sample of alloy without the necessity for chemical separations. The operation of the methods is fully described, including details for the construction of the necessary calibration graphs.

The presence of certain anomalies tends to detract from an otherwise well-written text. Thus, the ordinates of the many specimen calibration graphs are described as "drum readings" whereas the graphs are derived from "drum differences". In no less than four instances, 'direct' methods not involving difference readings are illustrated by 'typical' calibration graphs obtained from drum differences, in spite of the fact that in two of the cases it is stated that "Difference methods are not applicable". Such lapses are apt to confuse rather than assist. It is, perhaps, unfortunate that the authors did not devote more space to explaining why certain procedures have been adopted. It is not clear why, in the determination of manganese in steel and magnesium alloys, oxidation to permanganic acid is effected by means of ammonium persulphate and silver nitrate, while, for the same constituent in copper and aluminium alloys potassium periodate is used as the oxidant; neither is it explained why yellow filters are necessary when using the mercury lamp for determining manganese instead of the green filters which are used with the tungsten lamp and which are specified for other determinations with the mercury lamp. With the 'direct' methods which are described, certain interferences arise, and the need to correct for these is not mentioned in the text.

The utility of the book would have been increased appreciably by an explanation of these and certain other items, some of which conflict with my own experience. However, the book contains much information which should be welcome to laboratories contemplating the institution of absorptiometric methods, and it should make a useful addition to the library of the metallurgical chemist.

H. C. DAVIS.

INTRODUCTION TO PHYSICS

College Physics

By Dr. C. E. Mendenhall, Prof. A. S. Eve, Prof. D. A. Keys and Prof. R. M. Sutton. Pp. vii + 693. (Boston, Mass.: D. C. Heath and Co., 1944.) 4 dollars.

AN introductory course in physics should aim at presenting the fundamentals rigorously without being excessively mathematical in outlook, and should also arouse enthusiasm for the subject and stimulate the student to pursue it further. In planning this text-book for first-year students in American universities, the authors have clearly had these intentions in mind. Fifteen chapters are devoted to mechanics and general physics, eight to heat, thirteen to magnetism and electricity, thirteen to optics, and two to atomic physics. Modern ideas and applications are kept in view throughout the book.

The general treatment is sound, and the principles are very carefully expounded. The sections on wave motion, sound, physical optics, electron physics, and radio are good. In some places the text is necessarily condensed; for example, geometrical optics is rather briefly treated.

A few minor points suggest themselves for criticism. A simple magnifying glass is said to give "considerable chromatic aberration"; Newton's law of cooling is offered as a small-excess approximation to the fourth-power radiation law; 'thermal capacity' is used to mean thermal capacity of unit mass; and Figs. 537 and 539 on thin-film interference and Newton's rings are inaccurately drawn.

There are more than 650 well-chosen problems, with answers. The book is well illustrated and adequately indexed. Viewed in relation to the needs of British students, it should be useful for First M.B. candidates, and for biologists and others to whom a more severely mathematical approach makes no appeal. Its fresh outlook and clear presentation should commend it also to those students of related sciences who wish to appreciate what physicists are trying to do and how they are setting about it.

G. R. NOAKES.

American Men of Science

A Biographical Directory. Edited by Jaques Cattell. Seventh edition. Pp. vii+2033. (Lancaster, Pa.: Science Press, 1944.) 14 dollars.

THERE is no published record in Great Britain from which one can obtain the scientific record of a particular individual, apart from those included in "Who's Who". Attempts have been made to meet the need, but they have not persisted. North America is more fortunate. Since 1906 it has had "American Men of Science", now in its seventh edition. It is a bulky volume, in spite of the large page used, but the type is admirably clear, as should be the case in any reference book.

For those not familiar with this work, it can be described as an alphabetical list of scientific men (and women) of the United States and Canada. Under each name the following data are given: address; date and place of birth; academic distinctions with dates; posts occupied, again with dates; membership of scientific societies, with offices held; and chief scientific interests. By the ingenious use of abbreviations and italics, a surprising amount of information is provided. It is estimated that the present volume contains 34,000 names, as against 4,000 in the first edition. 250 names are marked with an asterisk as those of leaders in their particular subjects during the past five years; they are selected by popular vote.

No doubt such a compilation is expensive to produce and to keep under continuous revision, but its usefulness makes it well worth while. Is it too much to hope that the money will be forthcoming for a similar reference book of British men of science? Much of the necessary material is already in existence on the cards of the Central Register held by the Ministry of Labour and National Service.

Elementary Statistics

By Prof. Hyman Levy and E. E. Preidel. (Nelson's Aeroscience Manuals.) Pp. vii+184. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1944.) 5*s*. net.

THIS volume, in the series of Nelson's Aeroscience Manuals, covers the elementary ideas of statistical theory, including distributions, means, measures of dispersion, correlation, elements of probability, least squares and the normal distribution. The mathematics required are not very advanced and are carefully explained; and there are numerous examples and exercises. The book should be useful in giving a general idea of the subject to those who do not wish to specialize in it.

Statistical nomenclature is always something of a problem, but there are two expressions used in this book which the authors might reconsider. They refer to the arbitrary origin chosen to simplify the calculation of a mean as a "fictitious average", whereas most writers use the more descriptive phrase "working mean"; and later on extend their usage to a "fictitious standard deviation" for the root-mean-square. Secondly, the authors give the result that the probability of r events in n trials with probability p is $\binom{n}{r} p^r (1-p)^{n-r}$ and call it Bernoulli's theorem. The result was certainly given by James Bernoulli (though Pascal probably knew it); but what is now generally known as his theorem in probability is the much more advanced result at the end of the "Ars Conjectandi", to the effect that the proportion of successes in repeated trials approaches p with as great a probability as is desired. M. G. KENDALL.

Introduction to Differential Equations

By S. L. Green. Pp. iv+140. (London: University Tutorial Press, Ltd., 1945.) 7*s*. 6*d*.

IT is quite refreshing to see a new book on differential equations, and this introduction to the subject has been planned with skill and developed with a clear appreciation of the difficulties which usually confront the student. There are eight interesting chapters covering ordinary and first-order equations, including Bernoulli's equation, with applications to plane curves. Then follows a thoroughly sound treatment of partial equations and operational methods, with illustrations from surfaces and curves in space. Next come Lagrange's linear equation and total equations in three variables. Finally, there is a well-written chapter on solutions in series, embracing the method of Frobenius, Bessel's equation of order zero, and Laplace's equation.

The book is intended for students reading for university degrees in the faculties of arts, science and engineering. The course is one of pure rigorous mathematics with very few practical applications of the kind required by science and engineering students, although in the very numerous exercises set for the student's practice, several are drawn from physical problems. Nevertheless, the author has produced a thoroughly good book which gives a clear insight into some of the fundamental principles of so vast a subject. Not only is the volume of value to the student who is under the expert guidance of a teacher, but also the clarity of the style renders the text very readable and understandable to an intelligent private student. As the specialists in this subject are now unfortunately few, the book should be useful also to teachers for, after all, differential equations are fundamental to all applied science and engineering.

The book can be confidently recommended to all to whom the study of the subject is indispensable.

The Theory of Measure in Arithmetical Semi-Groups

By Aurel Wintner. Pp. v+56. (Baltimore, Md.: The Author, Johns Hopkins University, 1944.) 2 dollars.

THIS monograph, the title of which is somewhat abstruse, deals in fact with certain aspects of prime-number theory. Though self-contained in presentation, it is a continuation of the author's "Eratosthenian Averages" (Baltimore, 1943). A knowledge of analytical prime-number theory and of Tauberian theorems is assumed, and even readers possessing this knowledge will probably not find the book easy reading. The greater part of it is concerned with the properties of the set of all integers that are divisible only by the primes of a given sequence, and in particular the various senses in which the set may have a 'density'.

The attitude throughout is typical of one tendency in present-day mathematics: there is a detailed analysis of the logical relation between every proposition and (almost) every other, and of the 'depth' of each proposition. Much of this is interesting and instructive, but I cannot help thinking that the book would have been more readable if the author had been less thorough.

There is a mistake (not important for the sequel) on p. 32: if $L(x)$ is a monotonic function which tends to infinity with x, and if $L(x) = O(x^\varepsilon)$ for every positive ε, it does *not* follow that $L(x) \sim L(\theta x)$ for every fixed positive θ. The author has been misled by a statement of Pringsheim. H. DAVENPORT.

SCIENTIFIC RESEARCH IN INDIA

TOWARDS the end of 1943, Prof. A. V. Hill, one of the secretaries of the Royal Society, was invited by the Government of India to visit that country and discuss the organization of scientific and industrial research as part of the Indian post-war reconstruction plan, and its co-ordination with corresponding activities in Britain. Advice was also sought on current research problems, with visits to universities and other research centres. Prof. Hill was thus enabled to obtain a view of the position and progress of science and industry in India more comprehensive than has been vouchsafed to anyone since the examination of the industrial resources of the country carried out by the Indian Industrial Commission under the chairmanship of Sir Thomas Holland during the War of 1914–18.

That Prof. Hill took full advantage of this opportunity is apparent from his report, which has recently been published in India*. From the preface it is seen that the author regards this document rather as a logbook than as a formal or complete report. The material of the original logbook has, however, been regrouped into appropriate sections. These are necessarily many in number, so that to give a brief account of this important public document it seems desirable to mention the substance of each section, omitting Section 1, the Introduction.

Section 2. *Lack of Scientific Liaison*; and *Section* 4. *An Indian Scientific Office in London.*

In spite of the absence of scientific and technical liaison between India and Britain hitherto, Prof. Hill finds that there is a complete lack of any spirit of isolationism on the part of Indian scientific, technical, and medical men, and a frank recognition of the advantages of co-operation. To assure a liaison in the future, he proposes the establishment in London of an Indian Scientific Office with specialists in agriculture, defence, engineering, industry and medicine. This would follow a recommendation of the British Commonwealth Science Committee set up by the Royal Society:

"That a suggestion be made to the Governments of the various English-speaking countries that they should consider the possibility of maintaining permanent scientific representation in London and possibly also in other capital cities of the English-speaking world".

The Royal Society is prepared to set up a special committee of its fellows for the purpose of advising the Indian Scientific Office, the India Office, or the Office of the High Commissioner for India, on any special matter desired, for example on the filling of important scientific posts in India when suitable men are not available in India.

Section 5. *Scientific Liaison with the United States.*

India has many problems in common with the United States; for example, dust, erosion, floods, rural health and nursing services, control of pests, irrigation and hydro-electric developments. The British Central Scientific Office established in Washington since 1941 acts now for the Dominions as well as for the United Kingdom, and the attachment of representative Indian men of science to this office would be welcomed both by the director thereof and by the Americans.

* Scientific Research in India. By Prof. A. V. Hill. Pp. 40. (Simla: Government of India Press, 1944.)

Section 3. *Research Training of Young Indians in the United Kingdom.*

India has been largely cut off intellectually for nearly five years from the rest of the world, and it is urgently necessary to resume and enlarge arrangements that existed before the War for advanced study abroad, especially in Britain, by young Indian teachers, research workers, and members of technical staffs. On the other hand, the universities, medical schools, technical colleges, and research laboratories of Britain will be overwhelmed after the War with applications from others whose claims it will be difficult to resist. This means that there will be a severe competition for such facilities, and it will be imperative that the Indians sent overseas should be carefully selected. Such training will have to be financed by Government; but as Prof. Hill points out, there should be no difficulty over this as the sterling balance of India in Great Britain is already about £1,000 millions.

Section 6. *A Research Background in Medical Education.*

As a physiologist, Prof. Hill was given special opportunities of seeing hospitals, medical colleges, and departments of medical science. His general criticism of medical education in India is that there is little significant research done at the medical colleges either in (*a*) the pre-clinical sciences (anatomy, pharmacology, physiology, or normal psychology), in (*b*) pathology and bacteriology, or in (*c*) clinical science. The fundamental cause in each case is that departments are much understaffed; and of such staff as there is, most are only part-time employees of the colleges, depending usually on private practice for the major portion of their income. Prof. Hill cites the report of the Goodenough Committee in Britain as to the staff necessary for the various departments of a university medical centre; but he realizes that nothing on the same scale can be done in India at present, except at one or two centres, because there are not enough people of sufficiently high standard available. Also there would probably be considerable opposition to the full-time principle. Further, the universal adoption of provision for medical education on the scale suggested is bound to be very expensive.

Section 7. *An All-India Medical Centre.*

Recognizing the importance to any country of a really high type of medical practitioner and of a high type of medical teacher and research worker, Prof. Hill advocates the establishment of an All-India Medical Centre, staffed in all departments by the ablest people available anywhere, employed full-time and adequately paid. To attain this end, liberal expenditure on scholarships will be required. Further, in order to avoid communal, political, inter-provincial, and inter-State rivalries and jealousies, this Centre must be established at Delhi. It is desirable, if possible, that it should be built, equipped and endowed entirely from voluntary gifts, so as to strengthen its hand against eventual political or other pressure, and Prof. Hill suggests that such an All-India Medical Centre might be a very fitting national memorial to the Indian Forces after the War.

As malaria in India is the most serious public menace, Prof. Hill suggests that as part of this All-India Medical Centre there should be a special hospital for the clinical study of malaria.

Section 8. *Medical Research.*

Although medical colleges in India generally lack the research atmosphere for reasons already given, yet India has a high reputation for medical research, especially into tropical diseases (for example, malaria, cholera, plague, and kala-azar). This work has been done in the main at special institutes, for which the research department of the Indian Medical Service has been mainly responsible, helped by grants and salaries provided by the Indian Research Fund Association. The latter is an independent registered body drawing its funds from a 'user' department of the Government of India (Education, Health, and Lands). It should rank with the Medical Research Council in Great Britain, but does not because of the inadequacy of its funds. Prof. Hill would like these medical research institutes, where practicable, to be brought into closer contact with medical colleges and higher medical education, to the mutual benefit of both; this should also be borne in mind when new medical research units are planned.

Since the object of medical research is treatment of the sick and improvement of public health, it may help to give some idea of the magnitude of the medical and health problems before India if the reviewer intercalates here a comparison made for another purpose of the financial provision for medical and health purposes in India and Malaya respectively. In 1938 the provision in the Federated Malay States estimates under 'Medical and Health' was 2.43 dollars (Rs. 4–4–0) per head or 180 dollars per square mile. In India the expenditure on medical relief in twelve provinces varied in 1936 from one anna per head in the United Provinces to 8 annas 8 pies in Baluchistan. For Madras alone, from which the Tamil population of Malaya is largely derived, the figures were 2 annas 7 pies per head and Rs. 53 per square mile. Thus for Madras the provision per person was only one twenty-sixth of that in the Federated Malay States, while measured by area it was one sixth.

[Straits dollar = 2*s*. 4*d*. Rupee = 1*s*. 6*d*.]

Section 9. *Vital Statistics and Population.*

Prof. Hill directs attention to the rapid increase in the population of India and to the fact that improved public health and nutrition, and diminution of the present high mortality, will cause the population to increase at a still higher rate, at least for some time; also that, contrary to what is commonly thought, industrialization, with a resultant higher standard of living, may at first also cause a rise in the birth-rate. As the decision regarding the direction in which the available effort for national development should be applied depends largely upon a public understanding of the facts and probable trends of morbidity, mortality, reproduction, and population, more accurate data on these points, and their more detailed analysis, are required.

Section 10. *Agricultural Research.*

Agriculture is India's most important industry, but great expansion is necessary, first to provide more adequate nutrition for the present population of some 400 millions, secondly to anticipate the needs of the expected increase of population, and thirdly to provide for the expansion of crops required for industry and export.

Excellent work is being done in India in agricultural research by a variety of organizations maintained both centrally and provincially and by Indian States. Nevertheless, the total expenditure is only two thirds of that in Great Britain before the War on agricultural research, although Great Britain has only one eighth the population and one twentieth the area. The expenditure in India is still only about one quarter of an anna per person per annum, and one tenth of an anna per acre of the total area.

Section 11. *Surveys and Natural Resources.*

The great natural resources of India are still inadequately known. Consequently the Geological Survey must be expanded, the Botanical Survey restored, and the Zoological Survey extended. The proposed research institutes on marine and fresh-water fisheries should be set up as soon as possible. Other subjects, such as water-power, water-supply, forests and soil, require fuller investigation. A central research board for surveys and natural resources is recommended.

Section 12. *Industrial Research under the Government.*

The Board of Scientific and Industrial Research founded in 1940 has already produced important results, but the headquarters staff assisting the Director of Scientific and Industrial Research is far too small. It will be important for this Board to be in close and familiar contact with the Department of Scientific and Industrial Research in Britain and with corresponding bodies in the Dominions.

Section 13. *Scientific Research by Industry.*

Examples are given of the giant research organizations maintained in the United States and Britain by some of the leading industrial organizations; for example, the Bell Telephone Laboratories in New York, the Eastman Kodak at Rochester, N.Y., the G.E.C. at Wembley, Imperial Chemical Industries, Ltd., Burroughs Wellcome, Lever Bros., and various engine and aircraft firms. In addition to these many private enterprises of individual firms in Britain, there are twenty-four industrial research associations maintained jointly by industry and the Department of Scientific and Industrial Research.

In India the nearest approach to the American and British model is the Metallurgical Laboratory of the Tata Iron and Steel Co. Admitting that India as a whole is poor, and that the number of men capable of the requisite effort in any field is very limited, Prof. Hill thinks that Indian industry is not yet making nearly the research effort it could on its own behalf, especially as some of its industries have recently been prospering exceedingly.

Section 14. *Technology.*

In Great Britain there is as yet no institution comparable in magnitude, in the quality of equipment and in excellence of teaching and research work with the Massachusetts Institute of Technology at Cambridge, Mass.; the view is held in Britain that two or three such institutions should be set up, or that existing institutions should be expanded for the purpose, at such centres as Glasgow, Manchester, Birmingham and London. This being the view held in a country where, after all, the conditions are not so bad, how much more can we recognize the necessity for one or two such institutes or colleges of very high standard in India? For the future of Indian industrial and agricultural development must depend on the supply of first-class technical brains, trained in an atmosphere of original research and practical experience. Of existing organizations, the Indian Institute of Science at Bangalore comes closest to what is wanted. One chief purpose of the proposed new institutes of technology would be to provide teachers and research workers of high quality for other places.

Section 15. *Meteorological Research.*

The requirements of the Fighting Services and particularly of the Air Force, and the needs of civil aviation, have expanded greatly the usefulness of the India Meteorological Department; but meteorology has many other applications; for example, in radio and, in India particularly, in agriculture and in emergency warning of floods. Proposals have been made to the Board of Scientific and Industrial Research for the further development of fundamental research in meteorology in India, and these proposals have been accepted.

Section 16. *Scientific Instruments and Equipment.*

This is a key industry, and urgently needs encouragement. Given training and experience, Indian workmen have all the natural aptitudes for such manufacture (as has been demonstrated for many years by the Survey of India).

Section 17. *Post-War Disposal of Government Stock.*

A considerable amount of scientific and medical equipment and machine tools will be available after the War. Prof. Hill recommends that a free distribution should be made to university and other institutions of the equipment they require; for one of the most obvious criticisms of the majority of university laboratories in India refers to the poverty of their scientific equipment and the frequent absence of any proper workshop facilities and tools.

Section 18. *Research for Fighting Services.*

The existing research organization of the Defence Services in India was not designed for the contingency of India being the base for major naval, military and air operations. Any improvements that can now be made in the arrangements for research in connexion with the Services should be planned not only for the present War, but also in view of the future necessity of the Government of India under a new constitution taking full responsibility for her own defence. Prof. Hill proposes a War Research Board in liaison with a Central Organization for Scientific Research.

Section 19. *A Central Organization for Scientific Research.*

This is the most important section of Prof. Hill's report, because it contains constructive proposals for remedying the various shortcomings in the provision for scientific, medical, and industrial research that his survey has brought to his notice. Prof. Hill first enumerates and describes the various coordinating research bodies set up in Britain, namely, the Medical Research Council (1914), the Department of Scientific and Industrial Research (1916), the Agricultural Research Council (1931), and the War Cabinet Scientific Advisory Committee (1940). He proposes for India a Central Organization for Scientific Research working under the Honorable Member for Planning and Development, to control and coordinate six research boards, namely, medical, agricultural, industrial, engineering and war, and a board of surveys and natural resources.

Section 20. *A Central Register of Scientific and Industrial Personnel.*

The Scientific Section of the Central Register in Britain has proved of much value in selecting scientific and technical personnel for work connected with the war effort. It is regarded now as an institution of permanent value to the country; but how it will be organized and used in peace-time has not been decided. Prof. Hill considers that a similar register would be of use to India, and has suggested that the National Institute of Sciences of India should undertake its construction. The Board of Scientific and Industrial Research has made a suitable grant to the National Institute for this purpose.

Section 21. *Pay and Status of Scientific Workers in Government Service.*

One of the defects of employment in Government service both in Britain and India is that the administrator is usually much more highly paid than the scientific or technical man of the same standing, experience, training and ability, so that the scientific man has been unable to attain more than a very limited position and salary without undertaking administrative work. This difference requires modification if Government is to secure the ablest men in science and give them the best opportunities for developing and using their talents.

Section 22. *Scientific Societies in India.*

Prof. Hill points out that scientific societies are of two kinds, general and special, and that both kinds have an important part to play in the publication of scientific papers and results as well as in the formation of libraries and collections. "Scarcely less important is their influence in making living communities out of a number of people always critical and often highly individualist. In India where so many causes tend at present to separate individuals, groups and communities from one another a strong common interest in science as a whole, or in some branch of it, could have as a bye-product an important influence in keeping people working sensibly together". Prof. Hill outlines some of the ways in which these societies could be assisted and encouraged by Government without diminution of their independence. Once the National Institute of Sciences of India has been formally recognized as fulfilling in India functions similar to those of the Royal Society in Britain, it will be available to take up various matters with Government on behalf of sister societies, and to distribute Government grants for certain scientific purposes, such as grants for publications, and grants-in-aid for scientific investigations and for international scientific conferences. A beginning has been made by entrusting the National Institute with grants for publications and for the preparation of a Central Scientific Register.

Section 23. *Scientific Research in Indian Universities*

This subject would require long and careful study and a small commission under a scientific man as chairman might well be appointed to study the whole subject. Meanwhile, Prof. Hill remarks that scientific research in the universities, both for its own sake and as a background for scientific education, is the fundamental basis of all scientific progress. The most notable contributions of Indian men of science have been in physics, mathematics and chemistry, and there are in fact a good many strong departments in physics and chemistry at Indian universities. But in the biological sciences and in geology, the departments, where they exist, are nearly always small, ill-equipped and under-staffed. Even allowing for the founding of a few colleges of technology, there will be a need for universities to maintain departments in engineering of a sufficient standard to meet the ordinary needs of industry and public works. Last year the Royal Society set up a number of special committees to investigate the post-war needs of fundamental research in the United Kingdom. Similar investigations would be valuable in India.

Section 24. *Private Benefactions in Science.*

Although substantial benefactions have been made to science, medicine and technology in India from private sources, particularly by the Tatas, yet most scientific work in India derives its financial support from the Government. There are in India many rich men who could easily contribute substantially to scientific research. What are specially needed are scholarships, which if endowed could commemorate the names of the donors, on the parallel of the numerous endowed scholarships, studentships, and fellowships in Britain and the United States. There are already in India a few completely non-official privately endowed scientific institutions, for example, the Indian Association for the Cultivation of Science and the Bose Institute in Calcutta, and the Tata Memorial (Cancer) Hospital in Bombay. Here is a great opportunity for Indian benefactors.

BIOLOGY TEACHING IN SCHOOLS AND UNIVERSITIES

ON March 24 the Association of British Zoologists met in the rooms of the Zoological Society of London, with Prof. James Ritchie in the chair. The morning session was devoted to a discussion of the interrelationship of biology teaching in schools and universities.

In opening the discussion, Dr. C. F. A. Pantin directed attention to the ultimate objects of a biological training. The first duty of a university biological department is to advance knowledge. The depletion during the War of university staffs in zoology has shown how serious the situation could become when research ceases and when individuals with expert knowledge in special fields cease to be available. The training of able students for university posts is essential. Nevertheless, the numbers required each year are few, and the vast majority who receive biological training at a university aim at some other professional career such as teaching in schools.

Important as biology is in education, one would not wish to produce biological instructors simply for the sake of training yet more. In the past, preliminary training for medicine occupied the largest number of zoological students who aimed at other careers, though their contact with the subject was brief. Only a few zoologists were absorbed into other professions. But one hopes to see in the future a steady and increasing demand for careers in veterinary work, agricultural entomology, fisheries in Britain and in the Colonies, as well as in special activities such as the protection of stored products and the prevention of fouling of ships.

It is probable that more zoologists will be required for professional or Government services than for industry. The problems of applied biology are rarely narrow and local. They may cover the whole country and may lead into physics, chemistry, mathematics and even more distant studies like sociology. There is little scope for technicians with limited but intensive training comparable to that of the radio expert in physics. The social importance of biological problems is not less for that reason.

However, the War has shown the value in an unexpected direction of the wide training a biologist receives. It has been the common experience that biologists are peculiarly fitted for the varied problems which come under the heading 'operational research'. Their advantage seems to depend on the fact that they are more accustomed than the physicist to hunting for general principles in a mass of apparently unconnected particular instances. The biologist cannot afford to reject any problem just because he is unable to examine and control it at leisure in the laboratory. He must often start with varied, qualitative and above all fugitive data. His problems are often of a kind which a physicist would reject as unsatisfactory for attack. But it is the solution of just this kind of difficulty which is needed in everyday life. We may hope that after the War biological students may find their place, attacking the general problems of industry just as they have attacked those of operational research.

It is clear that the preparation of the young biologist for any career will require a wide and sound scientific training. How far does the present educational system provide this ? The universities have often complained that the teaching at school is too specialized : an attempt is made to cover too much ground, so that elementary knowledge is weak and the necessary revision at the university bores the student. It is also claimed that another result of this specialization is lack of general education and inability of the student not merely to read languages other than his own but even to express himself in his mother tongue. Though this may be partly true, it is open to question whether the degree of illiteracy among biological students is as great as some have supposed. Another criticism directed at university entrants in biology is that their knowledge of mathematics and physical science is too weak. Many university teachers have been told: "I took up biology because I was no good at physics".

In all these criticisms there is some substance. But from the point of view of the universities, perhaps the most serious criticism of all is that under the present system the standard of knowledge of entrants in biological subjects varies so greatly that the construction of satisfactory preliminary courses at the university becomes extremely difficult. Pessimists have said that the only solution is to begin biological training at the university. They quote the case of the classic who turned over to biology and outstripped the rest of the class. They usually omit to remark that this is only characteristic of men of outstanding ability who would succeed in whatever direction they turned. But, in fact, teaching of biology at schools has come to stay. It must never be forgotten that the majority of school-children are not in fact going on to a university at all, and the case for giving the general citizen an elementary biological training is overwhelming. Moreover, a good school training in biology can be of the very greatest value to the university entrant. Time presses, and education is long and expensive. It may be further encroached upon by national service. Everything that helps the student on his way without detriment to educational principle is to the good.

Those who are responsible for teaching in schools fully agree that the relation between natural science at school and at the university is very far from satisfactory. They point out, however, with justification that they are the victims of circumstances. They complain of the very high standard demanded in scholarship examinations, particularly those of the colleges at Oxford and Cambridge. It was realization of the force of this complaint which led to recent conferences between school teachers and college and university officers at Cambridge. As a result of these conferences, the principle was accepted that the factual basis of the scholarship examinations should be the same as that for the higher school certificate examinations in natural sciences subjects. But while this should ease the situation, nothing can really justify the use of an examination designed to select the very few ablest university candidates as the basis of natural science education for every kind of child at school.

University scholarships are not alone responsible for the school-masters' difficulties. The discussion showed how the laudable effort to reduce the long and expensive period of professional training, particularly for medicine, has resulted in specialized work being pushed into preliminary examinations. In England, preliminary medical examinations are commonly taken at school, and this has led to great specialization: a difficulty avoided in Scotland, where the examination remains a university one. Yet another difficulty faces the schools in that there are no fewer than eight separate bodies controlling certificate examinations, each with its own syllabus and each giving the successful candidate special 'credits' which are of university rather than school importance. It thus comes about that a biology master at school may have to break up quite a small class into three or four groups each pursuing a different syllabus. Further, these syllabuses are not constructed primarily because of their educational value at the school-level but are determined by university and professional requirements.

What can be done about this? The discussion showed the unanimity of opinion in favour of biological training at school being based upon the educational needs of the school-child. The needs of the majority of students who will not in fact go to a university are paramount, and these students require a general biological education. This would in fact also be desirable for the few who are going on to a university. In either case, specialized study anticipating later professional requirements is undesirable. Thus, many schools have complained of the demands made by embryology in the preliminary medical examinations. A thorough grounding in embryology is justifiable for the student of medicine at some stage; but detailed embryology is beyond the average school-child, and attempts to cover it make far too large demands upon teaching time.

It was pointed out in discussion that though special educational requirements should be discarded in favour of general biological syllabuses for schools, there is great advantage in some part of the syllabus being studied intensively. As remarked in the syllabuses recently published by the Cambridge Joint Advisory Committee for Biology, one cannot train scientific judgment when knowledge in all parts of the subject is scanty. But the part selected for intensive study should be one suited to the boy or girl at school, as is, for example, natural history. Further to ease the burden on the school-master and also to help preliminary work at universities, it is desirable that the school biological syllabuses of different examining bodies should have common aims and cover approximately the same kind of ground. Finally, in the interests of wider education, the total time spent at school on biology and indeed on natural science should not encroach too far on other fields of education. More than one recent conference between school-masters and university teachers have recommended that natural sciences subjects should not occupy more than two thirds of the teaching time.

It was with these things in mind that the Cambridge Local Examinations Syndicate and the Cambridge Syndicate of the Oxford and Cambridge Schools Examination Board recently set up a Joint Advisory Committee with members of the school-teaching profession to examine and report on their higher certificate syllabuses in natural sciences. These reports have now been published, and have in general had a very favourable reception. This Committee has tried to base its syllabuses on the various natural interests of the child. In zoology it has taken these to be: the structure and function of the human body, the variety of form and function in the animal kingdom, natural history, the relation of animals to man and other topics. Embryology is much reduced compared with current syllabuses. On the other hand, great stress is laid on the importance of natural history, because of the training it gives in observation and in the acquisition of knowledge at first hand, as opposed to the passive absorption of selected ideas in class. The syllabus indicates how the science of zoology can be built up from this basis. Thus the study of man is a starting point, rather than an anthropocentric goal. Scientifically this is good, because many questions of structure and function first arise in the study of one's own body and can most easily be examined in it.

One other question of considerable importance was discussed. Is it better that a young biologist at school should study zoology and botany as separate subjects or make one common study of biology? Certainly at an elementary stage there are no good grounds for any separation. From an educational point of view the single subject of biology has every advantage. But the encouragement of biology, rather than zoology and botany separately, raises certain difficulties in examinations. The school biologist is better trained who takes, say, biology, chemistry and physics rather than zoology, botany and some other subject. Yet the biologically minded student who takes the first combination stands at a disadvantage, since he has only one subject and not two in which he is likely to score credit. His situation is even more unsatisfactory when compared with that of the boy or girl taking physical sciences, who can choose three subjects, mathematics, physics and chemistry, for all of which he is mentally apt. This difficulty must in some way be overcome. It is part of a general problem which faces the educational system of Britain at the present time. How can we encourage a student to take subjects in which he does not excel, but which will be of the utmost value to him educationally, or even for the prosecution of his favourite study at a more advanced stage?

OBITUARIES

Mr. A. R. Hinks, C.B.E., F.R.S.

THE death, on April 14, at the age of seventy-two, of Mr. Arthur Hinks, for thirty years the distinguished secretary of the Royal Geographical Society, leaves a gap which it will be difficult to fill.

A mathematician and a graduate of Trinity College, Cambridge, Hinks devoted his attention to astronomy during the earlier part of his career, and it was for his work bearing upon the determination of stellar and solar parallax that he was awarded the gold medal of the Royal Astronomical Society in 1912, and was elected a fellow of the Royal Society in the following year. In accordance with a tradition observed by Sir Isaac Newton, but reaching back to the Greeks, geography is merely a branch of astronomy, and Mr. Hinks's interest in the earth as a planet, expressing itself in a series of lectures, and later of admirable text-books, upon surveying, cartography and map projections, led to his connexion with the Royal Geographical Society. His appointment as assistant secretary, and two years later (in 1915) as secretary, in succession to Sir John Keltie, was particularly apposite, since the fellows and Council of that Society were still primarily interested in travel and exploration, and Mr. Hinks not only organized and supervised the *ad hoc* instruction of intending travellers in practical surveying, but also was able to assist them in the interpretation, working up and presentation of their observations on their return. The most recent edition of the well-known "Hints to Travellers" is largely from his pen, and represents the fruits of his numberless contacts with British and foreign explorers. During the War of 1914–18, he was also able to be of very great assistance to the military in solving or advising upon various technical problems connected with maps, and it was for his services in this direction that he was made a C.B.E.

Mr. Hinks's own preoccupation with mathematical geography, and the Society's traditional function as a headquarters for exploration, had the result that the university geographer, attempting the systematic regional study of the earth and the interpretation of landscape, received rather a cold welcome at the House in Kensington Gore. The secretary was also editor of the Society's *Journal*, and his criticism and rejection, as editor, of academic research was by many felt to be unsympathetic and unduly harsh; but actually his standard of scholarship was high, while the achievements of British geography have been decidedly mediocre. The reason is not far to seek. There is an almost complete absence of scholarships, fellowships, research endowments and other opportunities for advancement and reward in geography, which naturally deters young men and women of first-class calibre from reading the subject at the universities. It was peculiarly unfortunate, in view of the help he might have given, that Mr. Hinks accepted the Royal Society's view that geography is not a part of natural knowledge, and does not fall under the head of "the examination and investigation of experiments and of natural things" for which under the Charter of 1663 that Society could lawfully hold meetings. Hence, except in its mathematical aspects, the subject of geography lacks status and can command no financial assistance.

Within his chosen field, Mr. Hinks himself contributed many valuable papers to the *Geographical Journal*, the subjects including photogrammetric survey, boundary delimitation, geodetic problems, cartographic technique, and novel or neglected projections. Quite recently, he designed and calculated a series of maps on the oblique Mercator network, accompanying them by a family of curves by means of which great circles could be plotted between any two points. The maps were immediately used in a discussion of the future of civil aviation. He was responsible, too, for the design and calculation of the very beautiful and effective map of Europe and the Middle East which was drawn by the Society's draughtsmen and published for the British Council. For beauty and elegance in map production, in so far as it was an expression of perfect fitness for function, he was always deeply concerned, and took part in many lively discussions upon alphabets and lettering with the officers of the Ordnance Survey.

Mr. Hinks's eminence in the fields of geodesy and cartography received world-wide recognition, and he was the recipient of the Royal Geographical Society's Victoria Medal in 1938, followed by the American Geographical Society's Cullum Medal in 1942. The present War robbed him of those years of leisure in retirement which were his due. He remained at his post, and only a few days before his death was answering correspondence upon projections, revising his standard text-book on the same subject, and giving vigorous expression to his opinion of a poorly conceived, badly designed and wretchedly executed map issued by a great public corporation.

E. G. R. TAYLOR.

Mr. G. V. Boys

GEOFFREY VERNON BOYS, secretary of the Institution of Naval Architects, died on March 15 at St. Mary Bourne, Andover. He was the only son of the late Sir Charles Vernon Boys, whose death at the age of eighty-nine occurred a year ago, and was born in 1893 at Oxford, where his father was then repeating, with improved accuracy, the Cavendish experiment, when he obtained 5·57 for the mean density of the earth.

G. V. Boys was educated at Marlborough and proceeded to Trinity College, Cambridge, in 1913. At the outbreak of the War in 1914 he served in the Royal Engineers, but was taken prisoner in August 1914. After spending some time in German prison camps, he was interned in Switzerland and resumed his residence at Cambridge in 1919, graduating in 1921. In the year following he lectured at the Royal College of Science, South Kensington, and in January 1922 joined the staff of Messrs. Kennedy and Donkin. As a senior engineer in this firm, he showed great skill in the use and application of mathematics and physics to engineering, and was frequently given difficult problems in design and always solved them. His work had the great merit of being accurate, and he possessed the admirable quality, especially in the application of science to engineering, of judging correctly the accuracy required without wasting time on irrelevant places of decimals. He was engaged *inter alia* on the Uhl River hydro-electric scheme for the Punjab Public Works Department and on many electricity transmission schemes, such as those in the Isle of Man and in Northern Ireland. He was responsible for the design and testing of the Central Electricity Board's grid towers in Scotland and north-west and south-west England, which are used to transmit electricity at 132 kilovolts throughout that part of the country. The work which he carried out for Kennedy and Donkin was of great value to them and was much appreciated on account of his sound judgment and his facility in finding the best method of attacking any complex problem.

In 1935 Boys was appointed secretary of the Institution of Naval Architects. He filled this post with great success and was popular with the members and staff and trusted by successive presidents of the Institution—the late Viscount Stonehaven and Admiral of the Fleet Lord Chatfield. Boys was also a good linguist; and when the Institution was invited to Germany in 1939, he attended as one of its representatives. He quickly became convinced of Germany's warlike intentions and on his return volunteered his services to the Admiralty. His offer was accepted, and in September 1939 he moved to Bath and became professional secretary to the Director of Naval Construction, retaining general control over Institution affairs. Although he was not a naval architect by training, he was soon giving useful help to the directors under whom he served—Sir Stanley Goodall and Mr. C. S. Lillicrap. Ill-health forced him to retire from the Admiralty in 1944. During his fatal illness he wrote or dictated letters to the office and his friends so long as he was able and showed great courage and patience throughout.

Boys had a good personality, mixing well with those he met, and was a man of knowledge and ability in many directions. He leaves a widow and a young son. L. WOOLLARD.

Mr. F. Percy Smith

F. PERCY SMITH, one of the pioneers of British film production, died on March 24.

It was in 1908 that Smith threw up an appointment with the Board of Education and gave himself up entirely to cinematography. He started working for Charles Urban and specialized in Nature and microscopic work. Even in these early days he had developed his special technique of speeded-up cinematography and had shown, in "The World before your Eyes" series, the beauties of the flower unfolding on the screen. Smith worked for Charles Urban for several years; but had no real opportunity of showing what he could do until in 1921 he joined Bruce Woolfe and took his part in the production of the "Secrets of Nature" series which, largely through Smith's contribution, has gone on ever since and has thus created a record for this or any other country of continuous production over a period of twenty-five years.

British cinematography has suffered a great loss as Smith's work was known and admired in nearly every country where cinematograph films are shown. Whenever a representative selection of British films has been shown to special audiences, something emanating from Smith's studio has always been included. In 1930 at the gala presentation organized by the Federation of British Industries to the delegates to the Imperial Conference his "Plants of the Underworld" was shown, and later, in 1933 at a similar gala presentation to world press representatives, he contributed "Gathering Moss".

Although much of Smith's work was shown in the theatres, and many will remember the weird beauty of his "Plants of the Underworld" and the drama of "The Life of a Plant", yet his main work was rather in the scientific film. Here he was undoubtedly in a class by himself, especially in the field of biology. In collaboration with Dr. Julian Huxley, he contributed a series of biological subjects that have done more to bring about the use of the cinema film in schools than any other single event. In connexion with this, Dr. Julian Huxley remarks: "Percy Smith had extraordinary patience and pertinacity in getting the results he wanted. In addition he was extremely ingenious in devising apparatus and gadgets of every description, His work was essential for the building up of high technical standards in the difficult art of biological film-making."

Although his studies of the chick and the frog were of very high quality, there is little doubt that it was his botanical films made in collaboration with Dr. E. J. Salisbury that opened up fresh possibilities to the cinematograph camera. As Dr. Salisbury writes: "Mr. Percy Smith was a first-rate cinematographer, who combined great technical skill with patience and observational acumen. The film which he took of the growth of roots is not only one of his most successful efforts, but exemplifies these qualities in a high degree. The knowledge of what is the life-history of a plant or its normal behaviour under particular conditions is not the end, but only the starting point in their pictorial portrayal. It was in the patience necessary to ascertain the precise phase of a phenomenon that best lent itself to pictorial record that Percy Smith exhibited so high a degree of skill almost amounting to genius."

The study, research and the patience that were necessary to complete such subjects as the life-histories of the fern and the moss were enormous, and nobody except a person whose sole interest lay in his work would have undertaken them. The fern film took three years to complete and that on the moss two and a half.

In the field of international competition, Smith's work had upheld the prestige of Great Britain, and prizes had been awarded his films in open competition against all comers, notably at Brussels and Venice.

Smith's was a strange personality. He had no thought for anything other than his work, and the only assistant he would tolerate was his wife. He was of a retiring and shy disposition, but with a keen sense of humour and a positive genius for the invention of 'gadgets'. In his studio he had machines to record the growth of plants; these, of course, had to work night and day. They were controlled by clockwork, made by himself, and it was essential they continued to function continuously, sometimes, for several weeks. As even he must sleep sometimes, he devised a means whereby if any of the machines stopped for any reason, it rang a bell by his bedside and woke him up.

In Percy Smith the British film industry loses a lovable personality and one whose work has done more than a little to uphold the prestige of British films. The sympathy of all will go out to his wife, who assisted him so ably, in her great loss.

WE regret to announce the following deaths:

Miss Emilia F. Miram, of the Zoological Museum of the Academy of Sciences of the U.S.S.R.

Prof. Andreas P. Semenov-Tian-Shansky, honorary president of the Russian Entomological Society.

Prof. William Trelease, emeritus professor of botany in the University of Illinois, on January 1, aged eighty-seven.

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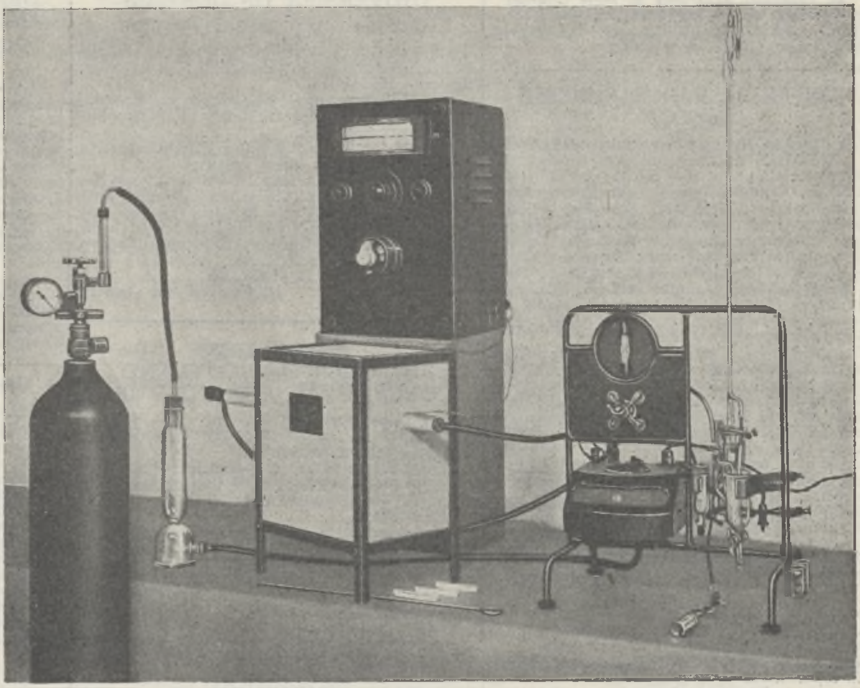

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The University,
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Write quoting C.2571.A to Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by May 28, 1945.

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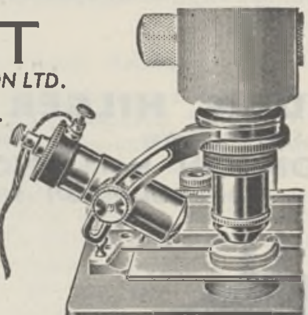

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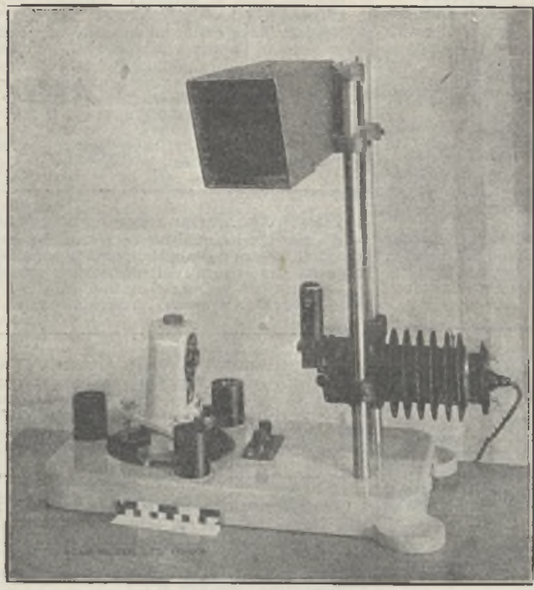

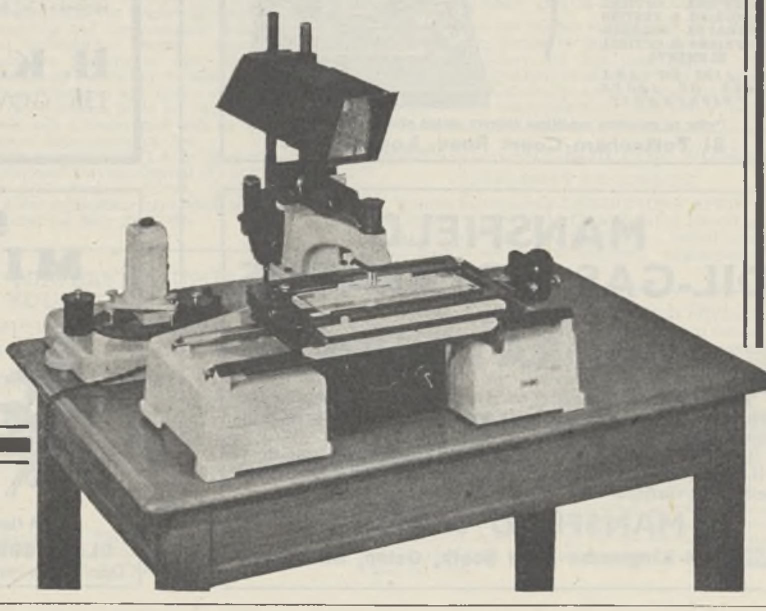

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NEWS and VIEWS

Chemical Society: Retirement of Mr. S. E. Carr

First as assistant and, later, general secretary, Mr. Stanley Ernest Carr has been identified with the Chemical Society for forty-two years. Mr. Carr's life's work has been such that much of the Society's progress must be ascribed to his guiding influence during that long period. Of necessity, there have to be frequent changes of honorary officers of a learned society, and it has to be left to the more permanent general secretary to preserve the continuity without which schemes for the advancement of the society and the science it represents would frequently fail or, at best, be only partly successful. The Chemical Society has been particularly fortunate in having Mr. Carr as general secretary for so long and during two periods of difficulty arising from emergencies when the importance of chemistry to the nation has had to be recognized. The history of the Chemical Society since the beginning of the present century is, indeed, almost an account of Mr. Carr's successful work for the Society and British chemistry. For example, on behalf of the Chemical Society, he has been intimately concerned with the introduction of the publication of the "Annual Reports on the Progress of Chemistry" (1904), the setting up of the Bureau of Chemical Abstracts (now, the Bureau of Chemical and Physiological Abstracts) and the setting up of the Chemical Council, so achieving co-operation with other societies and organizations concerned with chemical interests in Britain. Fellows of the Chemical Society owe a great debt to Mr. Carr both for his efficient work for the Society and for his courtesy and kindness at all times. They will wish him a peaceful retirement in which he will have happiness in the knowledge of the gratitude of those with whom he has worked.

Royal Geographical Society Awards

The King has approved the award of the Patron's Medal of the Royal Geographical Society to Sir Halford J. Mackinder, for his eminent contributions to geography, including the first ascent of Mount Kenya in 1899, and his long and distinguished service in the advancement of the science. His Majesty has given permission to the Council to postpone a recommendation for the Founder's Medal for 1945. The Council has resolved that the grant of the Society's awards for 1945 be postponed.

Bilingualism in Indian Education

In the *Journal of Education and Psychology* (Baroda, 1, No. 2; July 1943), A. I. Patel discusses bilingualism and Indian education. He surveys the results of the use of English as the medium of instruction in the earlier stages of education before the mother tongue has become an adequate mode of expression. He concludes that bilingualism hinders the process of education, renders its victims emotionally unstable, prevents moral development, dries up the sources of creative ability, and makes misfits of the students, adjusted to neither cultural group. The remedy is to realize that at present Indian education is neither Indian nor education. English should not be taught in the primary stage, but postponed to a late period in the secondary stage. It should rank as a second language, leaving the vernacular to be the medium of education. The present system, centred round the teaching of English, has had a fair trial and has failed. The writer admits that there will be difficulties but that for the sake of India they ought to be faced and overcome. He recommends the use of Basic English, when the time comes to learn English. He does not want to exclude English because it is the one language which can provide vital contact with European culture and civilization, but Indian language and literature should be the basis of education.

Science-Teaching in Schools

Yet another body speaks on the teaching of science in the schools of the future. The Essex Science Teachers' Association is an active one, holding several meetings each year under the able guidance of its secretary at the Mid-Essex Technical College, Chelmsford. It works for the advancement of science-teaching in all types of schools. The interim report, a fourteen-page brochure containing aims of science-teaching, suggestions for content of science syllabus and facilities for the teaching of science, is intended to be followed up with a series of publications dealing with science for the eleven-to-thirteen age-group, laboratory accommodation, etc. (The Content of the Science Curriculum in Post-Primary Schools. Interim Report of a Sub-Committee of the Essex Science Teachers' Association. Pp. ii+14. Chelmsford: Mid-Essex Technical College, 1944. 6*d*.)

The aims are admirably stated, a concise expression being given as "aims . . . to encourage pupils to learn the facts, principles and skills of science; to appreciate the spirit and service of science; and to acquire rational methods of working, observation, thought and expression". Material for the content of the syllabus, its order and depth of treatment, local environment, time requirements, scope and practical applications are all discussed. Rational suggestions are made with regard to sizes of classes, rooms and laboratories, equipment, workshop and repair facilities, staffing. Particularly valuable is the contribution of the non-science headmaster that concludes this much too brief report, many of the contents of which needed stating long and loudly; it is to be hoped that further publications will amplify many of the sections on facilities and content of syllabus.

Sixth Form Mathematics

The Cambridge Joint Advisory Committee for Mathematics, set up in November 1943, consists of eight school teachers and eight representatives of the University of Cambridge. The Committee has published a pamphlet "Syllabuses for Examinations taken by Sixth Form Pupils" (Cambridge University Press, 1945. 6*d*.), containing a scheme of two years work for higher school certificates and also for college entrance scholarships. It is recommended that the entrance scholarship papers should follow closely those for higher school certificates, and not give too much weight to advanced work. Pure and applied mathematics are regarded as a single subject, to which, even for specialists, not more than half the total teaching periods should be devoted. Another main subject, for example, physics, should also be taken, and at least one third of the total time should be reserved for general subjects. Having regard to the different requirements and levels of ability of the pupils, the Committee provides four different syllabuses, 'Subsidiary', 'Ordinary', 'Further', and 'Higher'. The 'Subsidiary' would be sufficient for those taking mathematics as an auxiliary to economics or biology, and includes, as an option, statistical method. This is an innovation of the greatest importance. The 'Ordinary' is roughly the present higher school certificate course for a 'Principal' subject, but again statistics may be taken if desired. The 'Further' and 'Higher' are suitable for candidates for university scholarships. Astronomy may be taken instead of some of the more advanced mechanics in the 'Further' course.

The Committee recognizes the great diversity of the needs to be catered for, and has tried to make the syllabuses as flexible as possible. Criticism and comment will be welcomed, and a revised edition of the syllabuses will, if necessary, be issued in the light of experience and of suggestions received. It is hoped that the Oxford and Cambridge Joint Board, the Cambridge Local Examinations Syndicate, and the Cambridge colleges will accept the syllabuses as a basis for their examinations. Approval has already been expressed by the Institute of Actuaries, and it is hoped that other professional bodies and the Services will also find them suitable.

National Museum of Wales

An important aspect of the annual report for 1943–44 of the National Museum of Wales is the evidence it provides of a council fully conscious of the Museum's educational function, which even under war-time conditions has been considerably developed. Lectures, demonstrations, special exhibitions, loans to research workers and schools, and the provision of facilities, material and instruction for teachers and students engaged in specialized work are striking examples of the valuable work being carried out by all departments. For the future, the opportunities provided by Section 100 of the 1944 Education Act for closer co-operation between schools and museums have been recognized. Accordingly the Council, in collaboration with the Welsh Department of the Ministry of Education, has already given consideration to the matter in relation to Welsh schools. Other authorities responsible for the conduct of museum affairs in a post-war world would do well to note this action. The Council also reports that its Memorandum on Museum and Art Gallery Services in Wales and Monmouthshire (summarized in the 1942–43 Report) has been forwarded to the Minister without Portfolio by the Welsh Reconstruction Advisory Council. With it the latter has sent a communication asking the Minister to give special attention to the importance of extensions to the National Museum being recognized as part of the official schedule of post-war reconstruction work; the provision of Government funds for an open-air museum as an essential auxiliary to the National Museum, and the establishment of a museum grant committee, there being a particular need for a grant for technical assistance to local museums in Wales.

Among the many other activities reported by the Council the following are noteworthy. Department of Botany: continuation of research on atmospheric pollen (see *New Phyt.*, 43, 49, 1944, and *Museums J.*, 44, 145, Dec. 1944). Department of Zoology: completion of a detailed list of all the mammalian remains of historic interest, and the continuation of the bibliographical indexing of Welsh species. Department of Archæology: continuation of survey work on ancient buildings in Monmouthshire, and the preparation of a report on the antiquities of West Gower (at the request of the Ancient Monuments Department of the Office of Works). Department of Geology: the provision (in response to many inquiries on various aspects of geology) of information relative to raw materials, water supply, drainage and roads. The Museum has made many interesting and valuable acquisitions during the year, and it should be noted that the important collection of Celtic antiquities found in 1943 in a bog near Holyhead, Anglesey, is now in the custody of the Archæological Department. A full bibliography of the publications of the National Museum of Wales is a useful appendix to this report.

Museums and Post-War Educational Developments

The annual report of the Manchester Museum (University of Manchester), while stating that the usual museum activities have been carried on during the year 1943–44, points out that its functions in relation to future educational developments can only be properly fulfilled when provision is made for an increase of technical staff, and for adequate working accommodation. As the report states, these needs are common to museums throughout Great Britain. At the present time, however, there are few or no signs that such needs—together with many others—will be met in the near future. No doubt the solution of the problem might be hastened if the Ministry of Education were to recognize in a more practical manner the considerable educational potentialities of these institutions. In the meantime, for lack of growing space, a valuable public service is unable to progress beyond its 'germination' stage.

Temperature Control

The lecture on 'The Practical Side of Fine Temperature Control" delivered by L. T. Townson and R. Barrington Brock to the Society of Chemical Industry in May of last year is now available in pamphlet form as No. 11 of the review *Service to Science* issued gratis by Messrs. Townson and Mercer. Ltd., of 390, Sydenham Road, Croydon. The lecture dealt with constant-temperature baths, particularly for medium temperatures, and concentrated attention mainly on water baths, which the authors point out are superior to air baths both because of the low heat capacity of air and also, they say, because its low density gives it little inertia, and enables vortices, with consequent temperature differences, to form more easily. The first matter which the authors stress, and on which they give experimental evidence, is the importance of stirring. They believe that paddle stirrers are not sufficiently effective, and that the whole of the liquid must be caused to flow through the bath; this involves the use of a second chamber of some sort, either entirely separate, or formed within the bath by means of false sides or some similar device. Other points which are discussed in the lecture are the effect of thermostat lag, the advantages and disadvantages of proportional control and the effect of heat losses. It is apparently not always realized that these lead to permanent differences of temperature in the bath. In this connexion, lagging is discussed, and the advantages of reflecting metal sheets as insulation are pointed out.

Biological Unit for Vitamin A

Vitamin A is unique in that the unit by which it has been defined has been measured with reference to a precursor, β-carotene, and not to vitamin A itself. This biological unit based on β-carotene as standard is cumbersome and subject to gross errors.

Certain foodstuffs are now required by law to include vitamin A, and regulations require that foodstuffs, claiming to contain vitamins, be labelled in units. Manufacturers who to-day handle vitamin A are dependent on the spectroscopic method of assay using the extinction coefficient at 325–328 mμ as a linear function of vitamin A activity, and it has been necessary to adopt a factor to relate the spectroscopic reading with the biological international unit. Such factors have become standardized in Great Britain and in America although at different levels.

N. T. Gridgeman, in "The Estimation of Vitamin A" (Lever Brothers and Unilever, Ltd., 74; 1944), assembles and reviews the evidence. He shows that these factors do not rest on a sound scientific basis, due mainly to the occurrence of a number of vitamin A congeners and to the fact that the biological test is very complex; for example, there is the synergism of vitamins A and E. He recommends the adoption of a new unit based on the spectroscopic assay method. A provisional skeleton definition would be "the unit of vitamin A is that quantity which made up to 100 ml. with a specified organic solvent gives a solution having an extinction coefficient at 325 mμ of 0·005". He adds that "the quest for a new easily measurable physiological criterion of response, sharply graded to increasing dosage, prophylactic or therapeutic, of vitamin A, can be regarded as a fruitful research problem".

Stars of the Southern Skies

LEAFLET No. 188 (Oct. 1944) of the Astronomical Society of the Pacific, by Leon E. Salanave, gives a simplified star chart and guide to observations with the unaided eye and with field-glasses. It has been compiled in response to numerous requests, from the South Pacific in particular, for star finders, constellation guides, etc., and is specially designed for a latitude 20° south of the equator. Only those stars are shown which are necessary to suggest the constellation figures, and after learning these the observer's knowledge can be extended with the aid of more complete charts. There is a brief description of the constellations, stars of the first magnitude, and of a few interesting objects such as the Great Nebula in Orion, the Large Magellanic Cloud, etc. The Leaflet will serve a useful purpose for those engaged in military operations who have found themselves under unfamiliar skies.

Association of British Zoologists

THE Association of British Zoologists, which had not met since January 1939 owing to the War, held its tenth annual general meeting on March 24 in the rooms of the Zoological Society of London. Proceedings opened with a business meeting during the course of which the following elections were made or, having been made by the Council, were confirmed: *President*, Prof. James Ritchie; *Hon. Secretary*, Dr. John Smart, British Museum (Natural History), London, S.W.7; *New Members of Council*, Prof. D. L. Mackinnon, Prof. James Gray, Mr. J. C. F. Fryer, Prof. C. H. O'Donoghue and Wing-Commander F. S. Russell; *New Trustees*, Mr. J. T. Saunders and Dr. W. E. Swinton. After the business meeting, the Association proceeded to a discussion on the "Post-War Teaching of Zoology in Schools and Universities". This discussion was opened by Dr. C. F. A. Pantin and is reported elsewhere in this issue (see p. 535). In the afternoon, a series of four shorter discussions centring around the general topic of "Some Developments of Post-War Research" was engaged in. The first, on "Marine Investigations", was opened by Dr. E. S. Russell and this was followed by one on "The Work of the Zoological Society" opened by Dr. S. A. Neave. Mr. J. C. F. Fryer opened the next, on "Zoological Interests of the Agricultural Research Council", and the final topic was "Freshwater Investigations", opened by Dr. E. B. Worthington.

Frank B. Jewett Research Fellowships

FIVE Frank B. Jewett Fellowships for research in the physical sciences have been awarded by the American Telephone and Telegraph Co. to Dr. Elliot R. Alexander, Dr. Albert S. Eisenstein, Dr. Kenneth Greisen, Dr. Boris Leaf and Dr. Harry Pollard. The availability of these men to accept their fellowships will depend upon the progress of the War, as each is now engaged in essential war research. Dr. Alexander is at present a research chemist at the du Pont Experimental Station at Wilmington; Dr. Eisenstein is a member of the Radiation Laboratory staff at Cambridge, Mass.; Dr. Greisen is engaged in war work at Santa Fé, New Mexico; Dr. Leaf is an associate chemist in the Metallurgical Laboratory of the University of Chicago; and Dr. Pollard is a member of the Applied Mathematics Group at Columbia University.

Announcements

THE following appointments have recently been made in the Colonial Services: D. Sturdy, senior agricultural officer, Tanganyika, to be director of agriculture, Jamaica; E. T. Ward, agricultural superintendent, Windward Islands, to be agricultural officer, Tanganyika; R. K. Hardy, assistant government chemist, Nigeria, to be government chemist, Nigeria; D. R. Rosevear, senior assistant conservator of forests, Nigeria, to be conservator of forests, Nigeria.

THE following appointments have been made to the technical staff of Ashe Laboratories, Ltd., 120/2, Victoria Street, London, S.W.1: Mr. D. I. Duveen now takes charge of the development of full-scale production of amino-acids and protein digests; he has worked in Paris and in London and has published papers, some in collaboration with Dr. J. Kenyon, on problems connected with optical activity and the preparation and isolation of substituted naphthacenes and their photo-oxides. Mr. Duveen will be assisted by Mr. E. G. Hatten, formerly of Glaxo Laboratories, who has had experience in the production of fine chemicals and therapeutic preparations. Mr. H. S. Young, formerly with Messrs. Crosse and Blackwell and C. and E. Morton, Ltd., has been appointed food chemist and will be responsible for the control and development of food preparations manufactured by the Ashe Laboratories. Mr. P. Lewis Smith, formerly with Messrs. Eli Lily and Co., has been appointed to the pharmaceutical section, where his long experience in the Far East will be of great assistance in the company's export programme. The new appointments will be under the general direction of Dr. W. E. Gaunt, who is known for his work on amino-acids and protein digests.

ERRATUM.—The new insecticide described in the communication entitled "Acaricidal Property of a New Insecticide, Hexachlorobenzene" printed in *Nature* of March 31, p. 393, was wrongly named. The substance referred to is benzene-hexachloride, or 1 : 2 : 3 : 4 : 5 : 6 : hexachlorocyclohexane.

LETTERS TO THE EDITORS

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

A New Rhesus Antibody

AN antibody of a type hitherto undescribed, which discriminates between certain Rhesus genotypes, has been found in the serum of a male patient, H.Br., of blood group O, suffering from a hæmolytic anæmia of uncertain ætiology. He was transfused on numerous occasions with unselected group O blood and ultimately began to have reactions suggestive of incompatibility. His serum was found to contain an agglutinin which clumped the red cells of all but about 4 per cent of group O donors. The cells of one group O Rhesus-negative subject, C.K., were agglutinated down to a dilution of 1 in 640 by serum obtained in April 1944. In May 1944 the titre against cells of the same subject had fallen to 80 and in January 1945 to 20. Most of the investigation was carried out with the May serum.

The red cells of 662 group O donors and other subjects, unselected with respect to the Rhesus factor, have been tested with the serum. Twenty-seven, or 4·1 per cent, are unagglutinated or '*Br*-negative'. Sixty-nine group O *Rh*-negatives, partly included in the above 662 subjects, have all been found to be *Br*-positive, and in addition 5 *Br*-negatives selected from a different panel from the 69 *Rh*-negatives have been found to be *Rh*-positive.

The Rhesus genotypes of eight *Br*-negatives, including H.Br. himself, were determined by Dr. R. Race and the late Dr. G. L. Taylor. Seven, including H.Br., fell into the class including Rh_2Rh_2 and Rh_2rh, and one was $Rh''rh$ or $Rh''Rh''$. The father and only child of H.Br. were found to be respectively Rh_2Rh_2 or Rh_2rh, and Rh_1Rh_2, both *Br*-positive.

Some *Br*-positives are extremely weak reactors with the rather low-titre specimens of serum now in use, and it appears probable that a few of the apparent negatives would react positively with a stronger serum. Nearly all the weak reactors tested for their *Rh* genotype have contained the gene Rh_2 or Rh''. *Rh*-negatives are almost invariably among the strongest reactors.

These properties are consistent with those of the antibody η predicted by Fisher[1]. η should agglutinate the cells of all *Rh* genotypes containing the genes Rh_1, Rh', Rh_0 and rh, but not those of genotypes composed exclusively of Rh_2, Rh'', Rh_z and Fisher's hypothetical Rh_y. Thus most of the negatives will belong to the genotype Rh_2Rh_2, and Rh_2Rh'' and $Rh''Rh''$ will also be unagglutinated. As stated above, eight subjects negative to *Br* have been tested with the four antibodies in previous use. If *Br* is the hypothetical antibody η, then at least 85 per cent of *Br*-negatives should fall in the class containing Rh_2Rh_2, which constitutes no more than 15 per cent of the population. Of these eight cases, seven in fact fall in this class. None should fall in the group of classes which does not react to anti-Rh_2 or H: none in fact has been found to do so. The proportion of η-negatives should be 2·9 per cent, which is in fair agreement with the 4·1 per cent found for *Br*, a figure almost certainly including a few false negatives due to the weakness of the serum.

In order further to test this hypothesis, use was made of a family at present under genetic investigation, where two members are unambiguously Rh_2Rh'' and one Rh_2rh. The former are both *Br*-negative and the latter *Br*-positive. These genotypes were formerly serologically indistinguishable.

The genotypes of strong and weak reactors respectively show that the *Br* reaction is stronger where two *Br*-positive genes are present than where there is only one. In showing this single- and double-dose effect, *Br* resembles *St*[2,3], the other antibody known to agglutinate *Rh*-negative cells.

There can thus be little doubt that *Br* is identical with η, but genetic studies are continuing which should further confirm their identity. The chief practical value of the serum will lie in distinguishing between the genotypes Rh_2Rh_2 and Rh_2rh, the only common ones not distinguished by formerly known sera. The distinction is especially important in the fathers of erythroblastotic babies, since the Rh_2Rh_2 men will have a much smaller chance of begetting healthy offspring than will Rh_2rh men. The discovery of this serum following soon after Race's discovery of the gene Rh_z[3,4] emphasizes the value of Fisher's theory as an instrument of prediction.

This work would not have been possible without the help of the late Dr. G. L. Taylor, who carried out most of the genotyping and gave me much very useful advice. Just before his untimely death, he was engaged in testing the serum against known genotypes and he appeared to have reached full agreement with the conclusions here stated. I am indebted for facilities for this work and much valuable assistance to Dr. H. F. Brewer, Prof. R. A. Fisher, Mr. R. Hudson and Dr. R. R. Race. My thanks are also due to Prof. R. V. Christie for the opportunity of investigating the patient concerned.

A. E. MOURANT.

N.E. London Blood Supply Depot,
St. Mary's Hospital,
Luton. March 21.

[1] See Race, *Nature*, 153, 771 (1944).
[2] Race and Taylor, *Nature*, 152, 300 (1943).
[3] Race, Taylor, Boorman and Dodd, *Nature*, 152, 563 (1943).
[4] Murray, Race and Taylor, *Nature*, 155, 112 (1945).

Anti-*Hr* Serum of Levine

IN 1941, Levine[1] in New York described a rare type of anti-*Rh* serum which was called anti-*Hr*. This antibody was found in the serum of an *Rh*-positive mother of an erythroblastotic infant. Unfortunately, the weakness of the antibody did not allow the genetics of its corresponding red blood cell antigen to be worked out[2].

In 1943, a powerful antiserum now called *St* was found in England and the genetics of the antigen which it recognized were worked out[3,4,5,6]. Anti-*Hr* and *St* sera were alike in that they both reacted with *Rh*-negative and with at least the majority of 'Rh_2' cells, but here the similarity ended. Wiener, however, has categorically stated that they are the same antibody[7]. A powerful example of anti-*Hr* serum has now been found and has recently been described by Waller and Levine[8]. From the description it is quite clear that anti-*Hr* and *St* are not the same antibody. Waller and Levine say "in tests with a potent anti-*Hr* serum all the Rh_1Rh_2 bloods gave negative reactions. About 60% of Rh_1 bloods of white individuals and almost all coloured individuals tested possessed the *Hr* factor." The original *St* serum and three identical sera in our collection do react with all Rh_1Rh_2 bloods. It is a striking coincidence that the percentage of positive reactions in the Rh_1 group corresponds exactly with the percentage which we can recognize by means of *St* serum to belong to genotype Rh_1rh, and it seems highly probable that this potent anti-*Hr* serum agglutinates the Rh_1rh fraction of the Rh_1 group. If this is so, it must react with only a single dose of an *St* positive gene, and the failure to agglutinate Rh_1Rh_2 cells cannot be attributable to the presence of only a single *St*-positive component, namely, Rh_2.

It is interesting to compare the observed reactions of this potent anti-*Hr* serum with those predicted for the hypothetical antibody δ which Fisher's formulation anticipated[6].

	Rh-negatives	Rh_1Rh_2	'Rh₁ blood of white individuals' About 60 per cent Rh_1rh	and 40 per cent Rh_1Rh_1
Genetic structure in Fisher's scheme	$\frac{cde}{cde}$	$\frac{CDe}{cDE}$	$\frac{CDe}{cde}$	$\frac{CDe}{CDe}$
Observed reactions of anti-*Hr* (Levine)	+	−	+ with "about 60%"	
Predicted reactions of δ (Fisher)	+	−	+ with Rh_1rh (60 per cent)	− with Rh_1Rh_1 (40 per cent)
Observed reactions of *St* (or γ)	+	+	+ with Rh_1rh (60 per cent)	− with Rh_1Rh_1 (40 per cent)

The hypothetical δ reacts with *d*. *St* (or γ) reacts with *c*.

It was realized when Fisher proposed his scheme that if the antibody δ were encountered, it would be easily distinguishable from γ because the former would fail to agglutinate Rh_1Rh_2 cells.

The finding by Levine of an antibody possessing the characters of one predicted in Fisher's formulation of the genetics of the *Rh* blood groups greatly increases the probability that this formulation represents the actual state of affairs. That *St* serum and Levine's anti-*Hr* serum contain quite different antibodies is now certain; both react with *Rh*-negative blood, but with different components in its antigenic constitution.

It seems probable that Levine and Wiener are working with different anti-*Hr* sera. Levine's powerful anti-*Hr* appears to be the predicted δ, while Wiener's is probably *St* (γ).

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D. F. CAPPELL.
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University of St. Andrews Medical School,
Dundee. March 26.

[1] Levine, in the "Yearbook of Pathology and Immunology", 509 (1941).
[2] Levine, *J. Paed.*, 23, 6, 656 (1943).
[3] Race and Taylor, *Nature*, 152, 300 (1943).
[4] Race, Taylor, Boorman and Dodd, *Nature*, 152, 563 (1943).
[5] Race, Taylor, Cappell and McFarlane, *Nature*, 153, 52 (1944).
[6] Race, *Nature*, 153, 771 (1944).
[7] Wiener, Davidsohn and Potter, *J. Exp. Med.*, 81, 1, 63 (1945).
[8] Waller and Levine, *Science*, 100, 453 (1944).

WITH the complete set of six antibodies now apparently discovered, the recognition of rare genotypes will be immensely easier. All the homozygotes of the seven known allelomorphs can be distinguished unambiguously, and nine of the heterozygotes, namely (omitting *h*'s), R_0r, R_0R_2, R_0R_1, R_2R'', R_2R_z, $R''r$, $R'r$, R_1R_z, R_1R'. Three pairs of heterozygotes are indistinguishable

R_0R''	R_0R'	R_0R_z
R_2r	R_1r	R_1R_2

These leave little practical doubt, since in each case the genotype printed below is about one thousand times more frequent than that above.

Three more heterozygotes are capable of confusion only with a heterozygote involving R_y, which has not been discovered, and is unquestionably very rare:

R_yR_2	R_yR_1	R_yr
R_zR''	R_zR'	$R'R''$

It is among these that R_y may be looked for.

Finally, a group of three known genotypes, and one involving R_y, should react positively with all six reagents. These with their approximate frequencies in the British population are shown below:

R_1R''	R_2R'	R_zr	R_0R_y
0·8%	0·3%	0·4%	very rare indeed.

Thus it is only among these last that genotype recognition will have to rely on pedigree evidence. The interpretation of pedigree evidence also will now be greatly facilitated.

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An Unsuspected Relationship between the Viruses of Vaccinia and Infectious Ectromelia of Mice

IT has been observed that emulsions in saline of the lesions produced on the chorioallantois by the virus of infectious ectromelia of mice have the capacity of agglutinating fowl erythrocytes. As is the case with vaccinia virus preparations[1], only about 50 per cent of individual fowls provide susceptible cells. Cells susceptible to one virus are susceptible to agglutination by the other. Agglutination by infectious ectromelia virus is inhibited by anti-vaccinial immune serum from calves.

The possibility of the infectious ectromelia virus being contaminated with vaccinia virus can be excluded, first by the completely different appearance of the lesions produced by the two viruses on the chorioallantois, and secondly by the fact that liver and spleen emulsions from mice dead of infectious ectromelia give a similar agglutination of susceptible but not of insusceptible fowl cells.

Using a technique similar to that commonly used for hæmagglutination work with influenza virus, the titre of a stock membrane emulsion of ectromelia virus (each chorioallantois ground with 1 ml. of saline) is about 1 : 200. The same emulsion titrated on the chorioallantois gives approximately $1{\cdot}2 \times 10^7$ specific pocks per ml. This corresponds closely to the relationship found between the results with the same two methods of titration of vaccinia virus. Preliminary work suggests that a soluble product rather than the virus itself is responsible for the hæmagglutination.

Although the two viruses differ sharply in host-range and type of lesion produced, their physical qualities agree closely; and there seems to be no adequate reason why our findings should not be taken at their face value as indicating that infectious ectromelia is the murine representative of the mammalian pock diseases.

F. M. BURNET.
The Walter and Eliza Hall Institute,
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Jan. 24.

[1] Nagler, F. P. O., *Med. J. Australia*, 1, 281 (1942).

Effect of Adrenaline Solutions on Oat Roots

A SOLUTION of adrenaline, which is a catechol derivative, oxidizes in the presence of air and much more readily when some phenolases[1] are present. Solutions of adrenaline in tap water can inhibit the growth of oat roots in the concentrations indicated below.

Concentration of adrenaline	0·001 *M*	0·0005 *M*	0·0001 *M*	0·00005 *M*
Per cent growth value	59·4	75·8	83·8	97·3

In addition to the effect on growth as measured by extension of roots, certain effects on cell development are of note. After forty-eight hours growth in the more concentrated solutions, it was observed that the root cap, when viewed by reflected light, was jet black and by transmitted light dark brown in colour. Under the microscope the youngest part of the root was still light, and the crest of dark root-cap cells was an excellent demonstration of this tissue.

At the root base and extending down to the region of cell expansion, the piliferous layer was seen to be stained dark brown and the root hairs remained small or undeveloped. In addition, the normal expansion of the piliferous layer had been prevented so that splitting of this tissue had occurred exposing the relatively unstained underlying tissues.

It was observed that the cell walls of the piliferous layer were stained and often the outer wall of the exodermis, this latter tissue apparently performing its classical role as a selective barrier to substances in solution. The staining was almost certainly due to the more complete oxidation of the adrenaline by a phenolase from the root cells. Tests for oxidase in normal 48 hours old roots showed that with Nadi reagent a deep blue colour developed rapidly in the root cap and root hairs and in the root generally. In the presence of peroxide the catalase of the root caused a rapid evolution of oxygen.

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H. G. BAKER.

Department of Plant Physiology,
Hosa Research Laboratories,
Sunbury-on-Thames.

March 6.

[1] Martin, G. J., Ichniowski, C. T., Wisansky, W. A., and Ansbacher, S., *Amer. J. Physiol.*, 136, 66 (1942).

Control of the Potato-Root Eelworm *Heterodera rostochiensis* Wollenweber, by Allyl *Iso*thiocyanate

MORGAN[1] was the first to report that few eelworm cysts are found on the roots of potato plants grown together with white mustard in pots of soil infested with the potato-root eelworm. Afterwards[2] it was shown that root excretions from potato plants mixed with those from white mustard seedlings will no longer stimulate the emergence of eelworm larvæ from the cysts; this effect is also produced by black mustard, perhaps by cress, and, by certain solutions of allyl *iso*thiocyanate, the mustard oil of black mustard seed[3]. Field trials with white mustard as green manure were a failure[4,5], due, it has been suggested[6], to the difficulty of applying the excretions in sufficient quantity in the field; the results with allyl *iso*thiocyanate suggested that these difficulties might be overcome, and a small-scale field trial during 1944 gave promising results.

The mustard oil, on granular peat, was applied to the potato drills at the time of planting. Treated plants were superior to the various types of control throughout the season, and the difference became more pronounced as the season advanced. Yields were about 100 per cent above controls and the differences were statistically significant.

This is not the first occasion on which *iso*thiocyanates have been used in combating eelworm. Smedley[7] found the phenyl form to be very toxic to the eggs in the cysts, and used it in an extensive field trial; apparently unaware of the early work with white mustard and of the possible connexion of *iso*thiocyanates with the response of larvæ to potato root excretions, the oil, adsorbed on to talc, was applied all over the treated plots some time before planting. Comparison of the results of my experiment with 160 plants with those from an extensive field trial is somewhat presumptuous; but the results are very different. Application of phenyl *iso*thiocyanate at the rate of 2 cwt. per acre increased the yield by 35 per cent; smaller dressings were ineffective. On the other hand, allyl *iso*thiocyanate at the rate of only 0·1 cwt. or about 11 lb. per acre, increased the yield by 100 per cent; and this *iso*thiocyanate is also far cheaper. It remains to be seen whether the greater effect of the latter is due to the method of application, which takes account of the 'interaction' between mustard oil and potato root excretion, or whether it is due to differences in the properties of the substances.

A detailed account of this work will be published elsewhere.

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Use of Calomel on Onions

THE observations of Dr. J. R. Booer on the control of onion white rot (*Sclerotium cepivorum* Berk)[1] are very interesting. A fairly extensive experience in the use of mercurous chloride for onion seed treatment under field conditions has led me to believe that the use of this substance may have a wider significance than is realized.

A particular case may be noted. During 1942, 1943 and 1944, I had under observation plots of onion plants grown from seed which had received calomel treatment at the rate of ¾ lb. per lb. of seed. In these plots I was surprised to see what appeared to be a marked degree of control of eelworm (*Anguillulina dipsaci* Kühn), and a marked improvement in the crop itself.

Laboratory tests using calomel in water are entirely negative so far as any lethal effect on eelworm is concerned, but Dr. Booer tells me that in his opinion some lethal effect is not impossible when calomel is decomposed in the soil. If this is so, and further investigation confirms that some degree of control of eelworm may be obtained, and this in addition to the already established control of onion fly and onion white rot, it would seem that the use of calomel in respect of onion crops may be very valuable.

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Insect Epicuticle

Alexander, Kitchener and Briscoe[1,2] have shown that the desiccation of many insects caused by inert dust insecticides is due to adsorption of the epicuticle wax film, which becomes discontinuous and allows of increased loss of water through the cuticle. Further, Wigglesworth[3,4] has demonstrated abrasion of the wax film and increased evaporation of water caused by the application of an inert dust. It is evident, however, that insects differ considerably with regard to the epicuticle, for nymphs of *Rhodnius* are unaffected by adsorption but are susceptible to abrasion[3], whereas *Tenebrio* and other larvæ are more susceptible to adsorption than to abrasion[1].

Experiments with 'Neosyl' (a proprietary adsorbent silica dust) and carborundum powder show that *Sarcophaga* larvæ are affected neither by adsorption nor abrasion, suggesting that they differ from both *Rhodnius* and *Tenebrio* larvæ with regard to their epicuticular waxes. Histological examination shows that lipoid substances are confined to a very thin layer at the surface of a thin (4μ) protein epicuticle. This surface layer differs from the remainder of the cuticle in being insoluble in cold concentrated hydrochloric acid, and may therefore be isolated as a thin membrane. Prolonged treatment with lipoid solvents does not destroy the ability of this membrane to stain with Sudan Black B, and on account of its integrity after these treatments it is justifiable to regard it as a constituent layer of the cuticle, the outer epicuticle consisting apparently of a very stable lipo-protein complex. The bulk of the protein epicuticle does not stain readily with Sudan Black B, and is almost completely untanned.

A similar double epicuticle is present in the cockroach *Periplaneta*[5], which also possesses an external layer of labile fatty substance[6]. It seems, therefore, that lipoid substances may be associated with the insect epicuticle in one or more of a number of ways. They may be present as a readily removable surface layer; they may form a complex with the surface of the epicuticle so as to produce a distinct structural layer; and they may impregnate the whole of the epicuticle when this layer is tanned[7]. Variations in lipoid distribution in the cuticle must clearly be taken into account as one of the many factors determining the effectiveness of an inert dust insecticide on different insects.

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Units for Degree of Vacuum

It has long been considered in this laboratory that when working in the field of medium and high vacua (pressures of 1 mm. mercury or less), the usual methods of referring to and recording the degree of vacuum are extremely awkward verbally and little less so when written.

There are a number of known systems of recording such pressures, the bar and the millimetre of mercury pressure (mm. Hg) and their subdivisions being most widely known, the micron being a subdivision of the mm. and the Torr, found in German practice, being a name given to the millimetre of mercury pressure as a unit of pressure. The millimetre of mercury pressure is almost universally used, but when subdivisions of this unit are used, recourse is necessarily made to either the negative index method or the decimal method of reference or recording. Thus, a pressure of, say, 2×10^{-5} mm. mercury may be written so, or as 0·00002 mm. Hg; both methods are lengthy to write, but verbally these expressions are even more unwieldy.

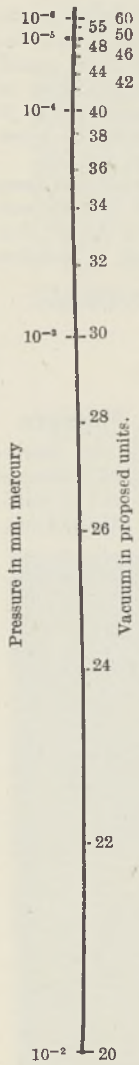

Fig. 1. SCALE OF TYPICAL McLEOD GAUGE. FULL SIZE.

It is proposed, therefore, that a new unit be adopted, based on the logarithm of the numerical value of the pressure in millimetres of mercury. The reading in these units is, in fact, the logarithm of the pressure in millimetres, reduced to its all-negative form and multiplied by minus 10, this being similar to the method of measuring power ratios, etc., in decibels, the reference-level in this case being 1 mm. mercury pressure. A scale formed on this basis is very simple in use, both for written record and verbal reference, resulting in pressures of 10^{-1}, 10^{-2} . . . 10^{-6} mm. mercury, etc., becoming vacua of 10, 20 . . . 60 units, etc. The pressure of 2×10^{-5} mm. mercury referred to becomes a vacuum of 47 units. This system also leads to the logical result, that a 'higher' vacuum has a higher numerical value.

Such a system as that suggested could, of course, be based on any other unit of pressure, such as the bar or the standard atmosphere; but it is considered that the basic level of 1 mm. mercury pressure gives the working-range fitting best with current practice. Also a pressure of 1 mm. mercury is, in a most marked manner, the border-line between the field of medium- and high-vacua work and the field of low-vacuum work, and there is seldom any overlap between the two fields. Consequently the fact that a pressure of greater than 1 mm. mercury would have a negative value on the suggested scale is of little disadvantage, since where work is consistently done in the low-vacuum range it is recommended that the scale of millimetres be adhered to.

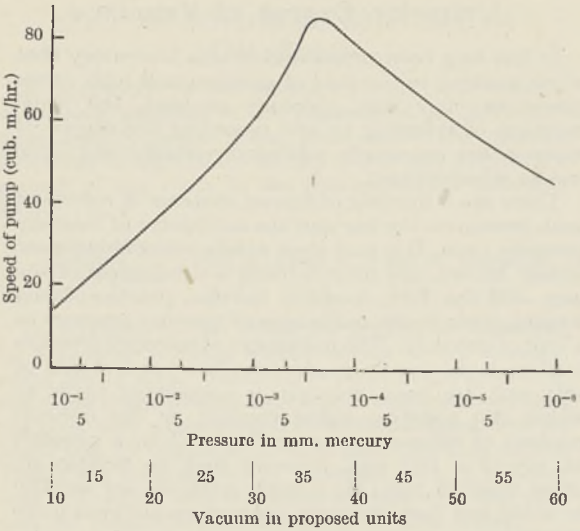

Fig. 2. SPEED OF 3-STAGE MERCURY DIFFUSION PUMP AT DIFFERENT VACUA.

A typical McLeod gauge scale, calibrated in the suggested manner, is shown in Fig. 1, and it may be seen that a more evenly marked scale than usual is obtained. Curves of pump performance, etc., may be plotted on ordinary squared paper, as shown in Fig. 2, and in both cases intermediate values may be more accurately interpolated than by the usual method.

No name has been given to this unit, as it has been found that reference to 'a vacuum of 47' is sufficient once the system has been established, but should this suggestion become more widely adopted, a suitable name should be found.

F. H. TOWNSEND.

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Cambridge. Feb. 22.

Reflexion in a Non-Isotropic Medium

THE way in which the extraordinary ray transmitted by a calcite crystal infringes the laws of simple refraction is, of course, a commonplace and is mentioned in all text-books that deal with polarization. On the other hand, I have not yet found an explicit reference to the infringement of the law of the equality of the angles of incidence and reflexion.

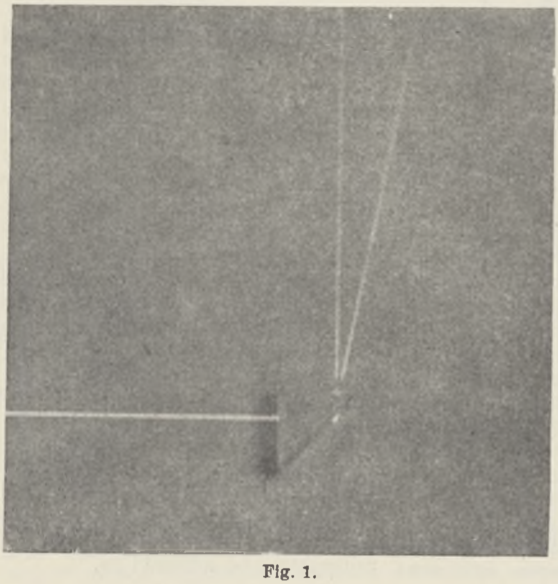

Fig. 1.

Hence the accompanying photograph (Fig. 1), which illustrates one simple case, may be of interest. It shows the trace, on a sheet of paper, of a ray of unpolarized light incident upon the totally reflecting face of a prism of calcite cut in such a way that the optic axis is parallel to the incident beam. Two plane polarized rays are reflected. The one reflected normally is the ordinary ray, with the electric vector perpendicular to the plane of the paper, whereas the one reflected at an obtuse angle is the extraordinary ray with the electric vector parallel to the plane of the paper. In the latter case it is clear that the angle of incidence made with the totally reflecting surface is not equal to the angle of reflexion.

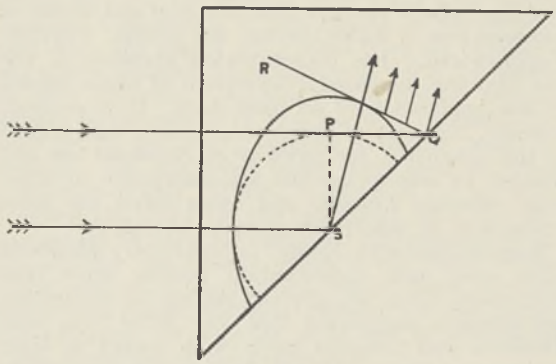

Fig. 2.

The result follows, of course, from the fact that, in the time waves take to travel from P to Q in Fig. 2, the extraordinary wave front that spreads out from S is an ellipse, and the reflected ray is thus propagated in the direction of the arrows on the tangent QR. After refraction this ray gives rise to the emergent ray seen in the photograph. The path of the ray thus calculated (using the accepted values of the ordinary and extraordinary refractive indexes) is in good agreement with the observed path.

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Action of Hydroxylamine on Polysaccharides Oxidized with Periodic Acid

BARRY[1] discovered that when a polysaccharide has been oxidized with periodic acid, the oxidation product on warming with phenylhydrazine yields glyoxalosazone. Thus, oxidized starch and cellulose are, theoretically at least, completely broken down into glyoxalosazone and erythrose phenylhydrazone, while 1,3 polysaccharides, such as laminarin, being attacked only at terminal units by periodic acid, have these oxidized terminal units completely removed by phenylhydrazine. It has now been found that a similar reaction takes place with hydroxylamine. Starch oxidized with periodic acid quickly dissolves in boiling water or absolute alcohol on addition of an alcoholic solution of hydroxylamine made by adding alcoholic potash to hydroxylamine hydrochloride until the solution is faintly alkaline. The solution becomes faintly acid as the starch dissolves and must be brought back to alkalinity by addition of more alcoholic potash. When the solution of the starch is complete, except for a small residue, the solvent is evaporated off, and ether will extract glyoxime from the residue after acidulation to set it free from its potassium compound.

Harries[2] found that when the semidiacetal of glyoxal, $CHO-CH(OC_2H_5)_2$, was treated with phenylhydrazine, an oily phenylhydrazone was formed; and when the mixture was heated, the acetal group also reacted with production of glyoxalosazone. An inspection of the formula for the oxidation product of starch with periodic acid shows that it is a polymerized semidiacetal of glyoxal and erythrose, so that Barry's reaction is a special case of that of Harries. Harries does not report any attempt to form glyoxime from his glyoxalsemidiacetal; but no doubt such a reaction would take place.

The yield of glyoxime from an oxidized starch has not so far been as good as the yield of glyoxalosazone, and has not exceeded about 30 per cent of that theoretically obtainable on the assumption that each unit of the starch has been oxidized. If, by further experiments, the yield can be made quantitative, the 'cleanness' of the reagent should make the oxime reaction a useful weapon for elucidating the structure of polysaccharides.

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Mechanism of Felting of Wool Fibres

THE theory of felting of wool in fabric form developed by Speakman and his collaborators[1] postulates that under the repeated application of pressure the unidirectional migration of wool, due to its scaliness, is achieved by local extension and contraction of the fibres, and conditions which favour these processes promote milling shrinkage. In the course of the present investigations, a full account of which will appear elsewhere, it became clear that in felting the frictional properties of wool are as important, if not more so, than its extensibility and power of recovery.

The reason why the fibres always travel in the direction of their root ends in milling is that the friction of wool is greater when rubbed from tip to root than from root to tip[2]. The difference between the maximum and the minimum coefficient of friction has been termed by Martin[3] the 'directional frictional effect', and it has been determined in the present experiments for a uniform sheet formed by several hundred wool fibres, with their scales all pointing in the same direction, against a horizontal polished glass surface immersed in the appropriate medium. Some of the results, all relating to the same fibres, are given in Table 1, from which it is evident that the directional frictional effect changes with the pH of the medium in the same sense as does the felting power of wool.

TABLE 1

Medium	Maximum coefficient	Minimum coefficient	Directional frictional effect
Hydrochloric acid (pH 0·63)	0·4428	0·3559	0·0869
Soap (pH 9·87)	0·3559	0·3014	0·0545
Borax (pH 9·20)	0·4486	0·3968	0·0518
Sodium carbonate (pH 9·90)	0·5815	0·5323	0·0492
Water (pH 8·40)	0·5000	0·4545	0·0455

These figures indicate, therefore, that the directional frictional effect is a very important factor in felting over this pH range; and in point of fact the recent communication of Whewell, Rigelhaupt and Selim[4] partly confirms this conclusion, although they still maintain that in alkaline solutions the elastic properties alone determine the felting power of wool.

The same authors[4], and Martin[3], showed that the success of the anti-felting treatments with such reagents as chlorine, sulphuryl chloride, proteolytic enzymes, etc., depends on their ability to reduce the directional frictional effect of wool fibres. On the other hand, it has recently been claimed by Barr and Speakman[5] that benzoquinone and mercuric acetate are the two substances which, in contrast, reduce the felting power of wool solely by modifying its elastic properties, which was also suggested earlier[6] to be the cause of the diminished shrinkability of woollen fabrics dyed with heavy concentrations of certain dyestuffs.

We were not able to confirm the latter observations when the directional frictional effect of fibres treated with mercuric acetate, benzoquinone and 50 per cent Solway Green *GS*, respectively, was measured in soap solution using the present method, as distinct from the violin bow or the so-called lepidometer employed by Speakman and his collaborators. The results, which are summarized in Table 2, show clearly that in each case the anti-felting treatment has led to a very considerable reduction in the directional frictional effect.

TABLE 2.*

Treatment	Maximum coefficient	Minimum coefficient	Directional frictional effect
Untreated	0·5333	0·4863	0·0470
Benzoquinone[5]	0·6191	0·6121	0·0070
Untreated	0·5037	0·4634	0·0403
Mercuric acetate[5]	0·6057	0·5957	0·0100
Untreated	0·2642	0·1837	0·0805
50 per cent Solway Green *GS*	0·4337	0·4047	0·0290

* The figures for each treatment refer, of course, to different sheets of fibres. The first two sets of results were obtained in 0·25 per cent soap solution, while the figures for the Solway Green *GS* treatment relate to 1 per cent soap solution.

Wool felts only to an insignificant extent in the absence of aqueous media, and this fact has been found to be also closely associated with the frictional properties of wool. Thus the directional frictional effect in ordinary air of air-dry fibres and of fibres immersed in lubricating oil has been discovered to be very low compared with the directional frictional effect of the same wool in an aqueous solution, as Table 3 shows:

TABLE 3.

Medium	Maximum coefficient	Minimum coefficient	Directional frictional effect
Water	0·5000	0·4545	0·0455
Ordinary air	0·2060	0·1806	0·0254
Lubricating oil	0·3652	0·3453	0·0199

To sum up, these three sets of results indicate that: (1) the variations in the felting-rate over the pH

range in unbuffered solutions are directly related to the changes in the directional frictional effect; (2) apparently all known anti-felting treatments cause diminution in the directional frictional effect, although it is possible that the ability of some of these reagents to increase the resistance to deformation of the fibres contributes to their efficiency by rendering fibre entanglement more difficult, and (3) the low felting power of wool in non-aqueous media is due to their apparent incapacity to enhance the directional frictional effect.

It would appear, therefore, that the peculiar frictional properties are a principal, if not the principal, governing factor in the felting of wool fibres. The present evidence also suggests that their surface characteristics are of a more complex nature than hitherto supposed.

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[1] Speakman and Stott, *J. Text. Inst.*, 22, T339 (1931). Speakman, Stott and Chang, *J. Text. Inst.*, 24, T273 (1933). Speakman, Menkart and Liu *J. Text. Inst.*, 35, T41 (1944).
[2] Monge, *Ann. Chim.*, 6, 300 (1790).
[3] Martin, *J. Soc. Dyers and Col.*, 60, 325 (1944).
[4] Whewell, Rigelhaupt and Selim, *Nature*, 154, 772 (1944).
[5] Barr and Speakman, *J. Soc. Dyers amd Col.*, 60, 335 (1944).
[6] Liu, Speakman and King, *J. Soc. Dyers and Col.*, 53, 183 (1939).

Röntgen Centenary

PROF. J. A. CROWTHER in his interesting article on "Röntgen" writes as follows: "The use of X-rays in the treatment of disease has scarcely made such satisfactory progress as its use in diagnosis". With Röntgen's first skiagram, radio-diagnosis was born; but what *a priori* reasons were there for supposing that X-rays would have any therapeutic value? None at all I think, yet some courageous few entered the field of exploration, and can anyone say that the results have in the circumstances really been unsatisfactory? Thirty-five years ago, all the beds in the Cancer Wing of the Middlesex Hospital were occupied by inoperable cases of cancer; there was no treatment except an almost superhuman kindness. In 1939 there was not one among the 92 patients in those wards who was not receiving active treatment, and for the great majority of them the treatment was by means of X-rays and radium. Though it cannot be claimed that these agents are a cure for cancer, the development of radiotherapy can scarcely be called unsatisfactory.

Prof. Crowther says later on in the same article, "The action of X-rays on tissue cells, whether healthy or diseased, is, it must be understood, always destructive". But is it so? Are the hæmostatic action of X-rays, their power of producing a lymphocytosis, their resolution (not destruction) of scar tissue, their action in regenerating bone, their excitation of the bone marrow to unusual activity, their temporary hold-up of mitosis, their enhancement of the mutation-rate, are these all to be labelled as destructive?

Treatment by means of X-rays and radium is a subject in which we do well to think in a rather less restricted manner than Prof. Crowther's article suggests.

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PROF. RUSS does well to be jealous on behalf of a subject which he has made peculiarly his own. I can assure him, if assurance is needed, that my admiration of the magnificent work both in the way of treatment and research which has been, is being, and will with ever-increasing success continue to be, done in our radiotherapy departments is no whit the less than his own. I am only surprised that anyone who has read carefully the whole paragraph of which Prof. Russ quotes the opening sentence should doubt it. "Unsatisfactory" is Prof. Russ's word not mine.

As regards my poor word "destructive" with which Prof. Russ quarrels, it all depends on whether one considers the immediate action of the radiation, or the long-distance results of the action. To take only the case of the production of mutations, which is one which we are just beginning to understand, the primary action of the X-radiation is to break a chromosome chain at two different points. This, of course, gives Nature its chance to arrange the pieces in a different order; nevertheless, the breaking of a chain is essentially a destructive action.

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Problems of Nomenclature

I HAVE read with much interest the discussion in *Nature* of December 30, p. 812, and wish to add a few suggestions to those there given. In the first place, it is highly desirable to have a single code of nomenclature for plants and animals. The problems are the same in both cases, and the existing codes are so much alike that a very moderate amount of revision would be necessary to secure uniformity. There are two matters which cause confusion, and should be dealt with.

(1) *Nomina seminuda*—names which have been introduced in an informal manner, without proper descriptions, but have been taken up because they could be interpreted in the light of subsequent researches. It would be a dangerous policy to rule that names poorly supported by descriptions should be rejected; but when there is nothing which will distinguish the species, and only subsequent studies of the fauna indicate by the locality what was referred to, the name should be rejected.

(2) Names proposed as of lower than specific rank. It should be ruled that subspecific names have the same validity as specific; that is, if a form is proposed as a subspecies, but later raised to specific rank, the subspecific term should be used. This is the usual practice, at least in zoology, but the botanists have mixed subspecies and individual variations under the designation 'variety', and it is not always easy to determine what the author had in mind. It would be well to take the lists of so-called varieties, and separate those names which were really intended for what zoologists call subspecies, rejecting the others as invalid for use as species names.

In such ways a good many really needless changes might be avoided. A very desirable reform in botanical writings is the dropping of the name of the author of the combination in ordinary references to plants. Such names are scarcely ever cited in zoology, and I cannot recall an instance in which their omission has caused any inconvenience. The botanical practice wastes a lot of printer's ink and paper.

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SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Science Masters' Association was held in the Science Department of the City of London School during April 9–11.

The presidential address by Mr. C. L. Bryant, late of Harrow School, and now, in his own words, of Perranporth Youth Club, dealt with "The Impact of Science on Human Beliefs". The theme was worthy of one who, for nearly forty years, has served the Association faithfully and well. Christian missions are criticized because they uproot the faith of the natives without planting anything more suitable in its place. Science is doing that here and now. Until about fifty years ago, men believed, more or less, what the Churches told them. Now, for the most part they believe in nothing at all; not even in science, except as a provider of luxuries. This is largely because there is no background of philosophy to the science which is commonly taught in schools. Many of the Churches are hampered by creeds in which minor and debatable points are magnified into articles of belief. It is difficult for a scientific layman to discuss such matters with ecclesiastics. In the interests of truth the barriers should be broken down, and Mr. Bryant pleaded for an approach between science and religion for (as we have recently seen) "where there is no vision the people perish". A group of members under Mr. Bryant's leadership is to tackle the problem.

"The Social Relations of Science" was the title of the Science and Citizenship Lecture given by Mr. J. G. Crowther, of the British Council. Mr. Crowther traced the development of scientific research from the small-scale activity before the War of 1914–18 to its present highly organized state, and outlined the consequent revolutionary changes in the place of science in the life of mankind in the last twenty years, and foreshadowed the equally great developments to be made in the next twenty years. Where are the men of science to come from to stimulate the application of science to many aspects of life in Britain? That is an educational problem. One of our chief tasks is to use the ability and enthusiasm of men of moderate ability much more efficiently than at present. In the education of such men the science master should be given every encouragement and material assistance, and such education should include a thorough study of the relation of science to other human activities. The men we need should be "statesmen of science" who approach the problems of humanity with the knowledge and understanding of statesmen; statesmen who approach them with a knowledge and understanding of science.

A large audience was privileged to hear Sir Alexander Fleming describe his discovery of penicillin and the subsequent researches which led to its manufacture and chemical use. By means of an excellent series of lantern slides he led his audience through years of patient researches with a clarity of exposition that enabled each to feel the thrill of discovery. He described the work of the chemists in isolating the pure substance and the skill with which they overcame the major obstacle of its instability. No written account could do justice to a lecture which combined lucidity with dry humour and conversational intimacy.

Mr. J. McG. Bruckshaw, of Imperial College, spoke on "Physics and Economic Geology" and gave a clear outline of the application of physics to the problem of locating mineral deposits. Mr. F. W. Cuckow, of the National Physics Laboratory, gave a fascinating account of the development and scope of the electron microscope; members enjoyed the speaker's intimate style and an excellent series of lantern slides. Mr. R. Maitland dealt with the chemistry of plastics, including an account of the replacement of carbon by silicon in the giant molecule. Mr. C. Bibby, education officer, Central Council for Health Education, talked eloquently on health education through school biology. The importance was stressed of distinguishing between habits which were the disciplining of natural functions and those aesthetic habits which were really habits of civilization.

A film show and discussion was held in the Ministry of Information theatre. Mr. Arthur Elton, president of the Scientific Film Association, opened by speaking on the scope and limitations of the science teaching film. Scientific films of a suitable nature were few, and he thought that it was the duty of the teaching profession to lay down their policy for films in collaboration with the Scientific Film Association—the kind of films they wanted and for what age-groups. Science films, including the "Transfer of Power" which was produced and directed by Arthur Elton and Geoffrey Bell, were shown. Mr. Geoffrey Bell discussed the film critically in a short talk on the making of a film. He stressed the need for careful research and script, good production and skilful editing; and invited the co-operation of members in helping to make good films. Mr. W. Farr, head of the Central Film Library of the Ministry of Information, spoke on the distribution of films. He hoped to see a Central Film Library linked with a number of local libraries—possibly twelve regional libraries dealing with free distribution of educational films to schools. Many members took part in the subsequent discussion. It was agreed that the best equipment for a school was one sound projector for use in the main hall plus one or more smaller silent machines for classroom use. A plea was made for using teachers not only in suggesting titles and the contents of scripts but also in the production of films and in getting better commentaries. The various types of films needed—historical, revision, etc.—were discussed and the relative advantages of film and film strip assessed. Members were pleased to learn that the Education Section of the Scientific Film Association were engaged in preparing lists of suitable films and of the offer of Imperial Chemical Industries, Ltd., to produce scientific films for purely educational purposes.

A general discussion on the role of science in the future educational system was opened by Mr. A. W. Wellings (Leamington College) and Mr. D. H. J. Marchant (Ilford County School). Mr. Wellings, after examining the criticism of existing science teaching, stressed the great opportunities for the Association to see that, within the general educational framework provided under the new Act, science teaching plays a vital part in preparing pupils for the difficult and exciting job of living in a rapidly changing world. He pleaded for emphasis on the adventure of science, and for an alteration in technique, and a new attitude, so that the pupils get a better idea of the way in which science affects human activities and progress at every point, and can be led to realize that the problems created by science will be, in part, theirs to solve. He gave suggestions how this could be attempted, including a plea for a re-orientation of chemical studies, so that they could be taught from the point of view of natural resources. Mr. Marchant dealt with the content of science courses. He advocated general science for all types of school, but emphasized that, although the course should cover a fairly wide field, whatever is taught must be science. He offered valuable suggestions on the elimination of irrelevant matter and on the economy of time and effort by presenting subjects with due consideration of the stage best suited to the difficulties. In developing theories, the tempo should not be that of research workers but accelerated in proportion to the richer background of fact which may now be assumed. Syllabuses should be planned concentrically so that general science and its possibilities for good could be worked out. Many members made valuable contributions to the discussion. Practical points such as the time allocation for science teaching (where the subject is taken to two credit stage in the School Certificate the allowance should be the same as for two separate science subjects), laboratory equipment, the relation between pre-school certificate work and post-school certificate studies, and courses for teachers. A plea was made for a fundamental approach so that science can be seen in proper perspective in the whole education of the future man. It was interesting to note, as distinct from pre-war discussions, that members seemed to assume that it was general science, and not separate science subjects, to be discussed.

The Members' Exhibition, though smaller than in recent years, was up to its usual high standard; and visits were made to hospitals, newspaper offices, the General Post Office and other places of scientific interest.

MARINE AND OTHER BIOLOGICAL LABORATORIES

By PROF. J. H. ORTON
University of Liverpool

DURING the war years, there have been a number of communications in *Nature*[1-4] on marine biological laboratories. It is possible that a review of these may be useful at the present time.

Great Britain

For many decades the Marine Biological Laboratory at Plymouth has been the centre of fundamental marine biological research in Great Britain; it has been the Mecca of zoologists from most British and many foreign universities. The chief reasons for the success of Plymouth are as follows. First, the abundance and variety of the fauna, the constituents and biology of which have steadily been defined by a succession of naturalists. The Laboratory was also able to supply research material at all times. The accessibility of Plymouth from the situation of the older universities was also important. The policy of the director, which pervaded the staff, has always been to hold to the principle that visiting and other researchers must be supplied with whatever living or other material they needed for their researches, so far as it was in the power of the staff and station to supply it. The policy of the Council has been to attract the nascent generation of zoologists as students of courses in marine biology, including ship and shore expeditions, and so to display the attractions of the subject and the station, and bring together researchers working on a variety of problems. Lastly, sustained and increasing support was given by governmental departments, and especially the Development Commission, to the Laboratory.

Thus, a visiting researcher knew from the published fauna list[5] what animals—or plants—he could expect to get in a living condition, and also that he would be given every reasonable help to conduct his researches. In the circumstances, a great variety of workers was attracted to the station, and their publications[6] show that investigations have been made over the whole range of biology, namely, morphology, systematics, embryology, growth, life-history, food and mode of feeding, digestion, general physiology, sex and breeding, variation and heredity, ecology, behaviour and mortality, as well as the more limited and special problems of marine biology.

With this perspective in mind, it is easy to understand the growing need of the newer universities—less conveniently situated to Plymouth than the older—for a laboratory in proximity to them where facilities for study comparable to those at Plymouth can be attained.

Marine biological laboratories have also been established at Port Erin (University of Liverpool), Millport (University of Glasgow), Cullercoats (University of Durham), St. Andrews, Nigg (University of Aberdeen), Robin Hood's Bay (University of Leeds), the Government stations at Lowestoft and Conway, Lough Ine (University College, Cork) in Eire, while the Welsh universities are also requiring one at Bangor. There is undoubtedly scope of some kind for all these stations, if scope be defined as facilities for visiting researchers, for special marine biological researchers and provision for student vacation courses. All these laboratories, except Lowestoft and Conway, differ from that at Plymouth in belonging to universities, and as such had to compete in pre-war years with other departments for the limited funds available, or be dependent upon external sources for existence; but as the external source was mainly the Development Commission (Advisory Committee on Fishery Research), which quite correctly gave its major support to the definitive research station at Plymouth, there was little financial support left for the university marine laboratories.

The question now arises what functions these laboratories are to serve in post-war years. In a long-term policy, are the prospects in marine biological research such as to justify the staffing of all these laboratories with research workers? If the staffs were provided, would they find an adequate outlet for their energies and careers, and also supply in a succession of personnel the needs for fishery and other research posts (including economic and industrial requirements) of Britain and the British Empire? The answers to these questions of policy are not simple. If we look no further ahead than twenty years, probably the answers can all be given in the affirmative. There is, however, need for caution in their own interest against over-production of marine biologists in the post-war years.

There is no doubt that all the university marine stations can pay handsome dividends for facilities for research in general biology, and for that familiarization of senior and junior students with the problems of living marine animals and plants and their habitats which constitutes for most students the most attractive part of a biology course. To this end it is necessary to maintain at least skeleton staffs in all stations.

Thus the claims of the different university stations for staffing will depend upon the functions assigned to them, the propensities and personalities of the associated biology departments, the suitability of the stations for marine research, and the accessibility of the stations. As all the stations have a common objective, a definite degree of association is necessary for co-operation in common problems; but it is imperative that each station be given freedom to follow in the main its own line of fundamental research.

At most of the stations, including Plymouth, the main bearing of the research has been zoological or planktonic. Prof. F. E. Fritsch[3] has directed attention to the field of research in Great Britain on the benthic flora, and the need for combined work by zoologists, botanists and physiologists on benthic problems. In this regard Fritsch points out that the larger staff at Plymouth—and, we can add, the accumulative knowledge of chemical and physical factors in the environment—points to Plymouth as the centre for this work. It has, however, perhaps been overlooked that an extensive bionomical survey[7] has been made of the littoral algæ in the Port Erin locality which, along with the similar survey[8] of the fauna, places the Port Erin station in a strong position for further development.

Freshwater Biology

In the development of biology in the future it is clear that freshwater biology is of increasing importance. The development of the research station of the Freshwater Biological Association at Wray Castle is following closely that of Plymouth in marine biology, and a glance at its publications[9] shows that, besides pure freshwater problems, fundamental researches are being carried out as well as the training of senior students. Freshwater biology is of great importance in the training of teachers in biology, since most teachers are located in inland situations and can more easily obtain living freshwater than marine material for their pupils, who, moreover, can collect the material for themselves. The bulk of biology students in most universities are destined to become teachers, therefore every university will in the future sooner or later need some kind of laboratory adjacent to the university where freshwater problems can be studied. Those universities in inland situations—and indeed many schools—may very well find a freshwater station more useful than a marine station; and a freshwater station can easily be improvised and equipped at relatively low cost.

Colonial and Foreign Marine Biological Laboratories

The correspondence in *Nature*[1,2] has shown that for the training of marine biologists for tropical fishery posts, and research—and for general experience—a marine laboratory situated in the tropics would be of great value. There can be little doubt that most universities would welcome the opportunity of sending students and staff to such a tropical laboratory.

But so far the possibility of establishing a marine laboratory in a sub-polar locality has not been explored. It is likely that results of as great, or even greater, general interest would result from researches at such a station both on scientific and especially fishery economic problems. We know very little of the living conditions of marine organisms in latitudes of extreme cold, as expeditions to those parts have necessarily been mainly concerned in bottling their catches. New technique would be required and would be produced.

The Icelandic and White Sea fisheries present large economic problems, but general biology offers a wider and almost unknown field. The Danes, Russians (especially Gurganova[10]), as well as the British in the "Discovery" Investigations, have approached the problems, and would be interested in a station of this kind, which might indeed have an international character.

A site in Iceland or the east coast of Greenland, in addition to any the Russians may establish in the region of the White Sea, would, it is hoped, be accessible by air in post-war years; it would offer as great attractions as the tropics to adventuresome researchers.

[1] *Nature*, **152**, 47 (1943).
[2] *Nature*, **152**, 136 (1943).
[3] *Nature*, **154**, 144 (1944).
[4] *Nature*, **154**, 300 (1944).
[5] *J. Mar. Biol. Assoc.*, VII, 2, 155 (1904 and 1931).
[6] *J. Mar. Biol. Assoc.*, 15, 753 (1928).
[7] L.M.B.C. Memoir XXX. Manx Algae. By M. Knight and M. W. Parke (1931).
[8] *Proc. and Trans. Liv. Biol. Soc.*, 50, 5 (1936-37).
[9] Freshwater Biol. Assoc. Memorandum on Post-War Development, 13 (1944).
[10] *Explor. des Mers d'U.S.S.R.*, Fasc. 6, 5 (1928), and fifteen other papers.

RIPENING EFFECTS OF EMANATION FROM FRUITS

BECAUSE the emanation from ripe fruits will accelerate the ripening of unripe fruits, it is in general undesirable to store together fruits of many varieties which have normally different rates of ripening, as the early ripening varieties may induce an undesirable hastening of the ripening processes in longer keeping types. It is of interest, therefore, to note that R. M. Smock[1] finds that the stimulating effects are greatest with emanations from apples past their climacteric, while the post-climacteric apples are themselves almost unaffected by emanations from ripe apples. Sometimes the emanation induces in adjacent fruits well-defined symptoms of ethylene injury[2], but *Penicillium expansum* growing in the store does not produce sufficient ethylene (or other stimulating substance) to affect the ripening of apple fruits.

Immature pears put into store straight after picking produce only very small amounts of ethylene, but their ripening and respiration can be stimulated by ethylene and then they themselves produce ethylene[3].

So great can the stimulating effect of these emanations from ripe fruit be that in order to prevent, partially at least, accelerated ripening of the main bulk of fruit in a store, isolated early ripening individuals are frequently removed from store by hand picking. R. M. Smock[4] finds, however, that oiled paper wraps are helpful in protecting apples against emanations of other apples, but that this procedure is not so effective as the removal of ethylene from the air of the store; and this removal can be effected by the use of brominated active charcoal, prepared by fixing 5 c.c. bromine on 40 gm. of coconut shell charcoal.

[1] Smock, R. M., *Proc. Amer. Soc. Hort. Sci.*, **42**, 128 (1943).
[2] Smock, R. M., *Proc. Amer. Soc. Hort. Sci.*, **40**, 187 (1942).
[3] Hans n, E., *Proc. Amer. Soc. Hort. Sci.*, **43**, 69 (1943).
[4] Smock, R. M., *Proc. Amer. Soc. Hort. Sci.*, **44** 134 (1944).

FORTHCOMING EVENTS

Monday, May 7

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4 p.m.—Prof. F. Davies: "The Early Development of the Human Embryo" (Arris and Gale Lecture).

SOCIETY OF ENGINEERS (at Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. V. E. Yarsley: "Plastics in Engineering".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (ELECTRICAL AND MECHANICAL ENGINEERS GROUP) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Mr. M. Littmann: "Neuere Erkenntnisse über Hartmetall-Schneidewerkzeuge".

Tuesday, May 8

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (Geological Society, Burlington House, Piccadilly, W.1), at 2.30 p.m.—Mr. L. W. Needham and Mr. S. Lynch: "The Use of Suspensions as Heavy Liquids".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. F. C. Grigg: "The Mechanics of Chromosome Movements".

Wednesday, May 9

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. F. M. R. Walshe: "The Treatment of Infantile Paralysis".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. H. Savage: "Localization of Faults in Low-Voltage Cables, with special reference to Factory Technique".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. Alan D. Maclean: "Code of Electrical Practice for the Petroleum Industry".

Thursday, May 10

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at Linnean Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Miss E. M. Brown and Miss M. F. Sutton: "Observations on the Population of some Emergency Water Supply Tanks, with a Description of the Life-History of *Corixa panzeri* (Hemiptera Heteroptera)"; Dr. R. S. de Ropp: "Plant Tissue Culture; its Application in Botanical Research"; Mr. I. H. Burkill: "Flies of the Family Empididae and Other Insect-Visitors to the Flowers of *Tamus communis*"; Mr. A. L. Poole: "An Indigenous Induced *Phormium tenax* Forst. Swamp in New Zealand".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

Friday, May 11

ROYAL ASTRONOMICAL SOCIETY (Burlington House, Piccadilly, London, W.1), at 4.30 p.m.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Lawrence Bragg, F.R.S.: "X-Ray Analysis—Past, Present and Future".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the HYDRAULICS GROUP and the MANUFACTURE GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. F. H. Towler: "The Modern Direct-Hydraulic System".

Saturday, May 12

INSTITUTION OF THE RUBBER INDUSTRY (MIDLAND SECTION) (Imperial Hotel, Birmingham), at 10 a.m. and 2 p.m.—Symposium on "The Physical and Chemical Breakdown of Rubber".

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Cathays Park, Cardiff), at 2.30 p.m.—Prof. W. V. Mayneord: "The Use of Infra-Red Radiation in Medicine".

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATE SECTION) (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Annual General Meeting. Mr. Peter Masefield: "The Developments in the Design of Military Aircraft between 1918 and 1944".

APPOINTMENTS VACANT

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

SENIOR LECTURER IN MATHEMATICS—The Principal, Royal Holloway College, Englefield Green, Surrey (May 8).

WORKS MANAGER to control works in Surrey engaged on PRECISION INSTRUMENT PRODUCTION—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2 (quoting C.2562.XA.) (May 8).

CONSULTANT TO TIMBER RESEARCH LABORATORY, Transvaal Chamber of Mines, Johannesburg—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting F.3959.XA) (May 10).

TEACHER IN BIOLOGY—The Director of Education, Polytechnic, 309 Regent Street, London, W.1 (May 10).

AN ENTOMOLOGIST (Reference No. F.3966.A) and a BOTANIST (Reference No. F.3965.A) for the Government of Iraq—The Mini try of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street. Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (May 11).

TEACHERS OF MATHEMATICS, of ENGINEERING SUBJECTS and of HANDICRAFT AND DRAWING, at the Luton Technical College—The Director of Education, Shire Hall, Bedford (May 11).

TEACHER OF MINING SUBJECTS at Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (May 12).

ASSISTANT IN ADVISORY ECONOMIC SECTION (AGRICULTURAL), Leeds—The Registrar, University, Leeds (May 14).

LECTURER IN MECHANICAL ENGINEERING at Norwich City College—The Director of Education, City Hall, Norwich (May 14).

PRINCIPAL OF LISBURN TECHNICAL SCHOOL—The Secretary, Castle Chambers, Lisburn, Co. Antrim (May 14).

TEACHER OF CHEMISTRY, with special knowledge of Physical and Inorganic Chemistry, at Lancaster Technical College—The Divisional Education Officer, Education Office, High Street House, Lancaster (May 16).

DEMONSTRATOR IN PHYSIOLOGY—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women (May 19).

LECTURER IN SOCIOLOGY at the South-West Essex Technical College—The Chief Education Officer, County Offices, Chelmsford (May 19).

PRINCIPAL OF D RWEN TECHNICAL SCHOOL—The Education Officer, Darwen, Lancs. (May 31).

ENGINEER TO THE CLYDE NAVIGATION TRUST—The General Manager and Secretary, Clyde Navigation Trust, 16 Robertson Street, Glasgow, C.2 (marked 'Engineer') (May 31).

ASSISTANT LECTURER and also LECTURER IN GEOGRAPHY—The Secretary, University, Birmingham 3 (June 2).

DIRECTOR OF THE ROWETT RESEARCH INSTITUTE—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (June 18).

LECTURER IN SOCIAL ANTHROPOLOGY—The Secretary, University of Edinburgh (Sept. 30).

ASSISTANT LIBRARIAN—The Secretary, University, Aberdeen.

LECTURER IN BACTERIOLOGY—The Principal, Studley Agricultural College.

RESEARCH STAFF—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester, 20.

LECTURER IN MINING at St. Helens Municipal Technical College—The Director of Education, Education Office, St. Helens, Lancs.

TEACHER OF ENGINEERING at the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester.

ASSISTANT IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT, in the Portsmouth Municipal College—The Chief Education Officer.

LECTURER IN EDUCATION, with special qualifications in the methods of teaching Science—The Secretary, University, Birmingham, 3.

LECTURER IN BIOLOGY at Stockwell College, Bromley—The Principal, temporarily at Watcombe Park, St. Marychurch, Torquay.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 50, Section B, No. 9: The Male Genitalia of the British Stigmellidae (Nepticulidae) (Lep.). By Dr. Bryan P. Beirne. Pp. 181–218. (Dublin: Hodges. Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1945.) 2s. [54

University of London: University College. Annual Report, February 1944—February 1945. Pp. 44. (London: Taylor and Francis, Ltd., 1945.) [54

London Shellac Research Bureau. Abstracts bearing on Shellac Research Literature for the period 1st January to 31st December 1944. Pp. ii+6+vii. Bulletin No. 7: Determination of Volatile Matter in Lac. By Dr. B. S. Gidvani and N. R. Kamath. Pp. 24. Technical Paper No. 26: A Process for the Manufacture of Dewaxed Lac. By Dr. B. S. Gidvani and N. R. Kamath. Pp. 26. Technical Paper No. 27: Lac-Ethyl Cellulose Lacquers. By N. R. Kamath and Dr. B. S. Gidvani. Pp. 24. (London: London Shellac Research Bureau, 1945.) [54

Penicillin. Pp. 32+4 plates. (London: Therapeutic Research Corporation of Great Britain, Ltd., 1945.) [54

Imperial Cancer Research Fund. Forty-second Annual Report. 1944–1945. Pp. 32. (London: Royal College of Surgeons, 1945.) [94

Other Countries

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1943. Pp. 36. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1945.) 2s. [54

Brooklyn Botanic Garden Record. Vol. 33, No. 4: Supplement to the Thirty-third Annual Report of the Brooklyn Botanic Garden, January 1—June 30, 1944. Pp. viii+195–236. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences, 1944.) [94

U.S. Department of Agriculture. Circular No. 717: Chemical Impregnation of Trees and Poles for Wood Preservation. By B. H. Wilford. Pp. 30. (Washington, D.C.: Government Printing Office. 1944.) 10 cents. [94

University of Illinois: Engineering Experiment Station. Bulletin Series No. 352: Impact on Railway Bridges. By Charles T. G. Looney. Pp. 128. 1 dollar. Bulletin Series No. 354: The Viscosity of Gases at High Pressures. By Edward W. Cummings, Bertrand J. Mayland and Richard S. Egly. Pp. 68. 75 cents. Bulletin Series No. 355: Fuel Savings resulting from Use of Insulation and Storm Windows. By Alonzo P. Kratz and Seichi Konzo. Pp. 40. 40 cents. Bulletin Series No. 356: Heat Emission and Friction Heads of Hot-Water Radiators and Convectors. By Frederick E. Giesecke and Alonzo P. Kratz. Pp. 52. 50 cents. Circular Series No. 49: The Drainage of Airports. By W. W. Horner. Pp. 48. 50 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1944, 1945.) [94