NATURE

No. 3907 SATURDAY, SEPTEMBER 16, 1944 Vol. 154

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
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Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

SCIENTIFIC AND INDUSTRIAL RESEARCH.—IV

WE have now considered the questions which arise in regard to personnel, whether of its quality or of the tactics by which the best use can be made of the men and women trained for scientific and industrial research. We have seen that some regard must be paid to our needs, not only in respect of quality but also of the numbers of such workers. Any serious discrepancy between the output of such trained men and women from the universities and technical colleges and the demand of the nation for their services must have serious consequences, either by impeding the immediate execution of our research programmes, for example, or by discouraging men and women of the highest ability from entering on such careers.

No attempt can be made to estimate our quantitative requirements in regard to research workers and other classes of scientific workers without some consideration of the actual programmes of research at which they will be required to work or of the openings for their services in other fields. This, accordingly, is the next step to be taken in approaching the consideration of the actual organization to be set up for the planning and execution of our research programme. If, as the Nuffield College statement suggests, the vital question at present is how much Great Britain must spend at once on scientific and industrial research in order to reap the fullest possible advantage of her resources of man-power and productive capacity, the answer can only be given after consideration of specific needs and projects, and as a result of the elaboration of concrete plans of development in a great number of particular fields. Moreover, it is only as such specific plans take shape that we can see at what points development is uneven, what gaps require filling and what weaknesses should be strengthened.

The Nuffield College statement is not concerned with such specific plans, and largely excludes from its survey the needs of agriculture, health and other fields which make a special call on trained biologists. None the less its paragraph on the claims of biological science is clear warning that there must be some consideration of the relations of the particular programmes and the demands they involve in order that our available resources may be distributed to the best advantage, and our research effort not badly thrown out of balance. It may well be doubted whether hitherto biological studies have attracted anything like a high enough proportion of the best scientific minds, and if that is so, the position is one that can only be remedied over a period of years. Advances in the biological sciences are fundamental for progress in agriculture, horticulture, forestry, food preservation, fisheries, conservation of water supplies, health education, and for the solution of other pressing world problems. They are vital for the future of tropical countries, for the mastery of soil erosion and for the repair of much of the devastation wrought by man upon his environment during the years of wasteful exploitation of natural resources.

It was suggested by the Parliamentary and Scientific Committee in its report on "Scientific Research and the Universities" that the future impact of biological advances in agriculture, medicine, nutrition and sociology may be of the same order of importance as that of physics and chemistry in the past fifty years. The demand for biologists in the post-war world is bound to be very large, and Great Britain is not well equipped to supply it. Moreover, the Nuffield College statement further points out, the experience of the War has shown that the trained biologist is a highly adaptable person, capable of making most valuable contributions to the solutions of problems quite outside his special field of study. That has a bearing on the position of biological science in the content of our general plan of education, and there are other considerations which should induce us to give general biology a higher place in the curriculum. At least it can be said that the place of biology in reconstruction demands a special survey, with an expansion of research and the formation of further chairs at the universities in such related subjects as genetics, ecology, biochemistry, and veterinary science.

Closely related is the question of social biology. The contribution which biology might make to the ordering of a new world, not merely as a corrective to mechanized planning but also as a guide to a true way of life, to the establishment both of greater control over our environment and over ourselves has been well emphasized by Sir Walter Langdon-Brown (*Nature*, 152, 166; 1943) as well as by Dr. K. E. Barlow in "The Discipline of Peace". That contribution may be as vital to the wise use of our natural resources as to the development of the appropriate organization of our affairs, both in regard to the conduct of scientific and industrial research, and the better ordering of international relations. Discussions such as those proceeding on world security at Dumbarton Oaks need to be examined, and their proposals require objective criticism by those trained in the scientific method so that disciplined and well-informed judgments based on values and not on extravagant and prejudiced opinion are reached.

Here we touch on a further field where our research effort in the past has been inadequate and where our technique is yet only being developed, because the limitations of the scientific method in situations involving judgments of value have not always been fully recognized. In his admirable little survey of the British universities in 1930, Sir Charles Grant Robertson urged that the advancement of knowledge could not without grave danger be limited to research in the physical sciences. In a revised edition of that book, which has just appeared, his argument is reinforced by all the experience of the past fifteen years, and he affirms his conviction that the only knowledge worth advancing is 'related knowledge'—knowledge of which the affiliations to, and contacts with, all other forms of knowledge are recognized and the total sum of which is purposively related to the ends of a civilized society seeking to fulfil a spiritual interpretation of life.

Sir Charles Robertson's plea is essentially that the universities can make themselves the central arsenals of a true humanism, but this question of social and economic research goes further and has a close bearing on many of the material problems with which we are confronted. The Nuffield College statement, in a passing glance at research in relation to social and economic policy, indicates how fruitful such research could be even from the point of view of securing more effective use of the results achieved by advances in industrial research in the physical field. Indeed the determination of the best form of structure, both government and non-government, for bringing about a co-ordinated study of economic and technical problems so that the machinery devised for shaping general economic policy will effectively relate the needs of consumers to the real potentialities of the productive system, in respect of type of product, quality and price, in the light of impartial scientific evidence drawn from both fields of research, is pre-eminently a matter for the consideration of Nuffield College.

The whole trend of the recent report "Government and Industry: A Framework for the Future" issued by a Fabian research group encourages the hope of a more impartial and objective approach to such problems. The importance of this field and the wide scope for impartial inquiry it offers can well be seen in the annual report of the National Institute of Economic and Social Research and especially in the recently published account of its publications and programmes. The need for a more equable distribution of our research effort between the social and biological and the physical sciences, whether at the fundamental level in the universities or in the attack on the practical problems of production and administration, is well illustrated in an article on the "War-time Social Survey" contributed by its director, Mr. Louis Moss, to *Public Administration* of October–December 1943. Mr. Moss pointed out that social research assists the administrator by enabling him to take the major relevant social facts into consideration in framing his policy, to measure the extent to which his policy has been successful after it has been put into operation, and to decide what changes, if any, are necessary to ensure its success; he also indicates five main spheres in which the Social Survey could be of assistance to Government departments in the post-war period.

The significance of the Social Survey's studies of food and clothing habits, and particularly the improvement of sampling methods, and the bearing of such studies on cost-of-living indexes and inquiries are obvious. Similarly, the work already done in checking the effectiveness of the educational publicity of the Ministry of Health and in exploring resistance to such schemes as child immunization against diphtheria is a promising aid to prophylactic measures which could raise the general standard of health. The value of the techniques by which the Survey has during the War rapidly secured a fairly good picture of the nutritional situation of the nation as a whole, or of particular groups, is also clear. Social research can also make an effective contribution to the removal of obstacles to a complete productive effort and thus assist in the full use of our skilled

man-power which is likely to be no less important after, than during, the War, and finally it should equally assist in eliminating many of the errors in housing and building policy which have arisen through imperfect contact of the administrator and expert with public needs.

This function of social research is, of course, essentially the elaboration of an effective liaison system, thus enhancing the adaptability of our social and industrial organization—the vital problem in elaborating an effective organization, as Dr. J. T. MacCurdy insists. Without going into further detail, it should be emphasized that not only are research workers required in these broad fields of biology and economics and social science but until, in some degree, the programmes of research are formulated, we cannot forecast approximately the numbers of workers in these fields which the universities are expected to provide. Furthermore, as is brought out to some extent in the statement "A Post-War Policy for Science", issued by the Association of Scientific Workers, these programmes themselves at times impinge on programmes for the development of natural resources and may determine their expansion or contraction. Nor can we well consider the re-orientation of our research effort until the broad programmes of work proposed in the different fields are seen in sufficient detail for a true perspective to be obtained.

It must not be imagined, however, that it is only in the social and economic field that there are gaps in our research effort, or special reasons for expansion. Sir Ernest Simon, for example, has directed attention to the neglect of aeronautical engineering, and to the active intervention of the Ministry of Aircraft Production to found an effective school of aeronautical engineering research. Again it is only possible to assess the importance of such gaps when we obtain from the broad programmes a picture of the general position.

Some attempt has been made by the Association of Scientific Workers in the statement already mentioned to cover the ground, and a number of particular programmes has already been outlined, such as that of the British Coal Utilization Research Association, for a thorough scientific study of the fundamental properties of coal. Despite the stimulus of the proposals of the Hot Springs Conference no adequate programme of nutritional research or of agricultural research has yet been formulated. Some of the main specific topics in the latter field are indicated in the Association of Scientific Workers statement, while, as we have already seen, the former involves not merely biological research but also the co-operation of workers in social science.

Closely related to this last is the field of medical research, and it may well be expected that one consequence of a national service for health will be a fresh impetus to research on the elimination of conditions responsible for sickness absenteeism, accidents, industrial disease and low standards of health or physique. The man-power situation is also likely to increase the importance of such work, as is the general age-structure of the population. Apart from this there is the stimulus that is derived from the striking advances in chemotherapy during recent years and from the realization of the immense resources which science has given us for preventing and eliminating disease apart altogether from its treatment. Besides this, as Dr. Alan Gregg has suggested, increasing attention to the geography of disease and, as a natural corollary, to the study of the relation of climate to disease and health, is called for. The effect of differences of environment on genetically similar organisms, biophysics, and the application of genetics to the study of human disease and human physiology, as well as both chemotherapeutic and pharmacological research, are likewise fields where he considers development is needed and probable.

In deliberately directing attention to fields where research has been comparatively neglected, or where at least exceptional expansion is required, it is not suggested that other fields of research, either industrial or fundamental, should not figure prominently in our post-war programme. From the point of view of the national economy the main problems in some branches of manufacturing industry, in transport, and in communications may well be, as the Association of Scientific Workers suggests, concerned chiefly with effective planning and co-ordination in a policy of full employment and social welfare. In other branches of industry, progress is dependent on fundamental research on such questions as the mechanical and magnetic properties of metals, their corrosion and lubrication, the molecular physics and mechanics of rubber and plastics, including the various synthetic fibres, while the position of petroleum as a raw material is shifting the whole outlook of organic chemical industry, raising important economic as well as technical problems. Nor can our survey of programmes be limited to our own internal needs: we are already committed to large and to growing programmes of Colonial research, including industrial, agricultural, geological, fisheries, animal health, forestry and medical and social research, and topographical and geodetic surveys.

As we have already emphasized, if proper use is to be made of our available resources, both of man-power and materials, it is imperative that at an early stage there should be some overall view of the main objectives, as distinct from detailed or particular subjects in all the main fields of industrial and the chief branches of pure and applied science. Only so can be put together some rough estimate or global figure in terms either of men or financial or material cost. Until that has been done we are neither in a position to make the intelligent allocation of priorities of grants, of men and of materials, which in the early post-war years will be essential, or to see at what points there are gaps likely to delay progress, or obstacles to the prosecution of fundamental research for advancing the boundaries of knowledge on a broad front on which the ultimate success of any programme of research depends.

There can be no disguising the tremendous demands which this task of reviewing or co-ordinating the programmes of research in so many different fields will make. Scepticism as to the adequacy for such a

purpose of particular proposals as that of the London Chamber of Commerce in one of its recent reports should not induce a *non possumus* attitude. On the contrary, experience of what has in effect been achieved in the prosecution of the war effort should inspire a new attempt to improve on that organization, to adapt it where necessary, and, profiting by the mistakes of the past, to seek to deal with the research problems of the peace on lines retaining sufficient flexibility to avoid constricting the spirit of free inquiry, while ensuring that problems which are most urgent from the point of view of the public interest receive priority of effort and supplies; and that there is no neglect of important fields or problems vitally affecting public welfare, or the advance of either industry or of science because they are not sufficiently the concern of any particular body.

Finally, it must be remembered that from the point of view of scientific workers themselves some attempt to sum up the requirements of research from a national point of view and to indicate the broad fields to be intensively developed is equally important. First, it provides the universities with a rough basis on which to estimate the numbers of trained workers required both in total and in different branches of knowledge. Demands for workers in the natural sciences can be balanced with those for workers in the growing body of statistical, economic, sociological and psychological studies of no less importance to the community and to industry. But beyond this, it brings to research workers in any field a growing awareness of the relations of their problems to those of students in other fields. That consciousness, with the more intimate contact with research workers who are asking other questions and employing other methods, which should flow from the new and fuller integration of our research effort, should help to break down the isolation with which scientific workers have sometimes surrounded themselves in the past, and it should impart not merely a quickening sense of social or public service but also that fertilizing cross-current of ideas which always lies at the roots of creative thought and intellectual advance.

A SURVEY OF THE U.S.S.R.

The U.S.S.R.
An Economic and Social Survey. By Dr. S. P. Turin. Pp. xiii+220. (London: Methuen and Co., Ltd., 1944.) 16*s*. net.

ENGLISH readers often find it difficult to obtain trustworthy information about the U.S.S.R. They suspect anything that looks like propaganda and much prefer a cold and clear-cut account that aims only at presenting the facts without bias one way or the other. For this reason much that has been written has lacked permanent value, and has probably had far less influence than its authors had hoped. On the other hand, the official statistics, which are good, are not easily accessible to the ordinary reader.

Dr. Turin's survey has the special value that it is based on official statistics, elucidated often by diagrams and presented objectively. He begins with an account of the geography and ethnography of the U.S.S.R.; then he discusses its regional structure, with which many readers will be unfamiliar. The centralization of production in the hands of the State has meant the welding of great areas into huge industrial units. The Moscow industrial region, or *oblast*, for example, has a radius of about 100–120 miles with Moscow as its centre, but every town, every village and every hamlet within it forms part of one big industrial concern. The importance of this particular *oblast* is that although it represents only about 1 per cent of the U.S.S.R. territory, it contains about 10 per cent of the total population and more than 25 per cent of the total industrial population.

Next follows an account of the industries themselves, beginning with agriculture. Before the Revolution, about 75 per cent of the population were engaged in agriculture; the 1939 census, however, showed only about 50 per cent so occupied. The figures are not quite clear, however, because in the summary table the workers on the State farms are apparently grouped with town workers, while those on the collective farms are given separately. The change from the older inefficient peasant system to more modern methods, and the great development of mechanization, enabled men to be released from the farms for the staffing of the new factories without any loss of food-producing power; there has, on the contrary, been a gain. The products, however, still remain in the same order of importance as before: grain still has the first place and livestock represents only about one quarter of the value of the output: relatively less than in 1913 and not much more in actual value.

The author recognizes the profound change in character of the collective farms since their inception, although the name has been retained throughout, and in an appendix he gives a clear translation of the rules set up by the central authority in 1935 and still valid. Of the cereals, wheat is the most important, and its output, which fell for many years after the Revolution, has risen since the second Five Year Plan began in 1933. The author does not, however, mention that in that year a new method of estimating yield of cereals was introduced which gives higher values than the old method; it is almost certainly a better method and its results are more likely to be trustworthy, but the change makes comparisons difficult. It is stated on p. 109 that the yields used to be over-estimated; but the evidence appears to point the other way. Rye comes next in importance, but its output has not expanded since 1913 although the population has grown. Oats have the third place, and these have increased to about the same extent as wheat, a result of the increased output of livestock products. The tables would have given a more faithful picture of the cereal position had they been continued beyond 1937. That was a magnificent season for cereals, and the yields in many places exceeded all records. As the author points out, 1930 was also an exceptionally good year for wheat, and the output jumped up to 35 per cent above its general level for the two years before and after: in 1937 the jump was even greater. I myself saw both these crops, and there was no doubt about their exceptional character.

Other branches of agriculture, especially technical, market garden and fodder crops, have developed

rather more than cereal growing, as usual when agriculture is being improved. The quantity of milk supplied to markets was in 1938 some 5½ million tons, while in pre-Revolution days it had been only just over one million tons; the butter supplied to markets was formerly 120,000 tons per annum; in 1937 it rose to 185,000 tons. Meat production has also increased, and a packing industry has developed, this being the most convenient way of distributing the meat: nearly one thousand million cans are turned out annually, this being nearly six per head of population.

The timber industry has made less progress than agriculture, probably because of its inherent difficulties. There are in the U.S.S.R. (according to the "Great Soviet Encyclopædia") some 956 million hectares of forest, or 43 per cent of the total area, but much of this is in Siberia and transport of the timber is mostly by rail. Owing to clearances, increasing distances have to be covered: in 1933 the average distance of transport was 688 km., by 1937 it had become 1,055 km., and only 23 per cent of the timber could be transported by water. Added to these difficulties was what the author calls "the mistake of invading the industry with conscript labour, recruited from non-proletarian elements"—this, he says, has now been realized by the management of the industry as ill-advised.

The author has little to say about the industrial progress. An interesting chart on p. 122 compares the values of output from agriculture, industry and home industries in 1913 with those of later years, and shows the great fall by 1921 and the later recovery: by 1927 the values in millions of roubles were almost the same as in 1913. It is not stated whether the roubles had altered in value during that period, but the large preponderance of agriculture is strikingly brought out. Unfortunately the chart ends there, and there is nothing to show whether agriculture has kept this great lead or not. Extensive data are given for outputs of the raw products of industry—oil, coal, ores and minerals—and there is an interesting account of gold-mining, which is still partly in private hands.

The book ends with some useful summary tables of imports and exports, some in tons and some in roubles, and a footnote directs attention to a change in the value of the rouble introduced on April 1, 1936, which is sometimes overlooked by writers and lecturers. Values prior to that date have to be multiplied by 4·38 in order to make them comparable with later values. The author does not say whether he has made this correction or whether it is left for the reader himself to do.

The book is so useful that a second edition may well be required. It would add greatly to its value if the author would give a little more explanatory information about the statistics and clearer indications of their sources. Two sets of official data are generally available in Great Britain relating to the U.S.S.R.: those in the official year-books and those in the reports presented to the party congresses, but they are not always strictly comparable one with the other. Periodically also other data appear in other official publications, but these again are not always comparable with the preceding, however good they may be in themselves. These differences in comparability are not always clearly indicated in the text, nor are the dates to which the figures refer always given. A striking chart on p. 104 shows the relative contributions of the individual farm products to the "total value of the whole yield of agricultural products". Grain and potatoes are grouped together; they would have been better separated: together they are said to represent 41 per cent of the total value of output. Live-stock account for 27 per cent but 'pasture' is listed separately at 16 per cent. 'Pasture', however, has no meaning apart from live-stock, and the reader is left wondering whether the 'pasture' has also been included in the 27 per cent for live-stock, in which case there is a certain amount of double counting, or whether its value has to be added to that of live-stock, in which case the total would come above that for grain and potatoes. But this cannot be right, as the official figure for the value of livestock products in 1937 was 25 per cent of the total output value. The text seems to indicate that the diagram refers to the collective farms: does it take account of the large number of live-stock owned by the peasants? (From the results of an inquiry reported in "Kolkhozy vo vtoroi Stalinskoi Piatiletke, 1940", it appears that the peasants in 1936 owned more animals than the collective farms.) It is not stated to what months the live-stock data refer, nor whether the figures for arable land include fallows intended for sowing but not yet sown. Fuller information would be particularly useful for the charts, which are otherwise very helpful. No dates are given for the population charts on pp. 11 and 13, though one apparently refers to an early census and the other to a later one.

It would be helpful also to give a little more information about the natural regions: English readers still think of European Russia, and the author indeed makes incidental references to it, but only indirectly can the reader estimate its size. It would be particularly helpful to agricultural students if the classification of the regions into tundra, marsh, forest, steppe, desert, etc., given only in a footnote on p. 4, could be expanded: that is the one used mostly in Great Britain. Finally, we should be grateful for a table showing the land utilization in the various regions of the U.S.S.R. The book is so good that one can safely anticipate it will have a long and useful life, and anything that will add to its value can be welcomed.

E. J. RUSSELL.

A NEW DETERMINATIVE TABLE FOR ORGANIC COMPOUNDS

The Optical Properties of Organic Compounds
By Alexander N. Winchell. Pp. xiii+342. (Madison, Wis.: University of Wisconsin Press, 1943.) 5 dollars.

THE value of the polarizing microscope in identifying and characterizing minerals is well known, but its application to organic crystals is not yet by any means general. The customary description of a new compound includes a precise statement of its melting point, boiling point and other physical properties; but when it comes to crystalline form the description all too frequently lapses into the vagueness of white needles, orange prisms or colourless plates. A more careful description of superficial appearance is perhaps considered unnecessary because crystal habit is notoriously dependent upon environment during growth, and may vary from one preparation to another. If reasonably well developed crystal specimens are available, resort to the goniometer will provide data which are definitely char-

acteristic of the compound. Very often, however, such well-developed specimens can only be obtained with considerable difficulty, and the material is more usually in the form of minute, even microscopic crystals or fragments of crystals. It is perhaps not generally realized that on such unpromising material the polarizing microscope can provide accurate measurements, not of one but usually of several distinct physical constants which, taken together, provide an exceedingly reliable means of characterizing the compound.

The optical properties most useful for this purpose are the refractive indexes, usually three in number for compounds of low symmetry. The aim of the work before us has been to collect the crystallographic and optical properties of all organic compounds of which the indexes of refraction have been measured, up to and including the year 1940. The description of each compound gives name, formula, crystal data, including habit and cleavage, with frequent diagrams (no structural data are given, only axial ratios), density, melting point and a full and careful description of the optical constants. One difficulty which must be faced by the compiler of any work of this kind is in dealing with imperfectly determined data, as arises, for example, when crystals are studied in one position only (usually on the largest face, or cleavage surface). Indexes of refraction thus determined are not necessarily the true principal indexes, and in the present work all such cases have been carefully distinguished by listing such indexes as N_1 and N_2 to distinguish them from the true values of the principal indexes, N_g and N_p. Such careful and critical treatment of the data by one who is a recognized authority on the subject gives a high value to the present work.

The arrangement of the systematic section, which includes more than a thousand organic compounds, follows that of the fourth edition of Beilstein's "Handbuch der Organischen Chemie", with slight modifications to bring certain isomorphous salts together. This is followed by a determinative table, occupying about seventy pages, in which substances are arranged in order of increasing index of refraction (the index for the ordinary ray, N_o, or the intermediate ('mean') index, N_m, is used for anisotropic substances and the other indexes are also given). This information is then summarized in a very useful diagram on which all the compounds are plotted, refringence (N, N_o or N_m) along one axis, and positive or negative birefringence along the other. By means of this diagram and its key, any of the compounds listed can be very quickly identified solely by its refractive indexes.

The appearance of this work brings to mind two other systems, already in progress, which aim at the identification of a substance by means of its crystalline properties. In the Barker Index at Oxford, substances are classified according to their characteristic interfacial angles, and rules are provided to ensure that no ambiguity shall arise in the choice of the classification angles. It is understood that considerable progress has been made in the compilation of this index, and trials have shown that positive identifications can be made with considerable speed[1].

Finally, there is the Index of X-ray Diffraction Data prepared by the American Society for Testing Materials[2,3], which aims at rapidly identifying any substance that will give a powder photograph. This method is undoubtedly the most universal in its application, as visible single crystals of the material are unnecessary. But X-ray apparatus, however, is still a rarity in many chemical laboratories.

These various methods for the rapid identification of substances will undoubtedly become of increasing importance in the future, as the necessary data are accumulated and become classified. The factor which severely limits the usefulness of all these methods at present is the comparatively small amount of accurately ascertained data in comparison with the vast number of known chemical substances. Further progress on any of these projects will call for carefully planned co-operative work on a very large scale. Some kind of conference is needed to decide on the best methods and to organize the work.

Even if the average chemical laboratory does not possess a goniometer or an X-ray apparatus, it should at least have a good polarizing microscope, for optical measurements on crystals have an importance far exceeding the rather utilitarian aspect of mere identification. In elucidating unknown structures, for example, they played a great part in Bernal's early work on the sterols[4]. In the main day-to-day work of the chemical laboratory the microscope, if competently used, can effect a great saving of time and labour[5]. Winchell's book should therefore make a wide appeal to those who have become familiar with the uses of this valuable instrument.

J. MONTEATH ROBERTSON.

[1] *Nature*, **144**, 298 (1939).
[2] *Nature*, **149**, 437 (1942).
[3] *Nature*, **150**, 738 (1942).
[4] Bernal, J. D., Crowfoot, D., and Fankuchen, I., *Phil. Trans. Roy. Soc.*, A, **239**, 135 (1940).
[5] See, for example, Chapter 7 of "Crystals and the Polarising Microscope" by N. H. Hartshorne and A. Stuart (Arnold and Co., 1934).

BACKGROUND OF ART AND SCIENCE

Art and Scientific Thought

Historical Studies towards a Modern Revision of their Antagonism. By Martin Johnson. Pp. viii+192+16 plates. (London: Faber and Faber, Ltd., 1944.) 16*s*. net.

IT is impossible to mix with people these days without continuously meeting the question of values. "Why do we do this, and why do we do that?" Not so much *how* as *why*. Otherwise expressed, there is a tendency to show less interest in systems of law than in ends to be attained, an outlook essentially teleological in character. Historians, including those of the arts, will breathe freely in such an atmosphere, and scientific men (or at least some of them) would experience a certain awareness that experimental knowledge cannot indefinitely rid itself of responsibility for its discoveries, for good or for ill. Dispositions something like these have clearly been at work in Dr. Martin Johnson's mind, and the remarkable book before us is the result.

To begin at the beginning, Mr. Walter de la Mare writes as charming a foreword as only he can do. Discussing poetry, he says that "Mere endeavour will neither achieve its creation nor win the secret of its power and beauty". But immediately before this he remarks that "poetry . . . is essentially different" [from science]. The implication is perhaps scarcely happy. The supreme accomplishments of science are —of their kind—pure art, and those responsible for

them are, like poets, born not made. It is true, of course, that works of art endure, whereas even the best of scientific theories do not. The latter are for ever yielding place to less imperfect successors. But for all that, "power and beauty" are shared by art and science alike, in mutual reverence.

Dr. Martin Johnson himself starts with a series of essays, dealing with those features of the arts and sciences which show marked resemblances and contrasts. He traces the function of pattern, structure and form, and finds that, without metaphysical complications, the paramount need is for communication. To a work of art there is obviously an infinity of emotional patterns registered by different observers, whereas all mental judgments of a scientific theory tend necessarily to identity.

We are next presented with a number of examples of imaginative stimulus. Perhaps these are the most revealing pages of the book, and indeed they are entrancing. Beethoven's last years, and his music, are pictured with sensibility and yet with restraint. In a few sentences the author casts upon this scene of distress what Whitehead meant when he defined religion as "what the individual does with his own solitariness". It is all too likely that the great musician could but point others to the skies, chained and bound to earth as he was himself.

From such quests of the imaginative, Dr. Martin Johnson turns squarely to apply the historical method in his descriptions of Persian, Arab, Greek, Moslem and Chinese investigations relative to mathematics and the design of scientific instruments. It is well done, if a trifle heavy compared with the rest. These chapters end with an able discussion of symbolism and its place in some future conciliation between science, religion and art. Of course, this theme has been attempted before. One has only to recollect such diverse names as Otto, Streeter, Collingwood, to realize how 'pontifical' (in the correct sense of the word) an approach this is. Seldom can synthesis have been more effective.

The last five chapters are devoted to Leonardo da Vinci. Considering the weight of scholarship which has already descended upon the elucidation of this remarkable personality, this new contribution is fresh in outlook and distinguished in presentation. Leonardo had no love for pure mathematics, and even less for metaphysics. His experimental genius derives fundamentally from Archimedes, for whose works, by the way, he sought long and patiently, against enormous odds. There is little doubt that, consummate artist as he was, he became ever more and more engrossed in scientific work, which led him on to a type of extreme veneration for natural law.

In general, the historical point of view is suited to the aim of this volume; its constant use, however, tends to exclude completely certain modern aspects of the relations between the arts and sciences which are much to the point. Maybe the future will provide opportunities for ventilating them; in any event, such a background as we have here is a necessary pre-condition for their appreciation.

Incidentally, there are a few odd little mannerisms; readers' memories may be short, but it seems needless to repeat the dates of the Chou dynasty three times in six pages. The index is strangely capricious: sometimes proper names are entered, sometimes not, without any apparent reason. Occasionally the missing reference is much more interesting than the one which is listed.

Finally, this is certainly the moment to discern—and perhaps even the place to rejoice in—the author's abundant charity, which seeketh not her own [and] is not easily provoked. Dr. Martin Johnson has produced something of great price, and of engaging modesty; of that wisdom, in fact, which stoops to conquer.

F. IAN G. RAWLINS.

PHILOSOPHY AND PHYSICS

Fact and Fiction in Modern Science

By Henry V. Gill. Pp. vi+194. (Dublin: M. H. Gill and Son, Ltd., 1943.) 8*s*. 6*d*.

THIS book is substantially a reprint of essays which have appeared at different times in various journals. The author has the advantage of a more profound knowledge of philosophy than most popular writers on science, and his comments are more sober and orthodox than might perhaps be anticipated from the somewhat flamboyant title. The scope is sufficiently indicated by chapter-headings such as "The Nature of Scientific Knowledge", "From Physics to Philosophy", "Logic and Modern Science", and "Determinism, Uncertainty, and Free Will".

An interesting suggestion (p. 24) is that "the philosophy of Eddington would seem to approximate to that of the scholastics". To justify this affiliation, one may start from Eddington's affirmations that "all that physical science reveals to us in the external world is group-structure" and "Physical Knowledge is structural knowledge". But if we try to develop the Eddingtonian philosophy consistently beyond the point to which Eddington himself has carried it, we are led to inquire what (if anything) is this structure the structure *of*? What would, so to speak, be left behind if all structure could be imagined as annihilated? Clearly it cannot be ordinary matter, for ordinary matter even in its most elemental form as electrons, protons, etc., has qualities which must be included in the category of structure: the ultimate residuum which is wholly devoid of structure must be a limiting conception, a pure potentiality, something not capable of existing alone; and surely this is nothing other than the *materia prima* of the scholastics, Eddington's 'structure' being equivalent to the scholastic 'form'.

The author makes a curious slip when he says (p. 178), "To *prove* to one who denies it that two and two could not in any condition of things make five is beyond the power of any philosopher". Although this particular problem does not figure explicitly in Whitehead and Russell's "Principia Mathematica", a demonstration could undoubtedly be provided by the methods of that work.

The treatment is, generally speaking, well informed on the purely scientific side, the only noteworthy exception being that the author misconceives Heisenberg's uncertainty principle. In one place (p. 111, last three lines), he seems to be under the impression that the uncertainty is merely a consequence of the inadequacy of experimental methods now available, instead of being, as it actually is, an uncertainty *in principle*. Elsewhere (p. 24, lines 9–11) he seems to confuse it with the lack of detailed information about individuals which is characteristic of all statistical systems. But these are minor blemishes in a readable and instructive book.

E. T. WHITTAKER.

'D.D.T.': A NEW INSECTICIDE

By PROF. J. W. MUNRO
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A STATEMENT by Government to the public Press on recent developments in the application of the insecticidal substance known as 'D.D.T.' and the extensive publicity given in the American Press and technical journals to this insecticide have directed attention to a field of work in applied entomology which in peace-time is almost unknown except to the specialists.

With the outbreak of war, and especially when Japan entered the War, the need to protect growing crops and stores of food from insect attack, and above all the need to protect the Fighting Services from insect-borne diseases, created an unprecedented demand for insecticides. In the face of that enormously increased demand, by the mere entry of Japan into the War, supplies of the important insecticide pyrethrum from that country to the United States were cut off. Worse still, with the loss of Malaya the main source of rotenone derived from *Derris elliptica*, a second important insecticide, was lost. The chief, almost the only important, source of pyrethrum left to the Allies was Kenya Colony, but its production was unequal to the war demand. A limited supply of rotenone, inferior as an insecticide to that derived from Derris, was available in South America from the plant Lonchocarpus, but again the supply was unequal to the demand. It was in these circumstances, when an urgent and active search for substitutes for pyrethrum and for rotenone was being made, that attention was turned to 'D.D.T.'

'D.D.T.' is a term coined to designate briefly the substance dichloro-diphenyl-trichloroethane, and the term 'pure D.D.T.' designates *para-para*-dichloro-diphenyl-trichloroethane, which is the most active isomer. In the trade, an insecticide containing 'D.D.T.' as the active ingredient was marketed in the United States as 'Gesarol' and in Great Britain as 'Neocid'. Neither the discovery of the substance itself nor its use as an insecticide is new; but, under the necessity of finding substitutes or near substitutes for pyrethrum and for rotenone as insecticides, new applications or uses for 'D.D.T.' have been developed both in Britain and in the United States.

'D.D.T.' has proved an unusually effective insecticide with more uses than any other single substance so far available, and has already more than justified the intensive work done on its 'development'. For example, it has been used with signal success in Italy—notably in the control of a typhus outbreak in Naples when, in January 1944, 1,300,000 civilians were dusted with 'D.D.T.' powder and within three weeks the outbreak was completely under control. This is the first occasion in medical science when a typhus outbreak has been arrested in mid-winter.

The significance of 'D.D.T.' as an insecticide can best be assessed by comparing it with other insecticides used. Briefly, these are pyrethrum, derived from the flowers of *Chrysanthemum cinerariifolium*; rotenone, derived from the roots of certain leguminous plants, of which species of Derris and Lonchocarpus are the more important; and synthetic insecticides such as the organic thiocyantes and *iso*-butyl-undecylenamide.

The outstanding feature of pyrethrum is its rapid action, technically described as 'quick knockdown'. Its defects are that, as ordinarily applied as a 'pyrethrum-kerosene' spray, it is not persistent, and that to some skins it is irritant, and susceptibility to irritation increases under continued exposure.

Rotenone lacks the rapidity of action of pyrethrum, is not suited for application in kerosene but is more effective as a dust. In this form it is more persistent than pyrethrum and does not cause skin irritation.

The thiocyanates and *iso*-butyl-undecylenamide more nearly approach rotenone than pyrethrum in their insecticidal action—they lack the 'knockdown' action; they are more toxic to man and animals, and the thiocyanates have a persistent unpleasant odour which quite seriously limits their use.

'D.D.T.', while lacking the rapid action of pyrethrum, has all the good insecticidal qualities of rotenone and the synthetics. In pure form it is practically odourless and it is remarkably persistent. When sprayed on walls at a suitable concentration, 'D.D.T.' kills any fly alighting on them up to a period of three weeks; a bed sprayed with 'D.D.T.' is fatal to bed-bugs for three hundred days, and clothing dusted with it is safe from lice for a month even after several launderings.

In agricultural and in veterinary pest control, as the tests conducted by the U.S. Bureau of Entomology and Plant Quarantine[1] show, 'D.D.T.' also shows high promise.

The truly astonishing rate at which 'D.D.T.' has been 'put through its paces' by the biologists, chemists and malariologists both in the laboratory and in the field, and the extensive demonstration of its value as a general-purpose insecticide, has led in some quarters to the assumption that 'D.D.T.' will rapidly replace all the older insecticides, and even to the assumption that much research as, for example, on the methods of testing insecticides, on the relative merits of aerosols and sprays and on the physical and physiological modes of action of insecticides, is no longer necessary. Such assumptions are unwarranted. While on the practical side 'D.D.T.' has provided a solution of our difficulties far beyond expectation, on the scientific side it has raised many problems and difficulties which, while they cannot be fully tackled in war-time, must yet be tackled before the full potentiality of 'D.D.T.' and—this is important—of the methods of using it can be realized. This demonstration of our ignorance of many factors affecting the full use of 'D.D.T.' is bound to react on the development of other insecticides. 'D.D.T.' is not the successful rival ousting all other insecticides from the field. It is a challenge to the chemists and the entomologists to develop these other insecticides by applying to them the same exhaustive and critical study that has been given under pressure of war to 'D.D.T.' Pyrethrum, for example, is still essential as an ingredient—perhaps with 'D.D.T.'—of sprays designed for the rapid destruction of mosquitoes. When peace returns, the factor of costs both in production and in application will once again become important and rival insecticides will enter the field—one called '666' has already done so[2].

It should be borne in mind that an important factor in the success of 'D.D.T.' lies in its trial and use on a lavish—by pre-war standards on an extravagant—scale, and until the War ends it will be difficult to see 'D.D.T.' and its competitors in proper perspective.

In looking forward to that time, one may express the hope that the herculean efforts now being made to destroy insect vectors of disease and depredators

of our crops and food stores will not be abandoned, as efforts on a lesser scale were abandoned in 1919. During the War of 1914–18, the most widely used specific against lice was a rather crude mixture called 'N.C.I. powder'. It is interesting to note that, according to Prof. P. A. Buxton's monograph published in 1939[3], it was still on the active list.

The neglect of applied entomology except in times of crisis has cost us dearly enough; in this present War, but for the efforts of a group of administrators and men of science working in close concert, it might have cost us even more. In the United States, Government departments, university and research institutions and individual workers themselves have described the magnificent effort they have made in this field. In Great Britain, official reticence, if not secrecy, has delayed until now any reference to the equally great effort made by workers in many fields, administrative and technical; industrial and scientific. The co-ordination of that effort and the startlingly successful development of 'D.D.T.' was possible only under able and distinguished leadership, both in the military and in the civil branches, and it is to be hoped that in due course that leadership may be acknowledged.

[1] *J. Econ. Entom.*, 37, No. 1, 125 (1944).
[2] *Farmer and Stockbreeder*, 58, No. 2847, 688 (1944).
[3] "The Louse" (London: E. Arnold and Co., 1939).

THE VISUAL EDUCATION CENTRE, EXETER

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VISUAL education starts with certain raw material in the form of items of organized knowledge (usually in verbal form); converts it into *visual matter* (photograph, diagram, etc.); presents it through some *visual medium* (wall-mount, ciné-projector, etc.); and usually combines it with oral teaching—all to help the learner to learn more efficiently than by the latter alone. At every stage problems arise. The field is wide and there are many workers in it. At the Visual Education Centre at Exeter we are endeavouring to find solutions to these problems; at its recent research conference its possibilities of usefulness, both as a research institution and as a forum, were demonstrated. (The Museum has a very important function in visual education. I have made no attempt to deal with this as it is beyond the scope of my title.)

The problems fall naturally into three main groups, concerned with visual *matter*, visual *media* and visual *methods*, respectively. The distinction between matter and media is all-important. The matter may be pictures, diagrams, pictograms, maps, symbolic charts, mathematical graphs, etc. Any of these may be presented through any of the visual media, namely, wall-mount or text-book illustration, episcope projection, diascope projection through lantern slide or film-strip, and lastly ciné-projection (silent or sound). Moving matter (ciné-film), microscopic matter and stereoscopic matter are restricted, of course, to special forms of presentation.

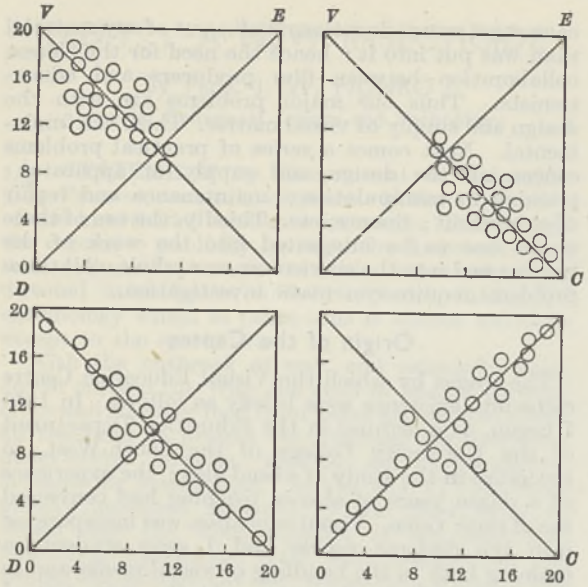
Extravagant claims for some particular medium are often made by enthusiasts who forget that we cannot get more educational value out of any material than was put into it; hence the need for the closest collaboration between film producers and educationists. Thus our major problems are with the design and supply of visual matter. These are fundamental. Next comes a series of practical problems concerning the design and supply of apparatus; training in manipulation; maintenance and repair of equipment; finance, etc. Thirdly, the use of these media has to be integrated into the work of the teacher and into the curriculum as a whole. All these problems require systematic investigation.

Origin of the Centre

The stages by which the Visual Education Centre came into existence were briefly as follows. In 1940 I began, as a lecturer in the Education Department of the University College of the South-West, to specialize in the study of visual aids; the experience of a dozen years of science teaching had convinced me of their value. Visual education was incorporated into the diploma course and I gave students a training both in the handling of visual media and in the design of visual matter. At the same time I became secretary of the Film Council of the South-West, a recently established committee for the encouragement of the cinematograph for both instruction and entertainment. The Council represents the local education authorities, the University College, the schools, the cinema trade, the Ministry of Information and the British Film Institute. The latter, together with the local education authorities and local subscriptions, finance the Film Council. The secretaryship, at first voluntary, came to be accepted as College work, thanks to the goodwill and foresight of Principal John Murray, and of Prof. S. H. Watkins of the Education Department. Other work had to be dropped and funds raised to appoint a substitute; the director of the British Film Institute was instrumental in obtaining grants from industrial concerns, and the position was consolidated by the establishment of a lectureship in visual education. Equipment was purchased, clerical and technical assistance provided, temporary huts appropriated, and last year a research assistant, Dr. Renée Marcousé (now assistant lecturer), was appointed.

The Centre is fully occupied in training students, providing teachers' courses, supplying advice and information, providing film shows and other visual demonstrations both in the College and outside, for schools, for the Forces, for civil defence and other national services, for adult education and so on. It now issues its own bulletin, approximately quarterly. It maintains a very wide circle of contacts in all branches of visual education. Recently problems of aeronautics and industry have been insistently raised, and the setting up of an industrial section is contemplated. All along, the Centre has paid its way by grants raised *ad hoc*, now running well into four figures.

One of the Film Council's earliest achievements was the establishment of a regional film library. Dartington Hall generously provided housing and personnel. The Ministry of Information substantially aided the new library by choosing this as a regional distributing centre for the whole south-west region. Much valuable experience has been gained in this way, and the five counties have been kept supplied with non-theatrical 16-mm. films for the last three years.



ASSESSMENT OF VISUAL MATERIAL BY TEST-SCORE ANALYSIS

The small circles represent individual test-questions. In any actual distribution they are numbered, and coloured according to type. Each has two co-ordinates *C* and *V*, being the number of correct responses to the question given by the Control group and the Visual group respectively. (There were approximately twenty children in each group.)

The four distributions shown are some of the extreme distributions theoretically possible: 1 indicates a test favouring the visual group almost exclusively; 2, Control group favoured; 3, approximately half the questions favour the Visual and half the Control group; 4, few questions discriminate between the two groups.

Obviously various statistical coefficients could be calculated from the data, but the main interest lies in the indications which the method provides of the detailed 'educational yield' of a particular piece of visual teaching.

DE may be called the 'axis of difficulty', and *VC* the 'visual-verbal axis'.

An Experimental Inquiry

Research, both experimental and theoretical, is the most important contribution a university centre can make. An investigation into visual teaching techniques has recently been completed in Exeter. The statistics are now being analysed, and a full report will be issued in due course. Owing to the inherent variability and multiplicity of the factors involved, the utmost caution is needed in interpreting the results of any educational experiment. A difference may be statistically significant, but the qualitative significance is often a matter of conjecture. A certain percentage difference ($\pm$ p.e.) between the average test-scores of two groups tells us very little. It is conceivable for two groups to have equal average scores and yet to have answered correctly two entirely different selections of questions. In the Exeter research particular attention was paid to the content and structure of the topics on one hand, and to the distribution of correct answers among the various test-questions on the other hand. The accompanying diagrams give four of the various theoretically possible distributions, with their interpretations. The actual distributions, still being worked out, tend to be mixed in type, as would be expected.

The research seeks detailed information of two kinds. The first is an objective educational assessment of a particular 'graphic' (to borrow a useful term introduced by Lieut.-Commander Rawnsley, covering all forms of visual material) whether film, set of photographs, etc., or combination of these. Such information is essential if visual production is ever to work by methods other than rule-of-thumb. The second is a descriptive account of the practical problems which arise in the classroom in handling 'graphics', and the solutions adopted by a number of different teachers. A comparatively small-scale experiment, closely recorded, may yield more valuable information than a much larger experiment which swamps the desired information in arrays of averages. Four schools were used. There were two groups in each, a 'visual' and a 'control'. The teachers were supplied with detailed notes of the topics and with visual materials. Initial, final and delayed tests were given. They were objective 'new-type' tests. Four different topics were chosen and each was tried out in all four schools, but the visual method was slightly different in each case. The four methods were: film alone, static pictures alone, film plus static, and segmented film plus static. (The theory of 'segments' will be given presently.) The test-questions were sub-divided under four headings according as they dealt with problems, observations (raw facts), representations (grouped facts, that is, laws) or inferences (explanations and theories). The dots representing each question in the analysis charts are coloured according to these four headings. The distribution then shows at a glance whether any one *type* of question is favoured by the visual or by the verbal method. This technique lends itself to considerable development, and promises to remove much of the subjectivity from judgments on educational materials and methods. Thus the research as a whole was not concerned with verifying any particular hypothesis but with creating techniques and obtaining valuable information.

Films often contain material which is essentially static. Such material is better presented in static form, the film medium being reserved for essentially kinetic aspects of the topic. The theory of 'segments' is that phases of growth, change, motion, etc., should be presented in short film-segments of, say, 1–3 minutes duration, for detailed study and for integration with static 'graphics'.

Discussion of Results

The idea of research conferences is a sound one in a field where variation and multiple causation are the order of the day. The suspicion of statistics *per se* is a healthy one, but statistics submitted to a competent body of critics may yield very useful interpretations. A conference was held at Exeter during July 1 and 2 with personnel from the Board of Education, the local education authorities, the museums, the British Film Institute, the participating schools, Film Centre, Shell Film Unit, Common Ground, Ltd., Dartington Hall Film Unit, the Film Council of the South-West and the University College of the South-West. In the opening session the plan of the research was described and the "Exeter technique of visual assessment" explained by myself with coloured charts. Dr. Marcousé then gave an account of her systematic observations of the

teaching procedure and of the overt responses of the children to the visual material. (In the full report this will be given in detail.)

Next came the teachers. All four schools had shown a most gratifying willingness to co-operate. Perhaps the most interesting feature of their testimony was the unlooked-for result that, quite apart from the stimulus to the children, the use of these visual techniques had a distinctly stimulating effect on the teachers. The extremely cordial relationship between the teachers, the Visual Education Centre staff and the director of education, Mr. G. A. Tue, was the *sine qua non* of the whole research. The four Exeter schools taking part were the two Episcopal Senior and the two Ladysmith Senior schools.

The lesson notes, tests and visual materials were all on view. The latter consisted of four films and still material consisting of large photographs of high quality, well-mounted, bearing full captions, and covering the four topics. Other material was also demonstrated.

Discussion took place on classroom techniques, on the use of museum material and on the planning of educational films. Miss Grayson (of the British Film Institute) stressed the need for co-ordination. The problem of making museum resources available for the schools was discussed. Mr. Neilson Baxter (Shell Film Unit) pointed to the valuable experience gained by many ciné-technicians in the production of instructional films during the War. Mr. Anstey (Film Centre) urged the setting up of a Government films department. The present author pointed out that if producers would plan educational films in series, each series following a characteristic treatment, a prototype film for each series could be made and tried out by the Exeter technique. The evidence so obtained would provide guidance for the rest of the series. The conference was summed up by Mr. K. de B. Codrington (Victoria and Albert Museum), who stressed the simple common elements which run through all good teaching and the need for using each type of visual material for the purpose to which it is most suited.

General Conclusions

Whatever researches are made on problems of media and methods, the fundamental problems are those of visual matter. Any visual production rests on a whole series of assumptions, conventions and decisions. No amount of technical or æsthetic virtuosity can compensate for a failure to come to terms with the philosophy of curriculum-building or the psychology of the child. One important factor often neglected is the contribution of intellectua security to emotional stability. Our existing curricula present children with an anarchic sequence of incommensurable and unintegrated approaches to knowledge. If visual education neglects its fundamentals, it may easily perpetuate this state of affairs. Theoretical research at the Visual Education Centre is therefore concerned with the bearing of three normative disciplines on visual production, namely, logic, semantics and statistical theory. Visual productions must be consistent, they must present their meaning clearly, and they must take account of the variability which all objects display. This is a long story, to be presented in a larger publication, together with an account of its bearing on the curriculum as a whole, and the significance of these new developments in relation to the teacher's function and to national (and international) educational needs.

MATHEMATICS FOR PHYSICISTS

"MATHEMATICAL teaching," said Klein, "is a function of two variables, the subject and the pupil." In other words, it is necessary to vary the presentation of the subject to suit minds of different types. Nineteenth-century physicists, such as Kelvin and Maxwell, started as mathematicians, and many of the contemporary mathematicians relied upon physical intuition, so at that time a common course of training was possible. The interests of the two parties have now diverged. The pure mathematicians have recognized that intuition may be successful for a long time, and yet lead in the end to a terrible blunder. They now keep to the straight and narrow path of rigorous logic. For example, they do not, like Fourier, assert that any function whatever can be expanded in an infinite series of harmonic terms, but occupy themselves with the difficult task of formulating the precise conditions necessary and sufficient for this expansion.

On the other hand, experimental physicists regard mathematics as a tool, to be used whenever it is convenient to supplement the results of experiment, or as a language in which these results can be concisely expressed. To them Fourier's theorem is merely the mathematical form of a general physical principle, firmly established by experience. Why should they worry about possible exceptions which may never happen ? They prefer vigour to mathematical rigour, which seems to them as devoid of live interest as *rigor mortis*. Even if they could appreciate the need for the purely logical discussion, they would not have time to study it. What has been said of Fourier's theorem applies also to the large amount of advanced mathematics which is inseparably connected with recent advances in physics. The traditional 'mathematics subsidiary to physics' is now quite inadequate, but experimental physicists cannot afford the time needed for a great extension of the mathematical course on its present lines.

To deal with this dilemma, the Institute of Physics and the Mathematical Association have held a conference and issued a joint report, "The Teaching of Mathematics to Physicists" (Institute of Physics, Spencer House, South Place, London, E.C.2). They recommend courses much wider in scope but simpler in technique than the usual subsidiary mathematics. For example, their Schedule A, which is to cover the minimum requirements of a fully trained physicist, includes roughly the contents of both the two subsidiary subjects pure mathematics and applied mathematics (which are alternative subjects at some universities, such as London), with the addition of a little statistics. This doubled syllabus is to be covered in the same time as before, say, one third of the physicist's total study hours for two years. This is to be made possible by omitting the solution of difficult problems, and merely requiring the student to recognize the applicability of the mathematics to physics. Specimen examination questions are given to show how this can be done.

The report also gives a Schedule B, suitable for the ablest undergraduates in their third year, and a Schedule C suitable for the postgraduate stage. At first sight these later schedules seem far beyond the capacity of any experimental physicist; but, as in Schedule A, it is intended that they should be treated with the minimum of technique. It is admitted that this will require special lectures and an increase in university staffs. It is suggested that such lectures

might be useful for students of other branches of science, but this has not been discussed in detail. It is recommended that the lecturer should be a member of the mathematics department, with a special sympathy towards the outlook of the physicists.

As a personal comment on these proposals, it may be stated that an optional course on these lines, as a supplement to the usual subsidiary mathematics, has been given for several years at University College, Nottingham. It seems to be appreciated by the stronger physicists, but it is rather a strain on the weaker ones. The surprising thing is that it is enjoyed by mathematicians, who apparently welcome a temporary release from the inhibitions of mathematical rigour.

H. T. H. PIAGGIO.

BIOLOGICAL APPLICATIONS OF THE ELECTRON MICROSCOPE*

By DR. G. E. DONOVAN

ELECTRON micrographs may be considered analogous to X-ray pictures, since the darkness and brightness depend on the thickness and density of the specimen; they are unlike micrographs taken with the light microscope, in which an image is formed due to differences in the amount of absorption or refraction within the object. The presence of very small particles in specimens for examination under the electron microscope will cause perceptible scattering, and the image formed of an object thicker than about 0·5 μ is merely an enlarged silhouette.

Another characteristic, which is usually an advantage, is the great depth of focus. This is useful for stereoscopic work.

Specimen Mounting

The vast majority of microscope specimens must be mounted upon a transparent support. Glass of a convenient thickness is the most suitable material when the illuminant is visible light, but it is opaque to an electron stream, and a new technique has therefore been built up, whereby specimens may be adequately prepared for examination. A very thin, uniform film of collodion or nitrocellulose can be produced so as to show no structure, similar to the glass slide used for supporting specimens in the ordinary microscope. It produces a uniform diminution of intensity, but if the film is thin enough, the amount of scattering and spread of velocity caused by it does not cause much interference with the picture. A very thin film is produced by dropping a small quantity of a 1·5 per cent solution of collodion in amyl acetate on water saturated with amyl acetate. The film spreading over the surface is taken up and dried on a small circular disk of 200-mesh wire gauze, less than $\frac{1}{8}$ in. in diameter. Gentle pressure on the diaphragm causes it to adhere to the film. Films of this kind are thinner than the length of a collodion molecule. The coated disks are separated from the rest of the membrane by means of delicate handling tools, lifted from the water, inverted so as to bring the film side uppermost, and placed upon a miniature pedestal. There the water clinging to the surface is removed, and a drop of a fluid containing the specimen in suspension, or solution, is placed upon it, and the fluid allowed to evaporate. The whole is then placed in position on the 'cartridge', which in its turn is inserted through the air-lock into the microscope into the space about to be evacuated. The surfaces of certain materials, for example, metals and alloys, can be studied by light reflected from them in the light microscope, but this is generally impracticable with electron rays. A cast of the surface can be made by using some sort of plastic in solution and allowing the solvent to evaporate; a negative solid replica of the surface structure can be produced by peeling off the film from the original, and can be examined like an ordinary specimen in the electron microscope. An electron image of such a film will develop more strongly where the plastic material is thinnest. In some cases, where a replica cannot be stripped off, satisfactory results can be obtained by dissolving the original in some acid or other solution which the plastic film can withstand. The cast technique may be useful for examining the surface of such structures as metals, teeth, etc.

* From a paper on "The Electron Microscope: its Applications to Medicine" read before the Royal Society of Medicine on June 21.

Practical Applications

Until very recently, the electron microscope remained an experimental instrument in the hands of the physicists, and it is only in the last few years that any serious attempt has been made to exploit its possibilities for research. Most of the examinations so far reported have been directed towards the discovery of possible fields of research, rather than towards the solution of particular problems. It holds great promise in almost every field of science, especially in chemistry, metallurgy, medicine and biology, as it reveals many important structures and reactions which have hitherto been inaccessible to direct observation and measurements.

Dusts and smokes are among the simplest kind of materials to view in the electron microscope, revealing groups of ultra-microscopic particles that float in the air. This type of research is of interest to the public health worker and those interested in environmental diseases, such as the medical man in industry, etc. A great number of the particles found in human lungs are smaller than 5 μ in diameter, and an appreciable portion less than 0·2 μ. Electron micrographs have been published of smoke particles resulting from the combustion of zinc, magnesium ribbon, aluminium, etc. The physical structure of these varies; for example, the electron micrograph of magnesium oxide shows small cubic crystals, aluminium oxide smoke is made up of strings of spherical globules, etc.

Powders are required for many purposes, and a knowledge of their physical structure is of importance. A sample of lead arsenate insecticide which possessed unusual covering power and toxicity showed under the electron microscope, magnification 56,500, that the particles consisted of extremely thin flakes, which naturally possess a large surface and clinging power. A popular face powder owed much of its popularity to the fact that it did not easily come off. The electron microscope showed that its particles were of a highly angular shape, capable of hooking themselves into the epidermis.

The instrument has many uses in organic chemistry; for example, an electron-micrograph has been published[1] showing a specimen of polyvinylchloride. The magnification (100,000) shows the specimen to be mottled with an evenly spaced succession of spots. The spots are considered small enough to constitute single molecules, and there is little doubt that visual

confirmation is here obtained of the truth of the molecular theory. It has been used in the study of protein molecules[2].

It is now possible to obtain electron micrographs of the location of certain chemical reactions incident to the metabolism of the bacterial cell. The reduction of potassium tellurite by *C. diphtheriæ* has been studied[3]. It has been demonstrated that tellurium crystals form in all parts of the micro-organism, in some cases puncturing its walls. A method of selective micro-chemical analysis has been developed[4] by taking electron pictures of bacteria after exposure to salts of heavy metals. The electron microscope has demonstrated changes in the bacterial cell brought about by the action of germicides and anti-bacterial substances[5]. The recording of the action of germicide agents on individual bacterial cells is a promising field of application of micro-chemical analysis.

Electron micrographs of bacteria have been published[6]. The *Myobacterium tuberculosis hominis* shows that its cell wall appears to be very delicate. Many small dark granules appear throughout the field, and in particular, adhering to the cell wall. Large black granules are shown within the protoplasm. A strain of Fusobacterium shows dense areas, but in contrast to that of the tubercular bacilli the dense areas are not localized in definite circumscribed granules. Monotrichates, for example, *Vibrio schuylkiliensis*, show a cell wall. Definite circumscribed granules are again seen within the protoplasm. The flagella of monotrichates—for example, vibrios—are on the whole wider in diameter than those of peritrichate and lophotrichate species. Unstained diphtheria bacilli show definite polar bodies. *Treponema pallidum* appears to have flagella-like processes at various points along its course. The morphology of *Leptospira ictero-hæmorrhagiæ* and *L. canicola* has been investigated[7].

If suspensions of streptococci are subjected for a short period to sonic vibrations, some of the cells are cytolysed[8]. These bacteria retain their original outline, but become transparent to the electron beam, appearing as pale grey bodies and contrasting strongly with the opaque normal cell. *B. subtilis*, after subjection to sonic vibrations, is shown to have the flagella continuous with the cell wall.

The combination of antibodies with flagella and somatic antigens has been demonstrated by the electron microscope[4]. It has long been known that the bacterial cell wall and flagella of organisms such as the bacilli of typhoid and paratyphoid are altered by the deposition of antibodies, and the combination of antibodies and antigens at bacterial surfaces has also been shown by quantitative analytical methods. These sensitized surfaces have now been examined under the electron microscope, and, as a result of the deposition of homologous antibodies upon them, the walls are found to become opaque, and less clear-cut in outline. The flagella become thicker, but less sharp and less uniform in outline, and they tend to coalesce.

The various viruses differ greatly in size, although each kind of virus is itself very uniform in size. During the last decade, a few of the viruses which attack plants have been isolated. Although they differ from each other in stability and analytical composition, all those purified have been shown to consist solely of nucleo-proteins of high molecular weight. These viruses seem to be a connecting link between living and non-living matter. They are actually protein molecules possessed of certain definite biological activity. On the other hand, there are viruses, that of vaccinia, for example, and all the Rickettsia disease agents, which are very much larger, and cannot be regarded as single molecules. The larger viruses appear to be true micro-organisms which can only live a parasitic existence. One of the first viruses to be photographed under the electron microscope was that of tobacco mosaic, and it at once confirmed the suggestions, based on other methods, about the size and shape of this virus. It was a rod about 300 mμ long. Particles of tobacco mosaic virus appear in purified form as discrete rod-like units with a tendency to side-to-side and end-to-end aggregation. The electron microscope has also been used in the study of the virus of tomato bushy stunt. The reaction between tobacco mosaic virus and its antiserum has been studied by means of the electron microscope[9]. This instrument has been used in the investigation of the morphological structure of the virus of vaccinia[10]. The elementary bodies of vaccinia are rectangular in shape, resembling a brick, and contain five areas of condensation, and are somewhat like the five spots of a dice. Sharp[11] and his colleagues have employed the electron microscope in their investigations of Western strain equine encephalomyelitis virus. Taylor and his associates have used this instrument on the Eastern strain equine encephalomyelitis virus. Studies have been published[12] on the nature of the virus of influenza with particular reference to the dispersion of the virus of influenza A in tissue emulsions, and in extra-embryonic fluids of the chick. The size of the infectious unit in influenza A has been investigated[13]. This instrument has been employed on the morphological structure of rickettsiæ[14]. It has also been used in studies on the papilloma virus protein[11].

Studies of bacteriophages[15] disclose an extremely constant and characteristic sperm-like appearance with a round head, and a much thinner tail; in many micrographs the head is filled with a dense internal structure. These are adsorbed to their specific micro-organisms by head or tail, and, after contact, it is possible to observe extensive damage of the bacterial cell. These results are interesting, as some years ago the bacteriophage was looked upon by some workers as of macromolecular nature. The discovery of such constant and detailed information is of interest also to geneticists, for genes are thought to be macromolecular entities. The sperms of the lamb and bull, due to their extreme flatness, are amenable to examination, and have already come under observation.

The electron microscope is of value in histological research. It has revealed characteristic cross-striations in collagen fibres, and the effects of various physical and chemical conditions on the fibres has been investigated[16] in a search for further knowledge of the molecular structure of collagen. To entomologists, this instrument shows hitherto unseen structures, and it allows the accurate measurement of those already recognized. The tracheæ, trachioles, air sacs, wing scales, and cuticle have been examined, and experiments[17] on the mode of penetration of the cuticle by non-volatile oils serve as an example of future useful applications.

The foregoing are only some of the many fields in which an electron microscope is useful.

Some Disadvantages

The electron microscope is not yet an instrument for every pathologist's bench, due to its cost, size and complexity. Its immediate future lies rather in

the research laboratory. The bombardment of specimens with high-speed electrons produces changes in protoplasm, and in molecules. Entomologists have remarked on shrinkage, evolution of gas, discoloration, and increased friability of their specimens. As the specimen for study must be placed in a high vacuum it must, therefore, be dry. Great difficulty is experienced in viewing anything but 'dead' specimens, and in consequence, movement must inevitably be 'frozen', and require a number of successive and similar operations to show progressive action. The objects to be examined must be extremely thin.

Some Further Developments

Due to the very small aperture of the electron rays, the electron microscope shows a surprisingly large depth of focus. Electron stereomicroscopy has been suggested by E. Ruska. M. v. Ardenne[18] has further developed this idea, and introduces in his electron microscope a particular object carrier which can be tilted by a few degrees between two successive exposures. A vivid impression of solidity is produced if the two corresponding photographs are examined under a stereoscope.

v. Ardenne has successfully applied dark-ground illumination and obtained resolving powers down to 5×10^{-7} cm., and he discusses[19] in this connexion the possibility of viewing single atoms, and studying their distribution in the object plane. There are, however, great practical difficulties; for example, the exposure time would have to be increased more than 1,000 times if ultra-microscopical methods were to be introduced.

O. Scherzer[20] discusses the possibility of improving the resolving power of the ordinary electron microscope with direct illumination by an improvement of the electron lenses leading to larger numerical apertures. He mentions in this connexion the practicability of correcting spherical aberration by introducing space charges into the lens. F. H. Nicoll in his patent proposal of 1936 discusses the introduction of an electron mirror into the instrument. As it is feasible to construct mirrors with negative aberration, a useful opportunity of correcting the mirror-microscope is given.

The most direct method of improving the resolving power is to use appreciably greater electron energies, and thus shorter wave-lengths. There is an upper limit to what we can hope for in this direction.

After the War is ended, there should be great developments in television, and some of this research work will be employed in improving the electron microscope.

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NEWS and VIEWS

Dr. W. K. Gregory

DR. W. K. GREGORY has recently retired under an age limit from the staff of the American Museum of Natural History. For some forty years he occupied a very special place in that great institution, for his knowledge of comparative anatomy extended over the whole range of vertebrates, both recent and fossil, and his philosophical mind led him to make wide ranging comparisons and detailed analyses of structure which have contributed very greatly to our understanding of structure and especially of the course of evolutionary processes. His early works on Tritubucular teeth and on the orders of mammals were of great importance, and were but the harbingers of many others which have since appeared. During the past twenty years his immense experience of mammalian structure has enabled him to contribute much to our understanding of the significance of the many fossil human skulls which have become known, and he has at the same time devoted much attention to the detailed structure of modern fish. But Dr. Gregory's retirement is only from his formal position; relieved of administration he may, we hope, continue even more actively his own researches.

Prof. James Drever

PROF. JAMES DREVER has recently retired from the chair of psychology in the University of Edinburgh, which he has held since its foundation in 1931. In 1918 he was elected to the Coombe lectureship in psychology at Edinburgh, and in 1924 he became University reader. When lecturer he had eighty students, and an assistant to help him. Shortly before the present War, the number of his students had increased to nearly six hundred, and his staff comprised a reader, two lecturers and four instructors. Prof. Drever graduated in arts in Edinburgh in 1893 and spent two years in studying medicine. Owing, however, to various difficulties he was then compelled to become a schoolmaster. But in 1907 he became assistant to the professor of education at Edinburgh, where he founded the Educational Laboratory, taking a keen interest in problems relating to human instinct, in the treatment of delinquent and difficult children, and in the institution of the degree of bachelor of education and of postgraduate psychological research for students of education. These early efforts led to his later work on the psychological treatment of the psycho-neuroses, on developing performance tests of

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

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

Full-time courses in Mining, Engineering, Chemistry, Physics, Mathematics, and General Science leading to B.Sc. Honours. Degrees of the University of London and the Diplomas of the College.

The College is well equipped with modern machinery and apparatus, and gives a thorough training.

Athletic Grounds (27 acres), Library, Refectory. The College is within easy access of excellent residential districts.

Fees for full-time Degree and Diploma Courses: Mining Degree and Diploma, Intermediate, 12 guineas; Final, 20 guineas. Other Degrees and Diplomas: Intermediate, 12 guineas; Final, 15 guineas. (Free Studentships and Scholarships are available.) Illustrated pamphlets free on application.

J. F. S. ROSS, M.C., B.Sc. Ph.D.(Lond.),
Principal.

ROYAL (DICK) VETERINARY COLLEGE

EDINBURGH, 9.

ANIMAL HUSBANDRY DEPT.

A Laboratory Assistant (Grade B) with experience of modern chemical and biochemical methods is required for the nutrition section of the above department. Salary according to age and experience on the range £130—£175 per annum, plus war bonus.—Applications, stating age, experience, etc., should be sent to the Professor of Animal Husbandry not later than Sept. 22.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of PROFESSOR OF PHYSICS. Minimum salary £1,150 per annum. It is hoped that suitably qualified persons engaged in national service will apply for the post.

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before October 18, 1944.

UNIVERSITY OF BRISTOL

The University invites applications for a TEMPORARY ASSISTANT LECTURER IN MATHEMATICS for the next Session which starts on Sept. 28, 1944, and ends on June 30, 1945. For this period the salary will be £300. The main duties required from the Assistant Lecturer will be to help in the teaching of Applied Mathematics.—Two copies of an application, together with the names and addresses of two persons who will act as referees, should reach the undersigned on or before Sept. 20, 1944.

WINIFRED SHAPLAND,
Secretary and Registrar.

UNIVERSITY OF MANCHESTER

There are vacancies in the Department of Chemistry for two Research Assistants in Physical Chemistry (low temperature polymerization), under a grant from the Department of Scientific and Industrial Research. The appointments are for one year from Oct. 1, 1944. Salary £300 per annum.—Applications, with the names of two references, should be sent to reach the Registrar, The University, Manchester, 13, by Sept. 20, 1944.

UNIVERSITY OF CEYLON

Applications are invited for the Chair of Physiology. Candidates must have medical qualifications as well as special qualifications in Physiology. Salary scale: Rs. 12,000 p.a., rising by annual increments to Rs. 17,250 p.a. Closing date for applications Sept. 30.—Further particulars from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

THE UNIVERSITY OF ADELAIDE

Applications are invited for the ELDER PROFESSORSHIP OF ANATOMY AND HISTOLOGY. Salary £1,200 (£100 of which is reserved for superannuation). The Professor is required to insure himself also to the amount of £50 annually. Term commences March 5, 1945.—Further particulars from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for applications October 31, 1944.

HARPER ADAMS AGRICULTURAL COLLEGE

ASSISTANT LECTURER IN AGRICULTURAL ZOOLOGY

Applications are invited for the above appointment. Salary up to £300 p.a. (plus war bonus), according to qualifications and experience.

Applications and enquiries for information should be addressed without delay to the Principal, H.A.A.C., Newport, Shropshire.

Progressive national organization, with home and overseas interests, has the following vacancies on its Research Staff: one Honours Graduate in Chemistry (London, F.2719XA); two Honours Graduates in Metallurgy (Neath, F.2720XA); Shipley, (F.2721XA); one Honours Graduate in Chemistry or Member of the Royal Institute of Chemistry, Branch E (London, F.2722XA). Ages 25 to 30 years; salaries £350 p.a., rising to £650 p.a., according to ability. Only men with first-class qualifications need apply; preference to chemists with experience of synthetic resins and varnishes; metallurgists with experience in machine building or wrought light alloys; food chemist with experience in the estimation of nutritional values.—Applicants should write, quoting the reference number for which they wish to be considered, to the Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before Oct. 21, 1944.

A Metallurgist is required for a firm on the North-East Coast operating under the Essential Works Order. Candidates should preferably possess an Honours Degree in Metallurgy and have had some industrial experience. The work involved is of a varied character and includes investigation of service failures, metallurgical advice in connection with new design and construction, and some longer distance research.—Applications, by letter only, giving age, full qualifications, experience, salary required, etc., should be sent to the Billingham Division Staff Superintendent, Imperial Chemical Industries Limited, Billingham, Co. Durham.

An old established Company with Works in the Manchester district, invites applications from qualified men between 25 and 30 years of age for: (1) ANALYTICAL CHEMIST, candidates must have a sound knowledge of analytical chemistry with preferably some experience in industry; (2) RESEARCH CHEMIST, candidates should hold a University Degree in Chemistry and have some experience in industrial research. These are progressive and permanent positions for men of ability and initiative.—Applications, in own handwriting, giving age and details of training and experience, should be addressed to Box 751, L.P.E., 110 St. Martin's Lane, London, W.C.2.

Physicist required for a Company in Birmingham. Must have first-class experience on problems relating to lighting and aircraft and automobile lamps. Approximate salary £450 to £550 per annum. Applicants should write, quoting A.630XA, to the Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before Sept. 20, 1944.

The Nyasaland Research and Development Company Limited in considering their post-war programme will shortly be appointing a BOTANIST AND ORGANIC CHEMIST, and invite applications. Salary according to qualifications and experience.—Applications to be addressed to Dr. M. Nierenstein, 2 Rylestone Grove, Bristol, 9. Further appointments will be made later on, and all such appointments to commence immediately after cessation of European hostilities.

Applications are invited for the post of SECOND VETERINARY OFFICER, Imperial Bureau of Animal Health, Weybridge. Salary, £600—£25—£850, plus cost of living bonus, also F.S.S.U. on confirmation. Commencing salary dependent upon qualifications and experience. Particulars of the conditions of service may be obtained on application to the Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1.

Large Firm in Midlands require for Research Staff, assistants of scientific training—preferably Honours B.Sc. standard. Previous experience of original work on heat transfer and fluid-flow problems advantageous.—Write, stating age, experience, and salary required, Box 243, T. G. Scott & Son, Ltd, 9 Arundel Street, London, W.C.2.

Geologist, 1st Class Cambridge degrees and wide experience, available on fee or salaried basis for petroleum or mineral work.—Box 242, T. G. Scott & Son, Ltd, 9 Arundel Street, London, W.C.2.

Male or female experimental physicists with research experience required. Remuneration according to qualifications and experience.—Write, Box C.P. 9, c/o 5 New Bridge Street, E.C.4.

Research Fellow (Biochemist) required.—Applications, with full particulars, to Secretary, Research Institute, 117 Grove Street, Liverpool 7.

Assistant for Medical Booksellers. Interesting work, excellent prospects.—Apply, Foyles, 121 Charing Cross Road, W.C.2.

Wanted: "An Introduction to Mathematical Philosophy" and "Principles of Mathematics," both by Russell; "Principia Mathematica," Vols. 1-3 of 1st ed., and Vol. 1 of 2nd ed., by Whitehead and Russell; "Reports on the Progress of Applied Chemistry," Vols. 8-26; a Japanese textbook of Chemistry (general, inorganic, organic, or physical), or numbers of a Japanese chemical periodical.—Box 240, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Infra-red and Violet High-speed flash-light photography by means of dual-purpose flexible filter bag, as used in the blackout by the Press since 1939. Snapshots possible up to 1/50th sec. at F/4.5 or 1/100th sec. at F/3.5 at 5 yards in the blackout. British, American, and Canadian patents. Price, with detailed instructions, 25s. to order.—Arthur Barrett, F.R.P.S., F.R.G.S., Balks House, Walker's Lane, Leeds 12.

Wanted: Autoclave depth of boiler at least 13 inches, diameter at least 10 inches. Heated by electricity (230 volts A.C.) with heater and connecting cable or by paraffin. To withstand pressures of at least 15 atmospheres (for biochemical work).—Box 241, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

For Sale: Microscope, Cooke, new condition, in case, 2/3, 1/6 (Watson); 1/12 apochrom. oil-imm. (Powell & Lealand) also Cooke mech. stage for above.—81 St. Hilda's Road, Harrogate.

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Microscope. Zeiss monocular, 5 sets of lenses. 1/12 oil imm. Quadruple nosepiece. £65, or nearest offer.—Box 244, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp. — Telephone or correspondence only: Chards, 47 Beckenham Road, West Wickham, Kent (Spring Park 1628).

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intelligence, on colour-blindness, and on instituting university teaching in medical and industrial psychology. His son has been appointed by the University to succeed him in his professorship.

Industrial Relations and the Cost of Living Index

A BROADSHEET "Wages and the Cost of Living Index" (No. 220) issued by Political and Economic Planning gives a useful brief review of the cost of living index itself and of the wage systems in the building and civil engineering, railways, iron and steel, coal and cotton industries and the Civil Service in Great Britain. The broadsheet forms part of a report on industrial relations which P E P is preparing, and does something to meet the need for a study of wages and other aspects of industrial relations which such innovations as 'pay-as-you-earn' have intensified. In addition to its descriptive part, the broadsheet includes the general conclusion, first, that if wage policy were sufficiently well co-ordinated between workers and employers and between different industries, it could be arranged that wages should not fall as much as prices during the down-swing, and that in return they should not be pushed up so much when prices are once more rising. Such a policy has been put into practice in Sweden with results that open up a vista of possible 'trade-cycle bargaining', under which the application of sliding scales as we know them would be inappropriate. From the workers' point of view it would be wrong to peg wages to the cost of living and thus stabilize real wages when their productivity is increasing and prices falling, for this would mean that their share in the product of their labour would be declining. One may expect that if post-war employment succeeds in producing a steadily rising national income, workers in most industries will prefer to rely on their bargaining power rather than on automatic scales. Part of the dynamic of a full employment policy must be the general striving for an uninterrupted rise in the standard of living, and therefore in real wages.

Where the workers in an industry have little expectation of increasing their standard of living, they may decide that the sliding scale will at least help to maintain their real wages. What is good for one industry, however, may not suit another; and the different sliding-scale schemes have different effects on the internal wage structure of the industries concerned. Cost of living calculations will remain of the greatest importance whether or not an automatic sliding scale is used. The minimum or subsistence allowance, in terms of money, for example, fails of its purpose unless it is adjusted to cover changes in the prices of the goods needed for subsistence, and for this purpose the sliding-scale method will continue to have an obvious justification. It would seem, however, that the avowed purpose of the index, to estimate changes in "the cost of maintaining unchanged the pre-war (i.e., pre-1914) standard of living of the working-classes" has not much relevance to present-day requirements, and that separate indexes are required for various income groups and for different localities. If authoritative indexes of this kind could be provided, much that is at present contentious guesswork in wage negotiations would be based on measurement and calculation, and the application of an accurate series of cost of living indexes would not be confined to wages but should form an essential part of national statistics.

Sunspots and Human Affairs

Two papers by W. G. Bowerman (*Pop. Astron.*, **52**, March, April, May, 1944) discuss the rather indefinite subject of the relations between sunspots and terrestrial conditions. The first illustrates a close parallelism between sunspot numbers and the total mortgage loans on residential property in the United States. This held during 1923–38 but broke down in 1939, presumably owing to the disturbance caused by the War. The second and longer paper describes in a 'popular' manner the quasi-periodic nature of outbreaks of sunspots and a good deal of recent American literature on relations between sunspot numbers and extremes of temperature and precipitation, as well as such indirect effects as industrial activity, forest fires and outbreaks of tropical diseases. The author accepts the views of Ellsworth Huntington and C. A. Mills that the major economic and cultural cycles of historical times result from long-period oscillations of solar activity, acting through *average* temperature, which in turn controls both the spread of disease organisms and the power of man to resist or cope with them. Within the 11-year cycle there is a 'sharp upthrust' of temperature near sunspot minimum, but the relations are complicated by volcanic eruptions.

The whole subject of the reaction of man with his environment is of considerable interest and importance to students of human affairs; but it is far too complex for superficial or partial studies to have any value. For example, the author refers casually to the effect of air-conditioning of hospitals in counteracting climatic control of disease; but he overlooks Major Markham's hypothesis that the poleward march of civilization is a function of the efficiency of house-warming. There is room here for a new system of philosophy, but the first necessity is to verify and comprehend the facts.

Structure and Classification of Bees

THE *Bulletin of the American Museum of Natural History*, **82**, 1944, contains a very comprehensive memoir on the above subject, written by C. D. Michener, an assistant curator of the Museum. The method which the author has adopted is to make a detailed study of the morphology of a single species of bee, for example, *Anthophora edwardsii*, and then to compare numerous other bees with this species. Finally, with these comparisons as a basis, the author gives an account of the interrelationships of the various groups of bees followed by a general scheme of classification. The latter deals with all groupings, from families to genera, represented in America north of Mexico. The memoir is one intended for the specialist on the order Hymenoptera. The anatomical section is concerned with external organs and parts only; the internal organs and musculature being outside the scope of the work. A certain number of new terms are used including the expressions mesosoma and metasoma for the regions commonly referred to as thorax and abdomen respectively. Six families of bees are recognized. The Colletidæ and Halictidæ are the two oldest groups. The next in order of antiquity are considered to be the Andrenidæ and Apidæ followed doubtfully by the Megachilidæ. The last family—the Melittidæ—is too imperfectly known to suggest its position in the series. The largest family is the Apidæ which is held to include a large number of bees usually considered to be outside its limits. The author mentions that cer-

tain of these have often been placed in separate families largely on the basis of the presence or absence of the pygidial plate. This character is regarded as being unreliable since it is often lost in very different bees.

Glossary of Communicable Diseases

A LIST of terms in the main European languages and in Latin denoting the various communicable diseases has recently been published ("Lexique Polyglotte des Maladies Contagieuses" (Polyglot Glossary of Communicable Diseases). By Dr. Yves Biraud. (London: Allen and Unwin: League of Nations Publications Dept., 1944. Pp. 354. 4*s*.). The author states in his introduction that circumstances did not allow of the sending of *questionnaires* to medical authorities of the various countries or of submitting proofs of the Glossary to them. This is quite obvious, and anyone looking for an accurate guide of this type will be well advised to await the appearance of a heavily amended second edition.

The term communicable is very widely interpreted, and the lists include appendicitis and Ludwig's angina, osteomyelitis and pemphigus of unspecified type. Catarrhal jaundice is listed twice, although this probably erroneous term for infective hepatitis is now nearly obsolete. Herpes zoster and herpes febrilis are given as synonyms. Chancroid, the most specific and commonly accepted name for soft chancre, does not appear. In the section on syphilis the terms for various manifestations do not correspond in the columns for the different languages.

Sulphadiazine Treatment of Meningitis

ACCORDING to the U.S. Office of the Surgeon General, a saving of 90 out of 100 soldiers from death by meningitis has been achieved by sulphadiazine. The death-rate from meningitis in the U.S. Army in the present War is less than 3 per cent, whereas it was 93·2 per cent in the Revolutionary and Civil Wars and 39·2 per cent in the War of 1914–18. According to the U.S. Army Commission on Meningitis, as little as two grams of sulphadiazine will banish the germs from the nose and throat of most persons for a period of several weeks.

Pole Treatment

IN an article on ground-line treatment of standing poles (*Bell Lab. Rec.*, 22, No. 11; July 1944), C. H. Amadon discusses the preservative method developed by Bell System engineers. External deterioration of an untreated pole in service begins in the ground section with infection by wood-destroying fungi which, once established, continue there unless adverse conditions are imposed, as for example, by the application of a suitable wood preservative. Two general classes of preservatives might be used for ground-line treatment, (1) oily materials such as creosote, and (2) water solutions of toxic salts such as zinc chloride and sodium fluoride. Sodium fluoride is particularly good for penetrating the heartwood of cedar and chestnut timbers, but it is not permanent. Creosote or creosote and coal tar, although not as penetrating as the water-soluble salt, is as lasting as any preservative known.

Beginning in 1935, Bell Laboratories engineers treated experimentally a total of 428 poles and posts with coal-tar creosote and other coal tar products, sodium fluoride, sodium silico-fluoride, and proprietary pastes and solutions containing preservative compounds. Periodic examinations and accumulated evidence during five years showed that treatment at the ground line with sodium fluoride and a mixture of creosote and coal tar is highly effective. This treatment effectively reduces the rate of deterioration of poles in line, and their service life (ground line condition) will be increased by about six years. This is sufficient to justify the costs involved, but an additional saving accrues from the possibility of placing pole line inspection on a six-year instead of the usual three-year cycle. The cumulative result of the ground-line treatment is a reduction in labour and expense of pole line maintenance-inspection and in the need for new poles.

Paint Drying by Radiant Heat

IMPERIAL CHEMICAL INDUSTRIES, LTD., has recently issued a handy twenty-page booklet on this subject for the purpose of providing information on the properties of radiant heat, to indicate how these apply to the different types of plant now available for stoving paints, and how the qualities of the paints used are affected by the process. The chapter contents of the booklet relate to heat transfer, radiant heat, methods of drying paint, radiant heating equipment, radiant heating technique, and paints and radiant heat. Copies of the booklet may be obtained, free of charge, from I.C.I., Ltd., Belmont, The Ridgeway, Mill Hill, London, N.W.7.

Seismology in China

IT is learned (*Earthquake Notes*, 15, Nos. 3 and 4; 1944) that the active recording of earthquakes is being continued in China. The Japanese invasion caused the National Geological Survey of China to change its headquarters to Chungking. The seismograph station at Chiufeng had to be abandoned. Dr. S. P. Lee has re-established the seismological work at Pehpei near Chungking. He has built a one-component instrument (north-south), which is being operated with a period of 4·5 sec. Recording began in October 1943.

University of Bristol

THE following appointments in the University of Bristol have recently been announced:

Dr. J. E. Harris, to be professor of zoology in succession to Prof. C. M. Yonge, who has been appointed Regius professor of zoology in the University of Glasgow.

Dr. Wilson Baker, to be Alfred Copper Pass professor of chemistry in succession to Prof. E. L. Hirst, who has been appointed professor of chemistry in the University of Manchester.

Dr. A. G. Pugsley, to be professor of civil engineering in succession to Prof. J. F. Baker, who is now professor of mechanical sciences in the University of Cambridge.

ERRATUM.—Sachchidananda Banerjee writes, in connexion with his communication "Effect of Vitamin C on the Adrenaline Content of the Adrenal Glands of Guinea Pigs" in *Nature* of April 29, p. 526, the phrase "The adrenal glands were extracted with trichloracetic acid for adrenaline and ascorbic acid according to the method of Rees[3]" should read: "The adrenal glands were extracted with trichloracetic acid for adrenaline and ascorbic acid according to the method of Barker and Marrian[2]. The adrenaline was estimated chemically by the method of Rees[3]".

LETTERS TO THE EDITORS

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

Relationship between Sulphonation and Desulphonation

THE familiar process of recovery of aromatic compounds from their sulphonic acids is probably almost universally regarded as one of hydrolysis. We have, however, confirmed our expectation that it might be more correctly comparable with the ordinary Dumas process of decarboxylation, and so involve their anions rather than the acids themselves; for a kinetic study of the desulphonation of *m*-cresolsulphonic acid in 90 per cent acetic acid containing also hydrobromic or sulphuric acid showed its velocity to be independent of the concentration of the sulphonic acid, to conform to the first-order equation and to be proportional to the hydrogen ion activity of the solution, but independent of the nature of the inorganic anion. Sulphonic acids of mesitylene, phenol, *p*-cresol, and 4-nitrodiphenylamine, exhibited a similar behaviour.

We must therefore formulate the recognized reversible relationship between sulphonation and desulphonation as follows:

$$Ar.SO'_3 + H_3O^{\cdot} \rightleftarrows Ar\begin{matrix}\diagup SO_3 \\ \diagdown H \ldots OH_2\end{matrix} \rightleftarrows Ar.H + H_2O.SO_3$$

(I)

Sulphonation and desulphonation are thus essentially determined by the distribution of the acids, proton and SO_3 (in the Brönsted-Lowry sense), between the bases phenyl anion and water. Similarly the absence of oxygen exchange between sulphate ions, unless sulphuric acid be present[1], shows that here also the essential reaction is the distribution of SO_3 between H_2O^{16} and H_2O^{18} or, as it may be regarded, sulphonation of the two types of water:

$$H_2O^{18} + O_3S \cdot O^{16}H_2 \rightleftarrows H_2O^{18}.SO_3 + O^{16}H_2.$$

The conclusion at which we arrive in this manner, that sulphonation directly involves $H_2O.SO_3$ rather than $SO_2(OH)_2$, accords with the suggestion of Benford and Ingold[2] that nitration involves ($H_2O.NO_2$), and the deduction by one of us[3] that nitrosation involves ($H_2O.NO$).

Furthermore, it will be seen that in the transition complex (I), water contributes to completion of the sulphonation forces by removal of the proton in the same way as it was suggested nitrite ion does in nitrosation[3]. This is in line with the observations of Martinsen[4] on velocities of nitration and sulphonation.

This brief discussion will perhaps serve to illustrate the wider implications of our experiments for the general problem of substitution. It need scarcely be pointed out that reversibility of the sulphonation process is much facilitated by the negative charge of the sulphonate ion. The lack of such a charge in other cases commonly inhibits reversibility; but it is familiar in the cases of nitramines and chloramines, as well as sulphamic acids; and even neutral nuclear substituents may be readily displaced by proton if, for example, steric influences provide the necessary facility for attachment of proton to the nucleus[5].

It is hoped to publish a more detailed account of this work elsewhere.

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Aug. 30.

[1] Winter, Carlton and Briscoe, *J. Chem. Soc.*, 31 (1940). Mills, *J. Amer. Chem. Soc.*, **62**, 2833 (1940).
[2] *J. Chem. Soc.*, 955 (1938).
[3] Kenner, *Chemistry and Industry*, **60**, 443 (1941).
[4] *Z. Phys. Chem.*, **50**, 385, 435 (1904); **59**, 605, 634 (1907); **62**, 713 (1908).
[5] Compare, Baddeley, *Nature*, **144**, 444 (1939).

Rod and Cone Responses in the Human Eye

THERE is abundant evidence to show that the human eye has two distinct receptor mechanisms, one for vision in bright daylight and the other for vision at night. The sensitivity of the former, the photopic mechanism, is greatest for the longer wavelengths and is not much changed by dark adaptation. That of the scotopic mechanism is greatest for green and blue, and may be increased or reduced a thousandfold by keeping the eye in darkness or light. From their distribution in the retina and in different animals, the cones are thought to be the photopic receptor organs and the rods the scotopic.

A new kind of evidence for the 'duplicity theory' has recently appeared from records of the potential changes developed in the human eye. Such records have been made before without adding much to what can be learnt from animals; but with modern technique the human electroretinogram can be seen to depend on two receptor systems with the characteristic photopic and scotopic properties. Leads have been taken from an electrode on the cheek and from a moist thread in contact with the front of the eyeball. The eye is exposed to a large field lit by brief flashes of light and the potential changes are recorded by an ink-writing oscillograph. With red light, which should stimulate mainly the cones (Wratten monochromatic filter No. 70), the response is a brief diphasic change, the cornea becoming initially negative (Fig. 1*A*). This response is very little affected by dark adaptation, though there is some increase in the first few minutes. With blue light, which should stimulate mainly the rods (Wratten filter No. 76), the response is a slower monophasic change with a longer latency (Fig. 1*B*). This response is

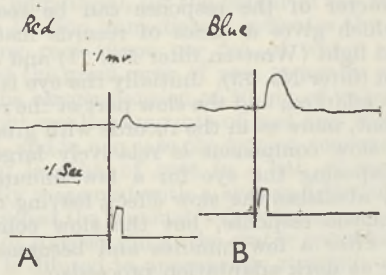

FIG. 1. *A*: ELECTRIC RESPONSE OF THE EYE TO A FLASH OF RED LIGHT. WRATTEN FILTER NO. 70. CENTRAL WAVE-LENGTH 690 mμ. *B*: RESPONSE TO A FLASH OF BLUE LIGHT. WRATTEN FILTER NO. 76. CENTRAL WAVE-LENGTH 440 mμ.

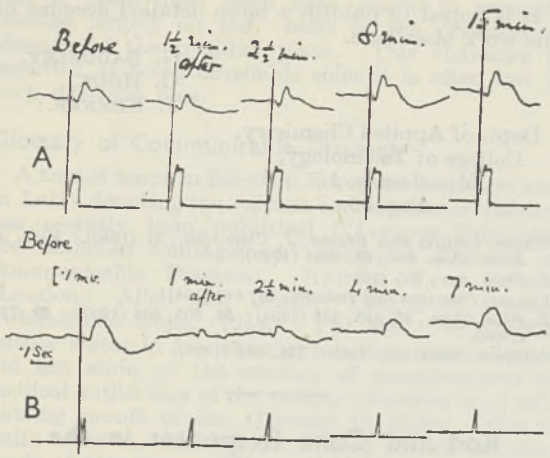

Fig. 2. EFFECT OF LIGHT ADAPTATION ON THE RESPONSE TO ORANGE-RED AND GREEN LIGHT.
A: WRATTEN FILTER No. 71. CENTRAL WAVE-LENGTH 640 mμ.
B: WRATTEN FILTER No. 73. CENTRAL WAVE-LENGTH 575 mμ.

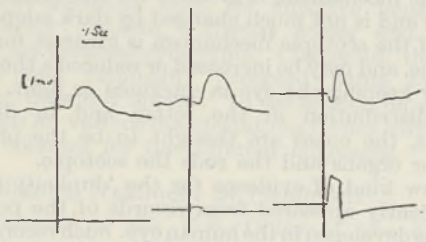

Fig. 3. RESPONSE TO FLASHES OF WHITE LIGHT OF INCREASING INTENSITY.

greatly affected by dark adaptation: it may be too small to detect (that is, less than about 20 microvolts) in the first few minutes after the eye has been exposed to a bright sky, but it will then increase steadily as dark adaptation proceeds, reaching 300 microvolts or more after 20 minutes.

With light of intermediate wave-length, the response seems to be compounded of both the rapid and the slow effects. The relative size of the two components depends on the degree of dark adaptation and can be varied by restricting the field to the central or peripheral parts of the retina, by altering the duration of the flash, or, with repetitive stimuli, by altering the frequency. Under standard conditions, the slower component is greatest with green-blue light and the rapid diphasic component with orange. The dual character of the response can be seen from Fig. 2, which gives a series of records made with orange-red light (Wratten filter No. 71) and another with green (filter No. 73). Initially the eye is moderately dark adapted, and the slow part of the response is prominent, more so in the records with green light since the slow component is relatively larger with green. Exposing the eye for a few minutes to a bright sky abolishes the slow effect, leaving only the initial diphasic response, but the slow component reappears after a few minutes and becomes larger and larger as dark adaptation proceeds.

With white light of moderate intensity the response has both components, since there is the initial negativity as well as the slower positive wave which can be increased by dark adaptation. With a bright flash, however, the slower component can no longer be seen (Fig. 3). The change in form suggests that at high intensities the photopic mechanism inhibits the scotopic, though other explanations are possible. When red or blue light is used, the form of the response, rapid or slow, is unaffected by a change in intensity within the limits of the apparatus in use.

The idea that the electric response of the retina has both a rod and a cone component is not new: it has been advocated particularly by Chaffee, Bovie and Hampson[1], but in animals other than man it has been difficult to establish a clear separation. It is easier to do this in man because the sensory performance of the human eye is so much better known.

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[1] Chaffee, E. L., Bovie, W. T., and Hampson, A., *J. Opt. Soc. Amer.*, 7, 1 (1923).

Proteases of Takadiastase

SOLUTIONS of takadiastase (Parke, Davis and Co., Ltd.) split casein, gelatin, leucylglycylglycine, leucylglycine and chloroacetyltyrosine. The same substrates undergo hydrolysis when the enzyme solutions are subjected to prolonged dialysis in 'Cellophane' bags against running tap water. If, however, the dialysed solutions are filtered by suction through kieselguhr layers, only leucylglycylglycine of all the above substrates is split. The addition of dialysate, inactivated by heating, does not restore the activity of the filtrates towards the other four substrates.

The carboxypolypeptidase component appears to be relatively stable, for the dialysed solutions retain about 50 per cent of their activity towards chloroacetyltyrosine after being kept at 37° for ten days. Under the same conditions, the dialysates lose 70–80 per cent of their activity towards casein and gelatin, whereas the activity towards leucylglycylglycine remains almost unchanged.

Leucylglutamic acid anhydride is not hydrolysed by the dialysates or by the undialysed solutions.

A detailed report on the foregoing and further experiments with the proteolytic enzymes of commercial takadiastase will be published elsewhere.

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Terminology of Lipoid-Protein Complexes

IN an otherwise excellent review by Lovern[1] a statement occurs on p. 32 that demands correction. In discussing the terminology of lipoid-protein complexes, Lovern rejects Macheboeuf's term 'cénapse', in favour of 'complex', claiming that the English spelling of 'cénapse' is 'synapse', to which anatomy has a prior claim.

'Cénapse' was compounded by Macheboeuf[2] from the Greek κοινός (= common) and ἅπτειν (= to fasten, tie, bind or join), with the meaning of union, bonding, binding, joining, etc. ("liaison, jonction").

It would be correctly anglicized not as 'synapse' but as 'cœnapse' or 'cenapse', and pronounced 'seenaps'. κοινός, with the meaning of 'common', anglicized to cœn- or cen- and pronounced 'seen-', occurs in many zoological terms, cœncœcium, cœnosarc, cœnosteum, cœnobium, cœnure, as well as in the more common words cœnobite or cenobite and cœnoby or cenoby. 'Synapse', pronounced in English 'sinaps', occurs with the same meaning and spelling in English as in French. It is derived ultimately from συν (= together), and ἅπτειν means literally a connexion or joining and may profitably be left with its specialized meanings to anatomy and cytology. By etymology, spelling and pronunciation, cœnapse and synapse are therefore distinctive, although their primary or literal meanings are very close.

Macheboeuf (p. 29) defines the meaning of cœnapse as follows: ". . . le terme cénapse que je propose ici s'applique non seulement aux produits créés par la saturation de telles valences residuelles*, mais encore aux produits créés par d'autres forces d'union quelles qu'elles soient, à condition que ces forces en unissant les constituants du cénapse en masquent ou modifient certaines des propriétés". Although he himself makes no claim to this ("cénapse . . . ne prejuge rien du mode de liaison") it could be argued in defence of 'cœnapse' that the prefix 'cœn-' readily suggests common or shared bonding mechanisms, that is, shared electrons of normal and particularly co-ordinated covalency, to which the more stable cœnapses such as Macheboeuf's C.A.M. are probably due; and it is not incompatible with the idea of mutual electrostatic attraction between homologous 'hydrocarbon functions' of proteins and the polymethylenic chains of lipoids, which Macheboeuf postulates to explain the less stable cœnapses. On the other hand, the meaning of 'complex', which etymologically evokes only the idea of intricate folding or entwining together, although precise enough as defined by Werner, is used in biochemistry very loosely to cover a variety of badly defined physico-chemical systems. However, my object is not so much to define 'cœnapse' against 'complex', on the grounds of precision, as to point out that Lovern's objection to 'cénapse', being founded upon an error of anglicization, is not valid.

While on the subject of etymology and correct anglicization, it seems worth while to direct attention to a misspelling of the term 'hydrophilic' as 'hydrophylic' which occurs repeatedly on p. 19 of Lovern's review and which occurs also in a communication in *Nature* by McFarlane[3]. Hydrophilic, from ὕδωρ (= water) and φιλεῖν (= to love"), hence 'water-loving', is of course the correct form in English, as is 'lipophilic', which is misspelled as 'lipophylic' in Lovern's review.

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* In reference to Willstätter's use of the term 'symplex' for compounds between protein and glycogen, etc., by means of secondary valencies.

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[2] Macheboeuf, M., "Etat des lipides dans la matière vivante. Les cénapses et leur importance biologique". "Actualités scientifiques et industrielles", No. 448. (Paris: Hermann et Cie, 1937.)

[3] McFarlane, A. S., *Nature*, 149, 439 (1942).

Standardization of Root Excretions for Immunity Trials on the Potato Root Eelworm

EXPERIMENTS with South American species of potato, carried out since 1941, have shown that, compared with British species, the South American plants are generally far less strongly attacked by the potato root eelworm; nor do their root excretions stimulate to the same extent the emergence of larvæ from the cysts. A full account of this work will be published in due course. It seemed desirable, however, to describe the method recently developed in an effort to test whether the differences in excretions were truly specific, and not due to variations in the vigour of the material available for test: it was thought that this might be of use in other fields of eelworm research.

Until more is known of the nature of root excretions, their standardization, in the chemical sense, is clearly impossible. In the present method the oxygen consumption of the roots is used for standardizing the solutions of root excretions, the assumption being made that the rate of production of the latter is related to the metabolic rate. Other activities, such as growth hormone production, might similarly be used; but the former appears to be particularly suitable as it can be done reasonably accurately and rapidly, the actual determination taking little more than 5 min.

Tubers are grown in sterilized sand. When a test is to be carried out, the roots are carefully washed, and placed in tap water. Air is excluded by covering the water surface with a half-inch layer of liquid paraffin. The oxygen dissolved in a sample of the water is determined prior to the addition of the roots and again after 2 hr., when the roots are removed. Sometimes a second sample is taken after 4 hr. In these short periods the oxygen consumption of bacteria or other organisms, and the degenerative changes in the severed roots, will be slight. The dissolved oxygen determination is carried out by the Winkler method in the usual way[1]. The iodine, however, is determined with sufficient accuracy by means of a Lovibond comparator, the dissolved oxygen, in parts per 100,000, being obtained directly; but it is possible that further test may justify the use of the more accurate titration method for some purposes, such as the comparison of varieties of the British species.

If the volume of water containing the roots is increased, the reduction in oxygen concentration will be proportionately less; the converse will be the case for an increase in the amount of root. The volume of water or the actual mass of root is, therefore, immaterial, for the extent of the reduction in oxygen tension immediately indicates the amount of respiring root tissue per ml. of water. It was found that the gram or so of root generally available reduced the oxygen tension of 50 ml. of water appreciably; but smaller amounts of root and water have been used, and in one case the oxygen consumption of two 2-cm. lengths of root in 5 ml. of water was successfully measured with a syringe pipette[2]. Having determined the 'amount' of respiring root present, in terms of oxygen units, the water remaining after sampling is diluted to appropriate strength and used in hatching trials with a single-cyst technique[3]. Consideration of an actual test may serve to demonstrate the utility of the method.

A comparison of the South American species, *Solanum calcense*, and the British species, *S. tuberosum* var. Great Scot, was carried out with root excretions from tubers of similar size grown in sand. The initial oxygen tension of 1·0 parts per 100,000 was reduced to 0·6 by the British, and to 0·7 by the South American species, when the roots were removed 2 hr. later. The 'amount' of respiring root tissue per unit volume, using 'amount' for the combination of 'mass' and 'quality' concerned, was therefore greater in the former case. As the object of the experiment was to test the immunity of the South American species, the test was heavily weighted against immunity by diluting the solution from the British species twofold; the relative 'strengths', in the present sense, were now in the ratio of 2 : 3, that is, the solution from the South American was now 50 per cent stronger than that from the British species. Nevertheless the stronger solution stimulated fewer larvæ to emerge, the figures being 137 and 343 respectively, from 50 cysts; and the mean values for larvæ/cyst differed significantly. Without some method of standardization it would be impossible to say that this difference was not due to the activity of the material available; but while no finality is claimed for the figures, it is clear that in this experiment, from equivalent respiring root masses, either the South American species produced less root excretion of the same type as the British, or it produced root excretion of a different and far less effective type. It must be emphasized that the assumption on which the technique rests, namely, that the metabolic rate of root, as measured by its oxygen consumption under the somewhat abnormal conditions of the experiment, is necessarily related to the rate at which it produces root excretion, is by no means proved; however, the fact that potato root eelworm larvæ almost invariably enter the root immediately behind the growing point[4] suggests that this may indeed be so.

I am grateful to Drs. P. S. Hudson and J. G. Hawkes, of the Imperial Bureau of Plant Breeding and Genetics, Cambridge, for supplying me with the South American material for test.

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[1] "Standard Methods of Water Analysis" (6th Edit., New York, 1925).
[2] Fox, H. M., and Wingfield, C. A., *J. Exper. Biol.*, 15, 437 (1938).
[3] Ellenby, C., *Nature*, 152, 133 (1943).
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Æstivation among Terrestrial Isopoda

So far as I am aware, æstivation among the terrestrial Isopoda (woodlice) is unknown, and among the freshwater forms I know of only one example, that recorded by Mackin and Hubricht[1], who in writing on *Caecidotea spatulata* Mac. and Hubr. state, "When the ponds dry up at the beginning of summer, they burrow into the mud, construct a small cell in which they remain dormant until the pools again fill with water the following spring".

Recently, when cleaning some Petri dishes, I turned out of one a circular cake of soil ⅜ in. in thickness which, owing to its dry condition, broke into a number of pieces when laid on the bench. This particular dish had not been in use since May 10. From the broken soil two specimens of *Trichoniscus pusillus* Brandt were seen to creep slowly out. On more closely examining the pieces of the cake of soil, an empty space or cell could be distinctly made out, where these two specimens had lived for just over two months.

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Aug. 1.

[1] *Trans. Amer. Micro. Soc.*, 59, 393 (1940).

Rotational Analysis of Ultra-Violet Bands of Silicon Monosulphide

SILICON monosulphide is a member of a group of diatomic oxides, sulphides, selenides and tellurides of carbon, silicon, germanium, tin and lead which has formed the subject of some recent spectroscopic investigations[1]. Its rotational constants are therefore of interest for comparison with other molecules of this group, and also for comparison with P_2, which possesses the same number of extra-nuclear electrons.

It was found some time ago[2,3] that a heavy-current positive-column discharge through the vapour of silicon monosulphide gave rise to a band-system in the region 2575–3875 A. The mode of production of this system in emission and the observation of a few of the stronger bands in absorption identified the carrier as SiS, and the values of the constants derived from the vibrational analysis suggested that the electronic transition involved was analogous to those responsible for the well-known ultra-violet systems of CS and SiO and the "Fourth Positive" ($A^1\Pi \rightleftharpoons X^1\Sigma$) system of CO. These observations on SiS have now been extended by a partial rotational analysis of the ultra-violet system.

The emission spectrum in the region 2800–3100 A. was photographed in a fourth order of the 10 ft.-concave grating at the Imperial College, London, the dispersion being about 1·28 A./mm. In spite of considerable overlapping and blending of the band lines, particularly near the origins, it has been possible to identify P, R and Q branches in the 0,1, 0,2, and 0,3 bands. Since the ground-state is almost certainly $^1\Sigma$, this indicates a $^1\Pi \rightarrow {}^1\Sigma$ transition, as expected. The values of the rotational constants obtained from these three bands are given below: they were derived from $\Delta_2F(J)$ differences involving only unblended lines and taking $D = 4B^3/\omega$.

Band	B''	B'	
0,1	0·3014 cm.$^{-1}$	0·2656 cm.$^{-1}$	B'_e (mean) = 0·2655.
0,2	0·2998	0·2656	
0,3	0·2983	0·2654	

The ground-state constants can be expressed by the equation

$$B_v'' = 0{\cdot}3037 - 0{\cdot}0015_5(v'' + \tfrac{1}{2}),$$

so that $B_e'' = 0{\cdot}3037$. Although branches were followed beyond $J = 100$, effects due to Λ-type doubling of the $^1\Pi$ state were found to be smaller than the experimental error: this would be expected by analogy with the results[4] for SiO.

From the above value of B_e'', the value of the equilibrium internuclear distance is found to be 1·928 A. for $^{28}Si^{32}S$. This may be compared with the single-bond covalent distance as taken, for example, from the tables of Schomaker and Stevenson[5], namely, 2·15 A. The observed shortening of the length, 0·22 A., is evidence for a bond order

greater than unity and accords well with the values found for SiO (0·25 A.) and for GeO (0·15 A.)[1].

Finally, it is of interest to compare the spectroscopic data for SiS in its ground-state with those[6] for P_2, which has the same total number of extra-nuclear electrons ($n = 30$).

	State	ω_e	$x_e\omega_e$	B_e	r_e	α_e
SiS	$^1\Sigma$	749·5	2·56	0·3037	1·928	$0·0015_5$
P_2	$^1\Sigma$	780·4	2·80	0·3046	1·890	0·00165

The constants for the two molecules are seen to be remarkably close. The similarity in properties of the 14-electron molecules CO and N_2 has, however, been recognized for some time (for example, Kronig[7]), and examination of the data for the molecules with 22 electrons, CS, SiO and PN[1,6], reveals an analogous situation. Further, such data as are yet available suggest a close similarity in the properties of other sets of isoelectronic molecules belonging to these groups of the Periodic Table[1]. These relations can scarcely be fortuitous, but it is hoped to extend and perhaps confirm them by examination of other molecules of these groups.

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Oxford.
July 28.

[1] Discussion on Band Spectra, *Proc. Phys. Soc.*, **56**, 204 (1944).
[2] Barrow, R. F., and Jevons, W., *Nature*, **141**, 833 (1938).
[3] Barrow, R. F., and Jevons, W., *Proc. Roy. Soc.*, A, **169**, 45 (1938).
[4] Saper, P. G., *Phys. Rev.*, **42**, 498 (1932).
[5] Schomaker, V., and Stevenson, D. P., *J. Amer. Chem. Soc.*, **63**, 37 (1941).
[6] Herzberg, G., "Molecular Spectra and Molecular Structure. I. Diatomic Molecules" (New York: Prentice-Hall, 1939.)
[7] Kronig, R. de L., "Optical Basis of the Theory of Valency" (Cambridge, 1935).

Banded Meson Spectrum and the Rossi Second Maximum

CHANDRASHEKHAR AIYA[1] has recently reported the interesting result that there is a discontinuity in the meson absorption curve as measured by Bhabha's method, when the total lead thickness is about 21 cm. He suggests that this has been brought out because of the special arrangement of counters shown in his communication. Bhabha[2] has also mentioned that by his arrangement of splitting lead and placing it between a tray of anti-coincidence counters actuated by showers, it should be possible to study much more accurately the range spectrum of mesons.

Though Bhabha has not indicated where additional lead is to be placed in order to study the longer range mesons, it is clear that so long as there is lead at III (see Aiya's communication) below the anti-coincidence counters, the above view is incorrect and the method cannot furnish any new information about the range spectrum. The range of mesons measured is determined by the total lead thickness, and not only by the thickness of lead above the shower-detecting tray. Further, Aiya's procedure of placing lead on top in position I is open to objections from the point of view of determining the meson spectrum. In the first place the efficacy of the optimum thickness of lead in position II in order to produce the maximum number of showers is lost as soon as additional lead is placed in position I, and in effect the arrangement nullifies the basic idea put forward by Bhabha. Besides this, the net result of Aiya's procedure is to superimpose on the meson absorption curve a Rossi curve, to be subtracted by virtue of the anti-coincidence arrangement, which rather complicates the interpretation in regard to the range spectrum.

If one does want to get a more accurate measurement of the range spectrum of mesons by preventing the effect of the secondary particles that might be produced after the mesons are stopped, one should keep a tray of anti-coincidence counters actuated by showers right at the bottom of the lead. Or better still, in order also to avoid high-energy electrons, there should be another tray after a lead thickness from the top corresponding to the maximum of the Rossi curve.

If what Aiya gets has anything to do with a banded meson spectrum, one should get it at least equally well with a straightforward counter telescope without any anti-coincidence arrangement. It seems, however, more likely that the effect is related to the second maximum of the Rossi curve. The presence of lead below the shower-detecting tray has the effect of discriminating against electronic showers, and this is probably the reason why the fall in the absorption curve due to the second maximum showers is so abrupt. Further, the fact that the fall is maintained for greater thickness of lead tends to show that the maximum is flat. This point would indeed be more clearly demonstrated if fourfold coincidences 123(45) were measured to give directly the Rossi curve for hard showers.

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July 13.

[1] Aiya, S. V. C., *Nature*, **153**, 375 (1944).
[2] Bhabha, *Proc. Ind. Acad. Sci.*, A, **19**, 23 (1944).

Importance of Film Records

MR. OLIVER BELL, in *Nature* of August 12, suggests that the British Film Institute might "convene a Conference to obtain expressions of opinion" on the important question of the preservation and circulation of privately made films.

The Medical Committee of the Scientific Film Association has already issued a *questionnaire* to collect data about medical films with the view of raising funds to preserve those of value and, where necessary, adding titles or commentaries. It is hoped eventually to make arrangements for central distribution.

Although the first steps have been taken in the medical field, the Association is equally anxious to obtain information about all privately made scientific and technical films, and is already taking steps to send out a similar *questionnaire* to industrial firms and scientific institutions. It is also collecting information about all films suitable for technical training purposes with the view of the publication of catalogues and hand-lists of these films.

MICHAEL MICHAELIS.
(Hon. Secretary.)

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RESEARCH ITEMS

Fishing Mortality and Effort

BARANOFF in 1918 formulated most of the present theory of the relation of the catch to rate of fishing, rate of natural mortality, of growth and of recruitment. His exposition, in the Russian language, was, however, somewhat inaccessible, and various other workers have discovered parts of the theory without knowing of Baranoff's work. William E. Ricker (*Copeia*, No. 1; 1944) has been back to Baranoff's paper, and has also corresponded with most of the other workers interested. He has now produced a clear and comprehensive development of the necessary definitions and equations. Formulæ are derived by which the expected catch can be calculated under different rates of fishing—given knowledge of the catch at one rate of fishing, and of the rates of natural mortality, of recruitment and of growth. Such calculations are necessary for advising immediately whether increase or decrease of fishing should take place, and Ricker's statement will therefore serve a practical purpose. He realizes, however, that no method exists at present by which one can extrapolate to determine the best rate of fishing, or the yield in any state very different from the one observed, unless Graham's approximation of 1935 is generally applicable—which remains to be seen. The difficulty in applying, in extrapolation, the kind of formulæ developed by Baranoff is that the rates of mortality, growth and recruitment are expected to vary with population density (growth-rate certainly does), and the law of their variation is not known. Graham's approximation assumes a simple law, which may be too crude; but it is regarded by Ricker as possibly the most interesting recent development in the theory of fishing.

New Fishes

IN a series of notes in *Notulæ Naturæ* of the Academy of Natural Sciences of Philadelphia, Nos. 115, 117, 119 and 120, March–April 1943, Henry W. Fowler describes several fishes which are new to science. These include a goby from the Fiji Islands, a species of Poecilia from Honduras, two new characins from eastern Ecuador and some additional new fishes obtained from the second Bolivian Expedition from the Academy of Natural Sciences of Philadelphia 1936–37.

Tegumental Glands in Cirripedes

C. M. YONGE's work on the tegumental glands in *Homarus vulgaris* has been extended to the Cirripedes by H. J. Thomas (*Quart. J. Micro. Sci.*, 84; 1944). As in the Decapods, the exoskeleton consists of a chitinous layer secreted by the chitinogenous epithelium, and outside this a cuticle secreted by the tegumental glands. In correlation with the sessile habit of the Cirripedes, the structure of the animal as a whole and of the tegumental glands have undergone specialization. Unicellular and compound glands secrete the cuticle of the peduncle and of the capitulum, and that of the surface of the mantle cavity is secreted by the labial and subœsophageal glands. The latter are sometimes, but inaccurately, termed the salivary glands. In the Operculata the labial glands also constantly secrete a material which entangles the waste matter entering the mantle cavity and so facilitates its removal. Apart from this activity the glands secrete only at the moult. The cement with which the animal attaches itself to the substratum is of the same nature as the cuticle, and consequently the glands secreting it are to be regarded as tegumental glands. In the Operculata, the gland cells degenerate after secretion and new cells are developed from the wall of the duct.

Structure of the Walls of Phloem Fibres

R. D. PRESTON (*Chronica Botanica*, 7, 414; 1943) points out that there is now considerable scope for the botanist, and especially the biophysicist, to make his contribution to the knowledge of the fine structure of the cellulose walls of plant cells. Owing to their commercial value, the fibres of the phloem (sclerenchyma) have so far been chiefly studied; in these the X-ray diagram indicates the presence of cellulose chains in the longitudinal direction only, while observations on swollen walls by optical methods have led to the view that at least two layers are present and that they differ in the direction of their cellulose chains. Crossed cellulose chains definitely occur in the walls of certain algæ. The X-ray diagrams of fibres of hemp and jute reveal the presence of cellulose chains in one direction only, running parallel with the major extinction plane; this diagram remains the same for fibres of different degrees of wall thickening, suggesting homogeneity of wall construction. However, by optical examination of swollen walls in cross-section, there is indication of heterogeneity, which does not appear to be accounted for entirely by differential distribution of lignin and pectin. Differential swelling of the wall in different regions leads to the production of striations of various kinds. Also the swollen material is easily broken into separate fibrils with associated change in direction of cellulose chains, which appears to have misled at least one worker. Swelling under certain conditions produces a 'ballooning' of the outer wall layer in hemp, but not in jute, and this fact, associated with observed optical phenomena, suggests that the outer layer in hemp and the inner in jute differ appreciably from the rest of the wall. It seems clear that in such walls the aggregates of the cellulose complex must differ in their association with one another in the different layers. Comparisons with long collenchyma cells suggests that the optical heterogeneity may be due to a variation in *angular dispersion* of the cellulose chains from layer to layer; this argument is less convincing for hemp and jute fibres, but not precluded by the X-ray diagram. There is therefore still doubt as to whether any chains exist in the secondary wall of these phloem fibres other than those which run in the longitudinal direction.

Internal Discharges in Dielectrics

A PAPER on the observation and analysis of internal discharges in dielectrics was read in London recently before the Institution of Electrical Engineers by A. E. W. Austen and Miss W. Hackett. Discharges on the surface of, or in inclusions in, insulants, constitute a particular case of a large class of discontinuous phenomena common in electrical equipment. They are important as they are a form of partial breakdown and may afford evidence of incipient failure, while also they give rise to undesirable currents and voltages. The present paper is concerned chiefly with the former aspect. In cases of gross defect or deterioration of condition, surface discharges may

be the forerunners of complete spark-over. Internal discharges may be the immediate cause of breakdown due to local overheating, but their effects are more commonly cumulative, the most important probably being the carbonization of organic insulants, resulting in field distortion and spreading of defects. The paper refers to the various detector circuits employed for observing the discharges and discusses the probable characteristics of the latter. In dealing with applications of the methods, particular attention is given to impregnated-paper capacitors and to paper-insulated cables. The conclusions which the authors have drawn from the investigation are that the validity of discharge-detection methods is established, and that, of the methods of observation described, the discharge detector approaches the form likely to give the greatest sensitivity attainable by normal methods and is satisfactory for the purpose. The oscillograph bridge, though less sensitive, is more suitable for the measurement of discharges and is capable of yielding much information on their sources.

Rapid Estimation of Sugar in Urine

J. E. STANLEY LEE (*Brit. Med. J.*, 847 ; June 24, 1944) describes an improved apparatus for the rapid estimation of sugar in the urine. This is adapted for use with Gerrard's cyano-cupric method, which depends on the power of the colourless double cyanide of copper and potash to hold cuprous oxide in solution. If Fehling's solution is titrated with a sugar solution in the presence of this cyanide, the blue colour gradually fades and there is no precipitate. The colourless end-point is therefore very sharp and, because there is no tendency to re-oxidation, the process can be carried out in an open flask. The apparatus, with its graduations, is illustrated, and directions for its use are given. The apparatus can also be used for estimation by Fehling's method.

New Complex Compounds of Rhenium

STARTING with the double chlorides of rhenium and potassium, K_2ReCl_6 and K_3ReCl_6, two Russian investigators, V. V. Lebedinskij and B. N. Ivanov-Emin, have succeeded in preparing complexes with ethylene diamine in which rhenium occurs in the cation (*J. Gen. Chem. U.S.S.R.*, 13, 253 ; 1943). At first they found that it was not possible to form complex rhenium compounds by the action of ammonia, pyridine or thiourea upon aqueous solutions of rhenichlorides. Anhydrous liquid ammonia reacted with the potassium rhenichlorides, but no stable amines could be isolated, whereas with excess of ethylene diamine on saturated rhenichloride solutions there was formed a new derivative of pentavalent rhenium having the formula $ReO_2(en)_2Cl$, where 'en' stands for ethylene diamine. This compound is soluble in water and does not form precipitates with anions except cobaltinitrite and platinichloride ions. A corresponding iodide, $ReO_2(en)_2I$, much less soluble than the chloride, was obtained from it by adding potassium iodide. With hydrochloric acid the rhenyl ethylene-diamine chloride gave a hydroxy-dichloride, $ReO(OH)(en)_2Cl_2$, which could be converted back into the monochloride by treatment with sodium hydroxide. This dichloride reacted with sodium platinichloride to yield a sparingly soluble complex rhenyl platinichloride, $ReO(OH)(en)_2PtCl_6$. With potassium iodide it gave the di-iodide, $ReO(OH)(en)_2I_2$. Excess of hydrochloric acid acted upon the original chloride derivative to form a further complex compound having the formula $Re(OH)_2(en)_2Cl_3$. These are the first reported instances of complexes with rhenium in the cation.

Periodic and Asymptotic Orbits in a Five-Body Problem

DANIEL BUCHANAN, dean of the Faculty of Arts and Science, University of British Columbia, Vancouver, B.C., has discussed this topic (*Canadian J. Research*, Sect. A, Phys. Sci. ; Jan. 1944). He considers four bodies of equal mass, which remain relatively fixed at the vertices of a square, while they revolve about their common centre of gravity with uniform angular velocity. An infinitesimal body is subject to the Newtonian attraction of the four finite bodies, and the problem is to determine the orbits in which it can move. A very full investigation of the subject is given, and periodic orbits in the plane of motion of the finite bodies and also cutting this plane, and in addition, asymptotic orbits within the above plane, are obtained for the infinitesimal body moving in the vicinity of its points of libration. Four diagrams show approximate orbits for different libration points, and among these are included the ellipse, parabola, a double loop and a figure-8 curve symmetrically situated with respect to the diagonal of the square of which the finite masses are the corners. The question of the convergence of the series arises because these solutions are power series in a parameter ε, ε denoting the scale factor of the orbits. Regarding the periodic solutions, their convergence can be established by an existing proof in which use is made of Poincaré's extension to Cauchy's theorem "Les méthodes nouvelles de la mécanique céleste" (1, 338 ; 1892–99). This shows that periodic solutions exist and will converge for all values of the time, provided ε is sufficiently small numerically. Alternatively, MacMillan's theorem (*Trans. Amer. Math. Soc.*, 13, 146 ; 1913) can be used. The convergence of asymptotic solutions was treated by Poincaré (see ref. above) and the conditions which he established are fully satisfied for the asymptotic orbits that were constructed.

Distribution of Intensity within the Solar Corona

H. A. BRÜCK has described the results of a photometric study of the inner corona, especially of the region extending from 2′ to 5′ from the solar limb (*Mon. Not. Roy. Astro. Soc.*, 104, 1 ; 1944). The photograph of the corona which has been used was taken by the late Prof. H. F. Newall during the eclipse of August 30, 1905, and photographic densities within the corona were investigated with the Cambridge recording microphotometer. Records were made of the variation of density along 72 solar radii, beginning with the radius in the direction from the solar centre to the north pole of rotation and proceeding along radii with equal intervals of 5° in position angle. The intensity gradients, the method for deriving which is briefly described, show in the immediate vicinity of the sun a definite correlation with the structure of the corona. Along streamers or rays the intensity decreases less rapidly with increasing distance from the sun than in normal regions. No such correlation is indicated for the region extending from 5·6′ to 8·7′ from the solar limb. An effect opposite to that found by Brück for the inner corona was observed by von Klüber for streamers extending from about 6′ to about 70′ from the solar limb.

BIOLOGICAL RESEARCH IN THE ARGENTINE

A NUMBER of reprints from *La Revista de la Facultad de Agronomía y Veterinaria*, **10**, 111, November 1943 (Universidad de Buenos Aires; Facultad de Agronomía y Veterinaria) have recently been received.

F. Monrós has a paper with the title, "Algunos coleópteros de interés forestal observados en la Isla Victoria (Gobernación del Neuquen)". Observations conducted at the Victoria island of the National Park of Nahuel Huapi, during the months of January and February 1943, enabled the author to compile a list of Coleoptera which were detrimental to forest trees. A brief outline of the ecology of the island is given with the object of locating more easily the various species which are catalogued. About a dozen species are mentioned, and a list of the families found on the island is given, with the percentage of species corresponding to each one of these. Certain species which are abundant in other parts are not found on the island, and none of the Coleoptera on the island has been discovered in the surrounding regi ns. Aquatic or sub-aquatic Coleoptera were very seldom found, and terrestrial Micro-coleoptera were poorly represented. Some species fed on decayed organic matter, and a few others lived on the flora. Other interesting information is supplied by the author, who has made a very exhaustive examination of the Coleoptera on the island.

José Vallega has a paper with the title "Razas fisiológicas de 'Puccinia graminis avenae' halladas en la Argentina", which deals with the above pest found especially in the central and northern parts of the cereal region of the Argentine. Physiological races 3 and 7 were equally abundant and had the same geographical distribution. Experiments on resistance showed that, in general, oats cultivated in the Argentine and Uruguay were very susceptible to the two races of Puccinia, but among the foreign varieties the following were remarkable for their resistance: Richland, Rainbow, Iogold, Green Russian, Hawkeye, and a number of hybrids descended from them. In addition to the genus Avena, a number of grasses showed certain degrees of susceptibility; a list of these is given. The technique adopted for the investigation of the infection, powers of resistance, and various other matters relating to the investigation, were described in detail in a previous work published in 1940.

In a paper with the title "Observaciones sobre la biología floral de *Solanum chacoense* Bitter", Enrique L. Ratera describes the results of his investigations on this species during the years 1935–42. Research was conducted at the field station of the Institute of Genetics of the Faculty of Agriculture and Veterinary Science of the University of Buenos Aires, where the species, which is self-fertilizing, flowered and fruited abundantly. Diagrams show the appearance of the flower in the early morning and at other times; the positions adopted towards evening and during the night favour self-pollination; the anthers mature simultaneously with the receptivity of the stigma. From numerous observations it appears that the duration of the flowers of the species is about 4–5 days, at least in the place where the experiments were conducted.

Juan B. Marchionatto has a paper with the title "La obra fitopatológica de L. Hauman en la Argentina" which deals with Prof. Hauman's researches, especially those of which the results were published during 1907–25. His work started in 1904 in the Instituto Superior de Agronomía y Veterinaria de Buenos Aires, which became later the Facultad de Agronomía y Veterinaria. Hauman's first results were published in collaboration with Juan A. Devoto in 1908, and were a prelude to a more important publication six years later under the title "Les parasites végétaux des plantes cultivées en Argentine et dans les regions limitrophes". As a supplementary work, which was indispensable for teaching purposes, a collection of phytopathological specimens was prepared; and it was found that a solution of copper formate preserved the colour of the green organisms as well as the vegetable structure. The most important of his studies was connected with the mutations of certain organisms in vegetables, a task on which he laboured for several years and which resulted in showing that *Mucor stolonifer* Erb. was responsible for the production of decaying matter in the potato, although other fungi and certain bacilli were capable of producing similar results under experimental conditions. A very important paper was published in 1913 in *Ann. l'Inst. Pasteur* (A **27**, 501), with the title "Contribution à l'étude des altérations microbiennes des organes charnus des plantes". The results of the investigation set forth in this paper were recognized as a serious contribution on the subject of parasites of plants and their action in the production of putrefaction. The paper deals with many other matters too numerous to mention, but a summary of Hauman's conclusions regarding the factors which favour or hinder parasitism in plants is as follows: (1) conditions which determine the abundance or scarcity in the environment of the organs of propagation of the parasites; (2) conditions more or less favourable in the medium for the development of the parasites; (3) conditions more or less favourable for the reception of, or resistance to, the host.

Jorge R. Christensen contributes a paper with the title "Estudio sobre el Género *Diabrotica* Chev. en la Argentina". The author has conducted very extensive research on the subject, and supplies a list of all the species which are pests of cultivated land, and in addition, has given indications of their hosts. The paper deals with the distribution and damage caused by the pest, its anatomy and external morphology, its life-cycle, and the method for combating it. Careful observation has shown that the most effective insecticide for dusting is rotenone, using a concentration of 0·5–1 per cent. Good results were also obtained by using 'Piretrina' in a 5 per cent concentration, but, on the whole, it was inferior to rotenone. In addition to a description of new species, there are also descriptions of species studied by other authors, and thirty-two illustrations at the end of the work.

A paper by Emilio F. Paulsen and Emilio S. Lio, with the title "Sobre el Contenido de arsénico en el tabaco", deals with the determination of the arsenical contents of smoking tobacco. The arsenic serves to combat certain pests, and the plant retains and absorbs a proportion of the insecticide, the amount depending on the nature of the preparation employed and also on the method of application. Considerable differences were found in the amount of arsenic present. Thus, in the case of the black cigarettes, 10–15 parts per million were found, while the contents for Virginian cigarettes fluctuated between

5·8 and 16·6 per million. In the natural tobacco on which no work had been expended before the tests were applied, the amount varied from 25 to 250 parts per million. The data refer to tobacco grown in the Argentine and worked up in its factories, with the exception of some specimens which contained mixtures of imported tobacco, and all the data refer to the types of cigars and cigarettes which find their way into the market. The danger of arsenic poisoning from tobacco is obviously very small.

MAGNETO-STRICTION NOISE FROM TELEPHONE WIRES

WHEN magnetic material is subjected to a mechanical force, its magnetization is changed; and conversely, if its magnetization is changed, the material expands or contracts. There is thus a relationship between the stress and magnetization of magnetic materials which is called magneto-striction. According to an article by M. T. Dow (*Bell Lab. Rec.*, 22, No. 10; June 1944), noise encountered some eight years ago on certain telephone lines was found to be caused by vibrations set up by wind in a long river-crossing consisting of steel conductors, and experiments indicated clearly that the noise was due to magneto-striction. The alternating stresses in the taut wires vibrating under the influence of wind, resulted in corresponding changes in the magnetization of the steel wires, and these magnetic fluctuations induced voltages in the wires that appeared as noise at the ends of the line.

Since the voltages induced by magneto-striction vary at rates which depend on the rates of change of stress in the wire, the noise frequencies are related to the frequencies of vibration of the wire, and these in turn are determined largely by the size of the wire and the velocity of the wind; wire tension, span-length, and other such factors also have some effect. It was found that practically all frequencies of the magneto-striction noise were in the voice range, and under certain conditions the dominant frequency was in the neighbourhood of 1,000 cycles/second, which is the range producing the greatest disturbing effect. The test results confirmed a simple relationship expressed as $f = 7(v/d)$, where f is the principal noise frequency in cycles/second, v is the wind velocity in m.p.h., and d is the diameter of the wire in inches. To produce a 1,000-cycle noise, therefore, the wind velocity is given by the expression $v = 143d$. Commonly used copper-steel wires are of 0·104 in. and 0·128 in. in diameter, and for these two sizes the wind velocities to give 1,000-cycle noise are about 15 and 18 m.p.h., respectively. These are velocities commonly encountered.

For the same velocity of wind, the greatest effect is experienced when the wind is approximately at right angles to the direction of the wires. Taut wires with sags of less than 8–10 in. in 130 ft. spans favour the generation of magneto-striction noise. Fairly steady winds with velocities around 20–35 m.p.h. produce the highest values of noise. Winds in this range of velocity favour the building up of resonance, which leads to high amplitudes, and also are likely to produce frequencies of the greatest disturbing effect. Turbulent winds, with velocities up to 64 m.p.h., seem to inhibit the building up of resonance, and thus are less effective in producing noise. The effect is greatest in all-steel wires, and becomes less the greater the relative amount of copper.

An estimate based on a study of the results obtained indicates that for tight wires, in an exposure of 25 miles or more in length where conditions favour magneto-striction noise, the unamplified noise generated during windy periods would probably average around 28 db. above reference noise. Occasionally, maxima might reach as high as 36 db. above reference noise. Both these figures are for tight, copper-clad wire of 40 per cent conductivity; the corresponding figures for wire of 30 per cent conductivity would be about 3 db. higher. Under similar conditions, the noise for all-steel wire is likely to be 10–25 db. higher. Actually, while magneto-striction noise has been experienced with steel wire, none has ever been reported on circuits employing copper-clad wire.

USE OF 'POLAROID' FOR THE MICROSCOPE

By DR. A. F. HALLIMOND
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FILMS of very strongly pleochroic material, usually mounted between glass plates, have been available during the past few years under the trade-name 'Polaroid'. For some purposes they can replace the nicol prism, but their use has been restricted because in a moderately strong light they transmit a noticeable reddish-violet colour at the position of extinction.

Disks of improved 'Polaroid' of high optical quality have since been made, and a British firm of instrument makers recently placed two of them at the disposal of H.M. Geological Survey for investigation of their possible use in the petrological microscope. The following is a brief report, communicated by permission of the Director, Geological Survey and Museum, on their properties, which rival those of the best nicol prisms.

Extinction. It has been understood that 'Polaroid' was prepared by the alignment of small pleochroic crystals in an artificial preparation. Consequently one might expect that the extinction would be less sharp than that for a nicol prism, and that a small proportion of the strongly absorbed ray would still be transmitted. For the pair of disks now to be described both these fears proved groundless.

Fig. 1 shows two examples from several curves that were measured by means of a visual micro-photometer, similar in purpose to that of M. Berek, which I hope to describe shortly. One nicol (or 'Polaroid') was fixed in the usual position in the microscope, while the other was placed on the rotating stage, which could be read to 0·1°. Stray light was excluded by means of black paper tubes. With a strong beam it was possible to obtain a variation of 100 units on the photometer scale within a rotation of $\pm 2°$ from extinction. Curve A is the ordinary extinction curve for two nicol prisms; there is good agreement between the photometer readings (shown by circles) and the continuous curve calculated from the usual formula, indicating that the photometer scale is practically linear. The readings along curve B were obtained with two 'Polaroids'; they again show substantial agreement with the corresponding calculated curve, even for the range nearest extinction.

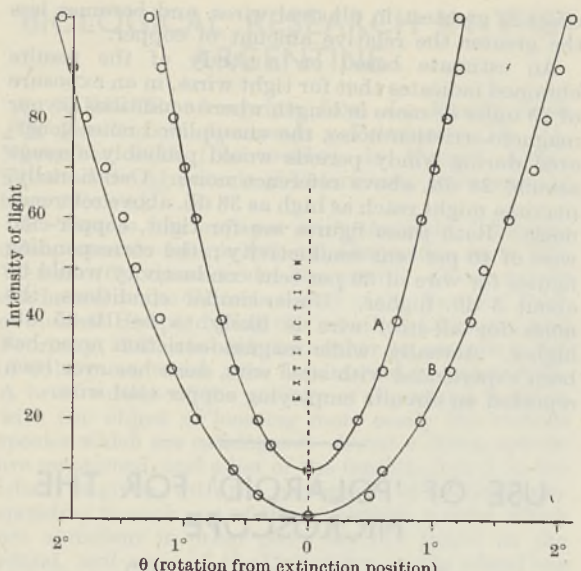

Fig. 1. EXTINCTION CURVES FOR NICOL PRISMS AND 'POLAROIDS'. ○, Photometer readings; full curves calculated from $\sin^2\theta$.

The intensity at extinction is not seriously different from that indicated by the curve drawn through the other readings. This curve was fully confirmed by a repetition with rather more residual light, so that the readings were from 10 units upward on the photometer scale. If the calculated curve is extrapolated to give the approximate photometer reading when the nicols (or 'Polaroids') are parallel, the percentage of residual light at the extinction position can be obtained; it is very low, being 0·0052 per cent for curve *A* and 0·0015 per cent for *B*. It follows that the absorption of the strongly absorbed ray in this 'Polaroid' is practically complete. When the sun or a lamp filament was examined directly through the crossed 'Polaroid' disks, the transmitted beam had a lilac colour, but in front of a microscope lamp it was too weak to be distinguished.

The residual light seen at extinction in the microscope, whether with nicols or 'Polaroids', is almost completely polarized by the analyser; it is thus to be assigned chiefly to the diffusion of light at the surfaces (or the admission of stray light) between the polarizer and the analyser. This is readily tested by examining the field at extinction through an additional nicol; light transmitted owing to the inadequacy of the analyser itself would be polarized at right angles to the above. The low value of the residual light in curve *B* is due to the relative ease with which the 'Polaroids' can be enclosed, and the small number of surfaces; it gives satisfactory evidence of the absence of cloudiness in the 'Polaroid' itself.

Definition. The 'Polaroid' disks can be made optically flat. When one was inserted in a microscope instead of the analysing nicol, the lateral displacement of the image was inappreciable and there was no apparent loss of definition. The slight displacement of focus due to the thickness of the glass was also practically negligible; if necessary, it could be completely compensated by placing a blank glass in the space usually left vacant.

Absorption of light. 'Polaroid' has a neutral smoky tint; measurement by the visual photometer showed a transmission of 32 per cent for green light, and later measurements gave 34 for green and 36·5 for a 'tricolour red' screen. In order to obtain a more complete determination of the absorption for the visible spectrum, the 'Polaroid' was submitted to Dr. J. McClelland at the Government Laboratory, and the following report is communicated by permission of the Government Chemist.

"The 'Polaroid' plate was fixed in front of the slit of a constant deviation glass spectrograph at right angles to a beam of light from a tungsten lamp, and rotated so as to transmit the maximum amount of light. Photographs were taken by the usual method, with exposures adjusted to give approximate equality of the spectra with and without the 'Polaroid'; the intensity of the images was then compared photometrically in a Hilger non-recording microphotometer over a series of wave-lengths. The results, one of which is represented in Fig. 2, are remarkably uniform, with a slight increase in absorption in the blue-green; otherwise there is no evidence of any noteworthy absorption band, even toward the limit of the visible spectrum."

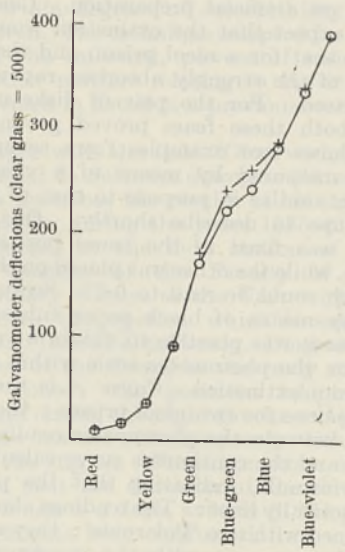

Fig. 2. ABSORPTION OF LIGHT BY 'POLAROID'. ○, 'Polaroid' (75 sec.) +, Light source (25 sec.)

These results imply the substantial absence of colour in the light transmitted by the 'Polaroid'. The small differences in the spectrum fall within those commonly found in the various 'daylight' screens and other sources usually employed. Of the incident light, approximately 50 per cent is completely absorbed by the polarizing action, as in the case of the nicol prism. The transmitted beam, which in a nicol would approach 50 per cent (with a small deduction for loss at the surfaces employed), is 33 per cent in the 'Polaroid', so that there is a loss of about 1/3 in the transmitted light with one 'Polaroid' and about 1/2 with two. In practice this difference seems to be more than compensated by the greater diameter at which the condenser can work when 'Polaroid' is used instead of a nicol, by the elimination of compensating lenses and by the improved extinction that may be obtained. In any event, for transmitted light there is no difficulty in using a rather stronger source. For the ore microscope the light-source is nearer the practicable limit and the aperture is often limited on other grounds; nevertheless 'Polaroid' would seem likely to be useful for all but the most exacting work on bireflexion, and for this also if a sufficient source is available.

From the preceding brief account, it would seem that the new 'Polaroid' is likely to require most serious consideration not only for students' use but also for research microscopes. Not only is there a substantial saving in cost if the material can be supplied at a similar price to the nicol prism or lower, but improvements are also possible in the optical system and in the microscope design.

THE MELLON INSTITUTE

WAR-TIME RESEARCH

UNDER the title "The Mellon Institute in the Second Year of War", a brief summary of the activities of the Mellon Institute has been condensed from the thirty-first annual report, indicating its contribution to the war effort. During the year, March 1, 1943–March 1, 1944, a multiple industrial fellowship on chain welding and metallurgy was divided into two separate fellowships on chain welding and on powder metallurgy techniques. The iodine fellowship was revived in April, and seven other proposals for research have been accepted. The Institute's industrial research staff now consists of 201 fellows and 214 fellowship assistants. Two of these fellowships have been active for thirty years, seven for twenty-five and eight for twenty; sixty in all have concluded at least five years of research. During the year the Institute's expenditure for pure and applied research amounted to 1,652,539 dollars. A new fellowship for research in the wood-container field is concerned to improve standards and production practices for shipping containers and also to eliminate the enormous amount of wood waste in the conversion of trees to such containers of finished lumber. A fellowship has been established to improve cotton fibres by altering the chemical structure without loss of identity or workability of the fibres, and another fellowship will conduct broad basic studies of the physical and chemical properties of cotton. A new fellowship of the Copperas Co. is devoted to studies of the oxidation products of major aromatics from tars.

Nine fellowships were completed during the year; they covered air-pollution control, anti-icing, garments, naphthalene chemistry, pasteurization, pencil technology, surgical supplies, synthetic rubber and tar treatment. Work on air-pollution control was brought to a temporary end through the death of the incumbent fellow. A report has been published on studies under the synthetic rubber fellowship of the toxicity of butadiene carried out for the Rubber Reserve Co.

The Institute's Department of Research in Pure Chemistry directed its efforts chiefly towards chemotherapy. Results obtained with certain new drugs as antimalarial agents are sufficiently encouraging to warrant further research. Under a scheme promoted by the National Research Council, arrangements have been made for evaluating the anti-malarial activity of new drugs. More than eighty new drugs have been submitted for antimalarial appraisal, and efforts have been directed towards possible ways of diminishing the toxicity of chemical structures recognized as possessing anti-malarial potentialities. Investigations on problems in the preparation of cinchona alkaloid derivatives with anti-pneumococcal potency have been terminated and the results published. Prototypes of a new class of modified cinchona derivative in which the phenolic hydroxyl group of apocupreine is replaced by an alkylamino constituent have been prepared by the Bucherer reaction, but the therapeutic action was not increased. A method has been evolved for the preparation of *p*-toluenesulphonyl esters of phenols and alcohols rapidly, economically and in high yield. A publication from the Department and the Department of Chemistry of the University of Pittsburgh deals with *cis*-3 : 6-endomethylene-Δ-4-tetrahydrophthalic acid: the anhydride of the corresponding hexahydrophthalic acid has been obtained quantitatively by direct catalytic hydrogenation under high pressure. The synthesis of 3-benzoyl-nor-camphane-2-carboxylic acid by a Friedel-Crafts reaction has been worked out.

Referring to researches proceeding in the Institute under the industrial fellowships, the report states that friction losses in vaned elbows of asbestos ducts have been determined in numerous designs; and the physical and chemical treatment of gypsum, which has received very thorough investigation during the past five years, has yielded especially valuable results in 1942–43. There are eight fellowships in all in the field of ceramics. Thirteen fellowships have been concerned with metallurgical studies and the failure of restrained welds; and the destructive testing of structural joints, involving special gaskets, has received much attention. Systems have been developed for centralized filtration of machine-tool coolants and a differential solubility process for treating waste pickle-liquor is announced. A research programme on the hydrogenation, dehydrogenation, oxidation and alkylation of coal products has been widened considerably, and several new catalytic processes are under development. A new process for ethylbenzene has been put into operation on the large scale, and another investigation has been concerned with the effect of paraffins on the nitration of toluene.

In addition to basic research on the production of phenols, another group is working on the separation of cresols and xylenols from their mixtures; new naphthalene derivatives are also receiving much attention. Studies of the rheological properties of bituminous materials have been continued, and substantial progress has been made in improving fractional distillation techniques under extremely high vacuum.

Under the seven fellowships pertaining to major problems of the food industry, improvements have been effected in dehydrating prepared foods, and new knowledge has been gleaned on decolorizing absorbents, including the evolution of a new synthetic granular absorbent for the sugar industry. In the textile field, the weathering of treated fabrics used as covers over the guns of coastal defences has been investigated to secure textiles more resistant to sun, salt air, wind and rain, and new yarns have been prepared from soya bean protein alone and with viscose, as well as a synthetic textile lubricant for the woollen industry. Reference is also made to advances in processing animal fibres used in felt and the co-relation of physical properties with felt quality. *GR-S* latex has been applied commercially to the saturation of sulphite papers, with results indicating a satisfactory comparability with rubber latex-treated papers but with somewhat less tensile strength. Growing attention to cyclopentadiene has greatly stimulated research on methods for its utilization. Compounds of interest for the manu-

facture of synthetic resins, rubbers and fibres have been prepared electrolytically and a new curable liner for container closures. New techniques have been developed for the preparation of vinyl resin coating compositions, and a thorough investigation made of the production, purification and analysis of butadiene and styrene by the multiple industrial fellowship on tar synthetics. Other studies have been concerned with specifications for metals for the construction of butadiene and styrene plant. Fundamental work has also been done on the physical chemistry of the purification of raw materials for synthetic rubber. The polymerization of butadiene, styrene and acrylonitrile are under close scrutiny, and new tests for the adhesive properties and ageing characteristics of paints and for the rheological properties of elastomeric adhesives have been adopted as guides in the development of new adhesives, while several new formulæ for 'Cellophane'-tape adhesives have been derived.

Other fellowships have been concerned with protective coatings. Several papers were published on the basic aspects of anti-fouling paint performance. Exhaustive studies of a possible accelerated corrosion effect from accidental or deliberate contact of steel hulls with the anti-fouling paint have indicated that appreciable acceleration can occur under the usual type of anti-fouling compositions containing heavy metals. The production of alkylene polyamines is being delineated precisely for industrial applications, and promising products for the synthesis of motor fuel, for the preparation of chemicals for synthetic rubber and as ingredients for lubricants, paints and insecticides have been developed from investigations on nickel compounds and catalysts. An insecticide which has given a 98 per cent kill of houseflies in the Peet-Grady chamber has been developed. Several new organic iodine compounds have been prepared in a search for improved iodine antiseptics. Work on intermediates for sulpha drugs has kept pace with current advances in this field.

Studies on the toxicity of several new products and of materials the health hazards of which were unknown but all used by the military forces or government contractors, such as dioctyl phthalate, low-temperature and extreme-pressure lubricants, insect repellents and cable-impregnating compounds have been completed.

Special reference is made to the work of the Industrial Hygiene Foundation, a non-profit association of industries for the maintenance and advancement of healthy working conditions, which has its headquarters and a multiple fellowship at the Mellon Institute. This Foundation has continued its investigation of sickness absenteeism commenced in 1941. It has given some attention to the placing of disabled soldiers who are returning to the United States and has conducted some fifty plant hygiene surveys, including exposures to such substances as synthetic resin dust, trichloroethylene, hydrogen fluoride, carbon tetrachloride, and excessive temperatures. The Foundation has continued to support medical investigations at the Saranac, New York, Laboratory under L. U. Gardner, covering disability through silica compounds and the effect of aluminium therapy. A grant was also made by the Foundation during the year for a plant investigation of health problems of women in industry. Publications on health problems of women in industry as well as on putting the disabled soldier back to work have been issued during the year.

FORTHCOMING EVENTS

Tuesday, September 19

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Dr. A. Sommer: "Principles of Photo-Electric Emission and their Application in Photo-Electric Cells".

Wednesday, September 20

INSTITUTE OF METALS (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 2.15 p.m.—Thirty-sixth Annual Autumn Meeting. Discussion on "Melting and Casting of Bronze".

PHYSICAL SOCIETY (COLOUR GROUP) (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 3.30 p.m.—Mr. H. G. W. Harding: "Illuminants for Colorimetry and the Colours of Total Radiators".

Friday, September 22

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND) (at 39 Elmbank Crescent, Glasgow), at 2 p.m.—Dr. J. Foster King: "Longitudinal Bending Moments"; Dr. J. Tutin: "Methods of Levying Charges for Services to Shipping"; Mr. B. Alwyn Jay: "Timber in Shipbuilding".

Saturday, September 23

BRITISH PSYCHOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. J. C. Flugel: "Psychological Aspects of Moral and Social Progress" (Papers in comment by Dr. Karl Mannheim and Dr. R. H. Thouless).

APPOINTMENTS VACANT

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

RESPONSIBLE LECTURER IN PHYSIOLOGY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 20).

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY (Low Temperature Polymerization)—The Registrar, The University, Manchester 13 (September 20).

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Secretary and Registrar, The University, Bristol (September 20).

RESEARCH ASSISTANT (male, temporary) in the Agricultural Entomology Division of the Ministry of Agriculture of Northern Ireland—The Assistant Secretary (Establishments), Ministry of Finance, Stormont, Belfast (September 21).

BIOCHEMIST (Reference No. F.2841.A), and a PHYSICAL CHEMIST (Reference No. F.2842.A.) at the Cereals Research Station, St. Albans—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (September 23).

TEACHER OF MATHEMATICS in the Newton Heath Technical School—The Director of Education, Education Offices, Deansgate, Manchester 3 (September 25).

QUALIFIED CIVIL OR MECHANICAL ENGINEER to teach Mechanical and Constructional Drawing—The Director of Education, The Polytechnic, Regent Street, London, W.1 (September 25).

CIVIL ENGINEER for the duties of Assistant Divisional Engineer by the Sudan Government Irrigation Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1114.A) (September 25).

TEACHER (full-time, graduate) OF ENGINEERING for Day and Evening Classes in the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester (September 26).

ELECTRICAL ENGINEER for the Nigerian Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.926.A) (September 26).

FIRST-CLASS ENGINEER to assist in Steam Turbine Design, Research and Development (location, Midlands)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2166.XA) (September 26).

CHAIR OF MINING—The Acting Registrar, The University, Leeds 2 (September 30).

DIRECTOR OF RESEARCH, Forest Products Research Laboratory, Princes Risborough—The Secretary, Department of Scientific and Industrial Research, Teddington, Middx. (October 9).

ASSISTANT TECHNICAL EXAMINING OFFICERS (temporary) in the Victualling Department of the Admiralty—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2911.A) (October 11).

LECTURER IN PHILOSOPHY—The Very Rev. the Dean, Christ Church, Oxford (October 15).

ELDER PROFESSORSHIP OF ANATOMY AND HISTOLOGY in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (October 31).

DIRECTOR OF THE DEPARTMENT OF SOCIAL STUDIES, University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (Sydney, December 1).

READER IN STATISTICS who will also act as Director of the Institute of Statistics—The Registrar, University of Oxford, Old Clarendon Building, Oxford.

ASSISTANT MECHANICAL ENGINEER for the Electrical Branch of the Nigerian Government Public Works Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1391).