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RECRUITMENT AND TRAINING OF TEACHERS

YOUTH LEADERS AND TEACHERS IN YOUNG PEOPLE'S COLLEGES

IN the second part of the McNair Report* it is significant that the sections on the supply, recruitment and training of youth leaders and teachers for young people's colleges have been grouped together. This implies a clear recognition that if the young people's colleges are to be successful, the more formal methods of the preceding school period will have to be dropped, and some of the spirit of informality which accompanied the growth of the youth movement and which has kept it vigorous and attractive will have to be preserved. Further, since the two services deal with approximately the same groups of young people, one attempting to meet their needs on the basis of compulsory and the other on the basis of voluntary attendance, Sir Arnold McNair's Committee insists that the foundations of the youth service must be laid during the years immediately following the break with full-time attendance at school.

Any attempt to draw up detailed proposals for the young people's colleges, which are not yet in existence, would have been a misuse of the Committee's time and energy, and it has therefore confined itself to a statement of broad principles.

Although the youth service differs in that it has a history, it presents a peculiar problem because, while that history has been in the main a story of voluntary initiative, to-day it is being woven into the pattern of education for which public authorities are responsible. This involves co-operation between voluntary and statutory bodies of a kind which calls for adjustment and tolerance rather than rigid rules and, if organization merely becomes an end in itself, its existence as part of the national system of education will be extremely precarious.

Many youth workers are anxious about what they call the 'professionalization' of work among young people and believe that it may result in a loss of spontaneity and freedom which is characteristic of the best voluntary work. The Committee strongly emphasizes that these fears about 'professionalization' will only be falsified if the quality of men and women recruited to the service of youth is sufficiently high to maintain the best of its traditions, and if statutory and voluntary bodies co-operate to put the needs of young people first and to leave administration and standardization to find their proper, but subsidiary, place.

Work with young people is so varied that those engaged in it can be classified in many ways. Two broad divisions are recommended in the report. First, full-time workers such as organizers, wardens and heads of large centres or institutions, who are almost invariably paid workers, and secondly, part-

* Teachers and Youth Leaders. Report of the Committee appointed by the President of the Board of Education to consider the Supply, Recruitment and Training of Teachers and Youth Leaders. (London : H.M. Stationery Office.) 2*s*.

time workers who may be paid or unpaid. In outlining a scheme for the training of youth leaders it must be recognized that this will in no way reduce the need for a tremendous number of voluntary workers to whom the service of youth owes its inception and high traditions.

The Committee points out that there is no recognized qualification for a youth leader, and there are few courses of systematic training. In the past these have been provided by the voluntary organizations and vary in duration from a few months to two and a half years. As a result of all these courses not more than 150 trained workers have been produced. Since the outbreak of war, the Board of Education has taken a hand in the sphere of training. Some of its staff have themselves conducted a number of short courses lasting from one to two weeks, and also in 1942, the Board announced its willingness to grant financial assistance on a student capitation basis to institutions and organizations which were prepared to conduct approved courses. These courses were to be regarded as experimental and were not to lead to a recognition of any course as providing a full qualification for youth service work (Circular 1598).

These different types of courses, for which more than three hundred students have enrolled, are serving a three-fold purpose. A number of war-time youth workers are being given a better background of knowledge and experience; a variety of organizations are experimenting in the new field of training, and, equally important, the Board of Education, local education authorities, the universities, training colleges and voluntary organizations are being brought together in the work of training. The experiences gained from these courses will be invaluable in the framing of future ones leading to the attainment of nationally recognized qualifications.

Another anomaly in the service of youth which the Committee underlines is the lack of a national scale of salary. Current educational journals include advertisements ranging from £100 (with board) to £250 for youth leaders and wardens and £200–£400 per annum for organizers. There is great disparity in the salaries offered for comparable posts, and provision for pensions for youth service workers as such do not exist. Even the maximum salaries offered at present are not sufficiently high to attract the best type of personnel for this all-important work.

The age of entry to work in the youth service varies between wide limits. Since the service of youth caters for young people ranging from fourteen to twenty years of age, it is essential that there be corresponding maturity on the part of those who may be called upon to guide and advise them. It is important, too, that the wide field from which youth leaders and organizers are at present drawn should not be restricted. Among part-time and voluntary workers there are few professions which are not somewhere represented. Whatever system of training is devised for youth leaders, this invigorating variety must be preserved.

With these general considerations as a working basis, the Committee then discusses and makes various recommendations on the future supply and training of youth leaders.

On the assumption that one leader will be required for about every three hundred boys and girls between fifteen and eighteen years of age, it is estimated that 5,000–6,000 full-time youth leaders will be required. Since physical activities constitute a very important part of the interests of youth, and since many other activities which young people pursue with zest make great physical demands on those older people who help to plan them, it is reasonable to assume that the active working life of the youth leader will be less than that of the teacher. Adding to this the normal depletion through death, illness or premature withdrawal to other types of work, it is anticipated that, once the full establishment is in being, an annual recruitment of about three hundred youth leaders will be required. The Committee rightly indicates that "this flow of 300 a year will not be achieved without the establishment of a profession involving approved courses of training of a satisfactory standard which lead to a recognised qualification and of a service in which adequate salaries are paid and acceptable conditions of service are secured".

Training is regarded as essential, although it may not be practicable to make it compulsory in the immediate future. The youth leader works with human material, and the unguided experience through which he now has to learn his profession is only too often bought at the expense of those whom he seeks to help. Moreover, complete absorption in work with young people to the exclusion of a personal life of his own is one of the temptations that beset a leader, and his education should give him something which minimizes the danger of his becoming unduly preoccupied with youth. The leader, like the teacher, should be a well-balanced, fully developed individual.

At the time of his first appointment to a post, it is suggested that the youth leader should have achieved a fairly high standard in some field of knowledge or in some craft of his own choosing. He should have a good working knowledge of the elements of citizenship. He should possess considerable understanding of the psychology of young people and their individual, social and industrial background, as well as a genuine interest in one or more of the many activities in which young people freely engage, such as music, drama, crafts of all kinds, gymnastics, games, and so on. It is essential, too, that he should have some experience of actual work with young people, including what is involved in the organization and business management of groups, clubs or institutions. Most important of all, he must be the kind of man whose personality is acceptable to young people and who has a genuine sense of vocation for his work.

For the beginner it is recommended that the training course should extend over at least three years. At least a quarter, and in some cases a half, of the course should be practical work, and should not mean merely a series of brief visits of observation to a number of institutions concerned with young people. It should include substantial periods of continuous

work in one or more institutions or among one or more groups of young people in different geographical and industrial areas. In order to minimize a possible lack of coherence in such training, a full-time tutor should be responsible for planning the study and practice of a defined and small group of students. Ideally, each course, because of its practical nature and the co-operation with active youth workers, should itself be a contribution to the youth work of the locality, and the training system as a whole should influence the work throughout the country.

The institutions offering courses of training should keep continuously before them the need for devising the proper machinery of selection. A new entrant to the training courses might either be tried out in some youth service work before he makes a firm application for training, or might be given a preliminary interview sufficiently in advance of the beginning of the course to enable him to do some practical work prior to a final decision being reached about his suitability for training. The first term or two of the training course should be regarded as probationary. An important and long-sighted recommendation is that a student's achievements during training and his fitness for full-time professional work should not be decided by the results of an examination at the end of the course. The core of the assessment must be the capacity to live and work with young people. As a great deal of experimental work is already in progress, the Committee strongly recommends that the Board of Education should obtain an intimate knowledge of the conduct and results of the present emergency courses which are being aided under Circular 1598. Much guidance for the future might be obtained if the experience of those conducting these courses was pooled, analysed, and made generally available. A mass survey of the type of training essential, with the help of existing organizations already in touch with the country's youth, for example, the Central Council for Health Education and youth organizations, might well be initiated now.

The minimum age at which a man or woman should in normal circumstances take up full-time work must be carefully considered. Maturity is the essence of the problem when dealing with boys or girls or young men and women of 15–20 years of age who have reached, or are on the way to, economic and social independence. The psychological and social problems with which a leader has to deal differ profoundly from those which face a teacher in a primary school or even a secondary school. As a general rule, therefore, local education authorities and voluntary organizations should not appoint young men and women to full-time posts before the age of twenty-three.

Shorter courses of training are recommended for potential youth leaders who have already achieved knowledge and experience which is relevant to their personal life or to their professional competence as youth leaders. These will include university graduates, holders of social science diplomas, men and women who have had considerable practical experience as part-time youth leaders and wish to qualify for full-time work, and business or professional men and women who may be unfamiliar with the structure of society as it affects young people or who need some stimulus to the revival of his or her cultural interests. Save in exceptional circumstances, no course of training should be less than one year.

For some years after training, the youth leader—or teacher—would be expected to serve in the capacity for which he has been specifically trained. If, after some years of experience, a youth leader—or teacher—seeks to transfer to another part of the educational field, and is suitable, he should be enabled to do so. Since the course of training which is proposed for youth leaders is comparable in content, standards and length with that proposed for teachers, it is necessary that the salaries of youth leaders should be comparable with those of teachers, and that service as a youth leader should be pensionable. Transfer from one service to the other should be facilitated by the necessary linking of superannuation arrangements and the provision of suitable short courses of training.

During their training, youth leaders should not be segregated. If properly representative of the interests of youth, the area training authority, which the Committee recommends as the organization responsible for the training of teachers, is also the right body to plan and provide courses of training for youth leaders. The universities, technical colleges, schools of art and training colleges are all accustomed to the maintenance of standards in their own field, and they must see that in academic subjects, in social studies, in crafts and skills, the standards of youth service training are built up and maintained at a high level. The Committee further recommends that each area training authority should be adequately representative of youth organizations and should appoint a person qualified to direct such training for leaders in the youth service as the area is called upon to provide. The first five years of the training should be regarded as an experimental period and, for the time being, the Board of Education should recognize the appointment to full-time posts of those who have not been trained, but are deemed otherwise to be suitably equipped.

To return to the training of teachers for young people's colleges. If these colleges are not to be subordinated to the fluctuating needs of industry and commerce and to the frequently narrow requirements of the 'jobs' which young people are doing, the periods when the young people attend them must be regarded primarily as educational periods during which young people are also at work, finding their feet in industry, commerce, agriculture or domestic activities. Only if these periods are regarded as educational will the colleges develop into institutions calculated to inspire loyalty and affection from young people generally.

With this consideration in mind the Committee discusses the problem of the staffing of young people's colleges. It is estimated that the colleges will require the services of about twenty thousand teachers, involving, on the basis of one day's attendance a week,

a replenishment of about a thousand a year. How should they be recruited and how trained ?

Young people's colleges, some of which may be residential, will be self-contained institutions, each with its own staff. They will be full-time institutions with, for the most part, full-time staff, but providing for students who will attend only part-time, and that under compulsion. This situation will present many difficult problems of organization and will complicate the planning of courses of study and activity. The uniform characteristic of the students will be that they are at work earning their living, or, if not at work, living at home and elsewhere in a state of semi-independence compared with the restrictions imposed when they were in full-time attendance at school. This change of status must be taken into account in the staffing of young people's colleges, but, on the other hand, its significance should not be exaggerated.

For young people's colleges, particularly, specific arrangements should be made for entry to the teaching profession of those who have had experience in some other profession or occupation. A rich field of recruitment will be the Service men and women, who have been labouring under great difficulties and yet built up a scheme of adult education the elasticity and breadth of which Great Britain has not seen before. These men and women will be eminently suitable for young people's colleges. Local education authorities should see that their experience is used to the full.

But while the staffs of young people's colleges will need to be persons with a wider experience of the world than is usual among the main body of teachers, the colleges will also require teachers with good qualifications in English, history, science, music, art, physical training, etc., as well as highly qualified teachers of technological and commercial subjects. It would be unwise to regard the colleges as institutions in which there is no place for the teacher with normal secondary or other school experience, or as institutions which require a kind of music or physical education wholly different in character from that to be found in other types of school or college. The staffing needs of young people's colleges can be met only by mobility of staff throughout the whole educational system.

While the need for mobility among teachers is essential, it is also vitally important that a common field for their education and training be ensured in order to avoid the segregation of particular groups of persons in training. The area training service would again be the appropriate body to undertake the training of teachers for young people's colleges, for thus would mobility be made more practicable.

In examining the supply and training of youth leaders and of the service of teachers in young people's colleges, the McNair Committee has entered practically unexplored fields. The service of youth is a recent development, and, save for a few pioneering experiments, young people's colleges do not at present exist. Nevertheless, the extent of its recommendations leaves little doubt that, within its terms of reference, the Committee has done its work admirably.

RESEARCH ON THE PHOTOGRAPHIC PROCESS

The Theory of the Photographic Process

By Dr. C. E. Kenneth Mees. Pp. xi+1124. (New York : The Macmillan Company, 1942.) 60*s*. net.

DR. C. E. K. MEES, with the help of the Kodak Research Laboratories, has written a book that will be for many years the standard authority on the photographic process. His title describes the book as an account of the theory ; but theory is not conceived in a narrow sense as the counterpart of experiment, but rather as including almost everything about photography except its practice. The first chapters deal with the emulsions, what they are made of and how they are prepared ; the action of light is then described, the processes that take place in photographic materials under its influence and the large number of theories which has been advanced to account for them. Development and fixation are then discussed, again with the emphasis on the details of changes that take place in emulsions and on attempts to explain them in terms of physics and chemistry. There are further chapters on sensitometry, on the nature of the developed image and on the photographic aspects of sound recording. Finally an account is given of the use of dyestuffs for the production of colour-sensitive film, and for desensitization.

It is remarkable how the advance of physical science often leads to an understanding of the new and unfamiliar long before it can explain phenomena apparently more commonplace. For example, Clerk Maxwell's mathematical genius enabled him to predict the properties of electric waves before they were shown to exist, and as a result the theory and the practice of wireless transmission have advanced side by side, neither proceeding far in advance of the other. The progress of the science of electronics has been similar ; there was no great technical advance in the use of cathode rays before their nature was understood, nor in the use of photo-electricity before Einstein's law and the quantum theory gave it a theoretical background. In fact, in the wide field of electrical engineering, the very existence of which could not have been anticipated until the end of the eighteenth century, theory has at times been in advance of practice and seldom far behind it. On the other hand, some of the properties of inorganic matter which have been familiar to mankind for a very long time still somehow resist the attempts of theoretical physics to explain them. Outstanding is the problem of the nature of the liquid phase, and the fact that most solids melt ; while solids and gases present no particular mystery and allow their equations of state to be calculated from first principles, this is not true of liquids. More important are perhaps the problems relating to strength of materials, in particular of metals. The enormous body of knowledge on their mechanical properties and on how their hardness and ductility can be influenced has been gained without the help of any theory to show what arrangements of atoms in the materials are responsible for these properties. So great is our ignorance on the theoretical side that it is still possible for experts to argue as to whether an ideally perfect crystal would be very hard or very soft.

Photography, or rather the art of making and processing emulsions, has, in the last ten or twenty years, been emerging from the state in which the

science of mechanical strength is now and gaining a status similar to that of electronics. Dr. C. E. K. Mees' book, therefore, is very welcome at the present time, both as tracing the development of the subject in the days when there was no guiding theory and not much connexion between photographic theory and the rest of physics, and the present position when this is no longer true. The advance in the last few years has been that we now feel that it is 'only to be expected', taking into account what is known from other sources about the behaviour of halide salts, that an emulsion of silver bromide would be light-sensitive and retain a latent image which could be made visible by a reducing agent such as a developer.

The picture given in Dr. Mees' book of the formation of the latent image is now quite definite. Silver halides, in common with many other salts, decompose under the action of light, and metallic silver is formed as little lumps on the surface of the halide grain. After prolonged exposure these can be seen under the microscope, and can be shown by the methods of X-ray spectroscopy to have the same structure as silver in bulk; and much evidence is given to show that the latent image after normal exposure, though too small to be seen, is of the same nature; the number of atoms in each speck may be some tens or hundreds. Particularly interesting is the account given of the researches of Dr. S. E. Sheppard, who showed that in a sensitive emulsion the halide grains must have on the surface a number of specks of silver sulphide. These he called sensitivity specks, and their role is to concentrate the silver atoms formed by the action of the light. They are formed by the presence in suitable gelatines of organic sulphur compounds, due to the predilection of cattle for sulphur-bearing plants, such as mustard—a most fortunate accident. Rabbits do not share this taste, and gelatine from their tissues is inactive, so that, if it is used for the preparation of emulsions, a low sensitivity results.

As regards the mechanism by which light releases silver atoms from the halide crystals, and the way in which these atoms are concentrated in the sensitivity specks, the theory put forward by Dr. Gurney and the present reviewer is in the main accepted and some account is given of the experimental work based upon it which has been carried out by the Kodak Research Laboratories both in Great Britain and the United States. According to this theory, the action of the light is to make the halide grains photoconducting, as a result of which the sensitivity specks acquire a negative charge; they then build up a speck of metal by electrolytic conduction within the halide grain, the positively charged silver ions moving through it towards the negative charge. Particularly interesting experimental work has followed the suggestion that development takes place by the same process, the developer charging the silver specks negatively, and the silver moving towards the latent image through the body of the grain, so that the developed silver is pushed out of the grain in long threads. The electron microscope has enabled very beautiful pictures of the developed image to be taken which suggest that it must be formed in this way; the developed silver grain is not solid, but consists of a tangle of metallic threads between 100 and 1000 A. in diameter, which are held in the space occupied by the original grain simply by the action of the surrounding gelatine. Excellent examples of these photographs, with a magnification of 40,000–50,000, are shown on p. 312 of the book under review.

Interesting and gratifying though it is to see photography gaining the status of an exact science with a theory behind it, it is impossible not to be impressed with the achievements made before this was so, and also perhaps with the number of apparently fortuitous circumstances which have made this advance possible. It is now known that a very large number of metallic salts can be reduced photolytically in suitable circumstances; for example, alkali halides, if illuminated with a wave-length that they absorb and held at a temperature, about 400° C., at which they show ionic conductivity. However, to be useful photographically a metallic salt must absorb light in the visible part of the spectrum, must show ionic conductivity at room temperature, and must on reduction give a metallic residue that does not react with water or oxidize in air. It is fortunate that silver halides and a few other salts have all these properties. That a substance with the properties of gelatine exists seems even more fortunate; it has to be rigid enough when wet to hold the halide grain in position against the somewhat large disruptive forces that must occur during development, and yet be porous enough to allow the large molecules of the developer to pass freely through it. Moreover, it was extremely helpful, for the early production of sensitive emulsions, that it contained organic sulphur compounds capable of attacking the halide grains and forming the sensitivity specks.

It would be wrong to suggest that the science of photographic emulsions does not still contain many interesting problems awaiting solution; perhaps the action of sensitizing dyes is the most outstanding. Dr. Mees' work will be of service in bringing these problems to the notice of physicists and chemists outside the photographic industry, and showing them that the study of emulsions can be interesting and important as much for the information that it gives about the interaction between matter and light as for the influence that it has on the technical applications.

The present reviewer has taken a reviewer's freedom to deal in detail only with those parts of the book which interest him personally; an organic chemist or a sound engineer would naturally have chosen quite different parts, and any review of so comprehensive a work is bound to be somewhat one-sided. In fact, photography now covers a very wide field of science, and this is well brought out in the book.

N. F. MOTT.

MATHEMATICAL PHYSICS

Methoden der mathematischen Physik

Von Prof. R. Courant und Prof. D. Hilbert. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian under License No. A. 82.) Band 1. Zweite verbesserte Auflage. Pp. xv+469. 8 dollars. Band 2. Pp. xiv+549. 8 dollars. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1931–1937.) 2 vols., 14 dollars.

THESE two volumes are photo-lithoprints of the second edition of Vol. 1, issued in 1930, and Vol. 2, issued in 1937. The first volume contains seven chapters as follows: 1, the algebra of linear transformations and quadratic forms; 2, the development of an arbitrary function in series; 3, the theory of linear integral equations; 4, the basic principles of the calculus of variations; 5, the oscillation and eigenvalue problems of mathematical

physics; 6, application of the calculus of variations to eigenvalue problems; 7, special functions defined by eigenvalue problems.

The original design of writing this work arose from the observation that while mathematics had in the past received inspiration from the close relation which exists between analysis and the intuitive conceptions of physics, the source of this inspiration was tending to run dry. Analysis was becoming more and more an end in itself and the physicist tended more and more to estrange himself from an understanding of the problems and methods of the analyst. No doubt there were faults on both sides; indeed, it is largely true that mathematics tends to outstrip its applications and it is probably too much to ask the physicist to interest himself in those parts of a subject for which he can see no immediate applications. Nevertheless, one cannot remain blind to the fact that this forging ahead on the part of mathematics has served the physicist well, for example, in the development in the present century of the theory of relativity and of quantum theory.

However that may be, Courant saw in this growing estrangement a danger signal to both sciences, and he set about writing a book which should effect a reconciliation by helping the student and preparing the ground for the research worker. This is from every point of view a worthy aim and one which has been ably fulfilled by the presentation in one place of a clear and scholarly account of mathematical methods which appeal to the physicist for their applicability and to the mathematician for their rigour. Moreover, the bringing together of a well-chosen selection from original papers and other published work makes smooth the path of the student to an extent which anyone can appreciate who has had to delve for himself. The usefulness of the work is further enhanced by the attempt to make each chapter substantially independent, thus affording the opportunity of selecting just that topic on which the reader requires orientation.

The second volume is largely independent of the first in that it aims at a systematic treatment of partial differential equations in their relation to mathematical physics. This volume contains seven chapters as follows: 1, preliminary notions; 2, general theory of partial differential equations of the first order; 3, linear differential equations of higher order; 4, differential equations of elliptic type and potential theory; 5, differentials equations of hyperbolic type in two independent variables; 6, differential equations of hyperbolic type in more than two independent variables; 7, solution of boundary and eigenvalue problems by the calculus of variations.

In the first volume many particular problems are considered in which linear partial differentials of higher order are concerned. In the second volume a systematization is attempted with the object of making the subject more approachable.

In mathematical physics it is seldom that the totality of all solutions of a differential equation is required; even the finding of a special class of solutions is not the object. Rather the aim is usually to pick out one particular solution which is to satisfy relations laid down by the problem itself, initial conditions or boundary conditions. In this respect it is important to observe that boundary value problems and partial differential equations of elliptic type belong naturally together, while initial value problems belong to equations of hyperbolic type such as arise in connexion with oscillations and radiation.

From the point of view of mathematics a physical problem is only properly stated when the solution (1) exists, (2) is unique, and (3) depends continuously on the data, the condition of physical determinateness. Throughout this volume the above general considerations are kept clearly before the reader, the emphasis throughout being on the broad connexion of ideas. The last chapter is very interesting, for here the direct method of the modern calculus of variations is applied to establish the existence and uniqueness of the solution of equations of elliptic type. The principle here is to replace the boundary problem by a variation problem in which a function is sought which has the necessary properties of differentiability, and which renders the appropriate variation expression a minimum. It is not assumed that such a minimum exists, but a lower bound d certainly does. There then exists a sequence of functions which are admissible in the variation problem and for which the variation expression tends to d. This sequence of functions, called a minimal sequence, does not necessarily converge, nor, if it does, is the existence of the derivatives of the limit function evident. But it can be shown that it is possible from the minimal sequence to extract a subsequence defining a function which has the required properties of differentiability and which satisfies the differential equation.

L. M. MILNE-THOMSON.

METALLURGY IN EVERYDAY TERMS

Metals in the Service of Man

By Arthur Street and William Alexander. (Pelican Books, A.125.) Pp. 192+20 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*. net.

THE purpose of this admirable little work is abundantly fulfilled—that of bringing home to the general reader the importance which metallurgy now occupies in our industrial life. While serving this useful purpose it will, nevertheless, be read with delight by those who already have a wider knowledge of the subject. Although not putting forward a text-book, the authors have succeeded in overcoming the difficulties which are inherent in summarizing so broad a field and this in a manner and with an accuracy of statement to which academical exponents of the subject could take very little exception.

The great merit of the authors of this book is the simplicity of language used in an exposition of matters relating, more particularly, to the character, structure and behaviour in use, of metals and alloys. It has the quality and value of the spoken word rather than the more formal phraseology of the text-book. For this very reason it should be of particular interest to those who are faced with the introduction of this subject to students, and it is to be hoped that the authors may find time and opportunity to demonstrate still further their gifts of exposition for the benefit of those who need some guidance in framing elementary courses of instruction in these important matters. The authors must have derived considerable enjoyment from the compilation of this short account of 'metallurgy without tears', and in making apt use of homely similes with which to press home fundamental principles. Their friendly artist must have shared this enjoyment in devising his quaint and original illustrations, which are diverting and yet convincing.

S. W. SMITH.

Wave Filters

By Dr. L. C. Jackson. (Methuen's Monographs on Physical Subjects.) Pp. vii+107. (London: Methuen and Co., Ltd., 1944.) 4*s*. 6*d*. net.

THE wave filter is the fundamental necessity of all telecommunication work which is not simple telephony. Carrier-telephony and voice-frequency telegraphy, which enable us to pass tens or even hundreds of times the quantity of information the basic systems permit, could not exist without the wave filter. The basic theory dates only from Campbell some thirty years ago. Since then, Zobel, Shea, Starr, Cauer, and many others have derived alternative methods of approach and practical schemes for arriving at economic designs of filters which are to fulfil more exacting conditions of operation.

The incorporation of quartz crystal elements as lowly damped resonant circuits gave a new degree of freedom in design, and permits the union and separation of hundreds of telephonic channels on a single circuit. The attainment of electrical recording for gramophone disks, and the perfection in so far as it was possible in the so-called acoustic reproduction of records, both resulted from applying what had been solved for electrical circuits to mechanisms intended to operate over a wide range of frequency. Acoustic filters for attenuating specific frequency-bands also followed along the same lines.

The difficulty for a student approaching the subject is either the mass of information contained in the standard text-books, or the skeleton data provided in handbooks or in single chapters in texts on wider subjects of electrical communication or radio. The present author tries to meet the student by outlining the above-mentioned subjects, with just as much theory as will give the student confidence in using any of the great mass of formulæ available in the actual production of filters. The author does not treat at any length the usage of filters in practice, for example, the impedance conditions which are imposed when filters are used in parallel, or any special conditions imposed by the association of filters with modulators. In the space available in these excellent monographs, the author has presented the subject in concise and readable terms, and if there is nothing original, the assistance which he affords the student of filters is ample justification.

L. E. C. HUGHES.

The Subject Index to Periodicals, 1942

Issued by the Library Association. Pp. x+175. (London: Library Association, 1944.) 7*s*. net.

THE seventeenth volume of "The Subject Index to Periodicals" covers the year 1942 and presents no new features. It is compiled on the plan of the 'dictionary catalogue', articles being entered under specific headings in alphabetical order. The principle is not carried to inconvenient extremes; for example, articles on the individual vitamins are collected under vitamins and are not dispersed under their respective names, while cross-references play an important part in linking up related subjects. Explanatory matter in square brackets is often added where the titles do not sufficiently indicate the subject. The preparation of the "Index", as formerly, has largely depended on the vast resources of the British Museum, while from September 1940 until October 1943 the editor and his staff were accommodated in the National Library of Wales, Aberystwyth. With some important exceptions, including, for example, NATURE, *Engineering*, the *British Medical Journal*, periodicals covered by the *Agricultural Index*, *Engineering Abstracts*, *Index Medicus*, *Journal of the Royal Society of Arts*, *Petroleum Institute Abstracts*, *Photographic Abstracts*, *Science Abstracts*, *Journal of the Textile Institute* and the *Royal Meteorological Society Bibliographies* are not indexed; but scientific workers will find the "Index" a useful means of picking up signed articles on scientific subjects in leading general periodicals, as well as in tracing authoritative articles on a wide range of social and economic problems, education, reconstruction, etc., in the leading reviews and periodicals.

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 27, 1942. Pp. 546. (London: Society of Chemical Industry, 1943.)

THE progress of applied chemistry, as illustrated by publication during 1942, is summarized by this report, which conforms to the established pattern. The following fields are reviewed: general, plant and machinery; fuel; gas, destructive distillation, tar and tar products; mineral oils; intermediates and colouring matters; fibres, textiles and cellulose; pulp and paper; acids, alkalis, salts, etc.; glass; ceramics, refractories and cements; iron and steel; non-ferrous metals; electrochemical and electrometallurgical industries; fats, fatty oils and detergents; plastics; resins, drying oils, varnishes and paints; rubber; leather; soils and fertilizers; sugars and starches; the fermentation industries; foods; fine chemicals and medicinal substances; photographic materials and processes; sanitation and water purification.

Great activity in the direction of synthetic chemical production by the petroleum industry is noted. Magnesium at 1*s*. per lb. is, if measured by volume, cheaper than aluminium at 7½*d*. per lb., and its use in aircraft construction is substantial. With reference to the potentialities of the electrochemical and electrometallurgical industries, it is estimated that in the British Empire some 107 million horse-power of water-power is available, and that of this only about 6 per cent has yet been developed. Progress in the soilless culture of plants is briefly summarized, and this technique of commercial food production is considered to possess every prospect of success. The blackening of potatoes is attributed to hydrolysis of an iron complex which is said to result from growth in soil deficient in potassium but rich in nitrogen.

Health and Hygiene

A Comprehensive Study of Disease Prevention and Health Promotion. By Lloyd Ackerman. Pp. xii+895. (Lancaster, Pa.: Jaques Cattell Press, 1943.) 5 dollars.

THE scope of this book is very wide. In providing a guide to the layman for the proper regulation of his mental and physical life, the author runs riot from physiology to psychology with nothing missed in between. It is doubtful if anyone could ever plough his way entirely through to the end, although this would certainly be an enlightening task. As a book of reference, a modern 'home doctor', this one has much to recommend it. The advice is always sound and common sense, and the explanations are clear and simple. Teachers, medical men, or lecturers preparing talks on any branch of hygiene for youths or adults would find here much useful and relevant information.

FUNGI AND MODERN AFFAIRS*

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IT is a little surprising that fungi should have received so little consideration from academic botanists, for they are more numerous in species and in individuals than is the rest of the plant kingdom. They are classed in the vegetable kingdom, for with the old divisions, plants, animals and minerals, there is nowhere else for them. But they are not plants in the ordinary sense of the word as they have no chlorophyll and there is no evidence that they were derived from organisms so provided. A great amount of research has been carried out during the last half-century to ascertain the precise methods by which green plants build up carbohydrates; but comparatively little attention has been paid to the manifold and diverse physiological processes by which fungi obtain their nutriment. In their search for food, fungi play many parts in the drama of Nature and in modern affairs.

To many the word fungus conveys the idea of something mysterious or foreboding: to others mushrooms and toadstools. J. Bauhin appeared to combine the two ideas when he derived the word from *funus* (funeral) and *ago* (to put in motion), a derivation which John Ray considered appropriate even if possibly not correct.

What is a mushroom? The term is often loosely applied to those larger fungi which are edible, it being assumed that only the field mushroom and possibly one or more of its near allies are safe to eat; the rest, assumed to be poisonous, are grouped together as toadstools. But the assumption puts the facts the wrong way round, for there are less than a dozen species which are in any way poisonous; the vast majority are harmless. It would be illogical to speak of even the three hundred or more edible species as mushrooms and the others as toadstools; it seems preferable to call all agarics 'toadstools', restricting 'mushroom' for the species of the genus Psalliota: in this way, moreover, some of our insular and peculiar prejudice against them might be toned down.

Toadstools have been eaten from the earliest times. There is no reference to them in the Bible, but classical writers leave us in no doubt that fungi were well known as peculiar organisms of strange growth, so well known indeed that they were the subject of puns. Accidents sometimes occurred and, as these seem to be specially noted, it has been assumed by some that the use of fungi as food was regarded as too dangerous to be indulged in. What is more probable was that fungi were a common food, but accidents were especially noted because of the difficulty of distinguishing between wholesome and poisonous species. It was comparatively simple to get a knowledge of what plants and fruits are safe to eat for they are easy to recognize again, they are lasting, and, even if annual, they are constant in their time and place. Consequently they all had names. Fungi, on the other hand, are difficult to describe, and the fleshy ones are of irregular occurrence and of short duration. For this reason we find rules for distinguishing between edible and poisonous species rather than names and descriptions. Many of these rules are still current—'peeling', and the non-blackening of a silver spoon being the most widely believed, and this throughout Europe, possibly owing to them being repeated in the old herbals. All are utterly worthless, even dangerous. There is only one real test. Many have tried it, and as there are numerous records of experiments which ended in disaster, we have a mass of evidence which relieves us of the necessity of personal trial.

It is only in Great Britain that toadstools are rejected as food. Eighty years ago, five or six species were on sale in Covent Garden Market; but later only the mushroom, wild or cultivated, was displayed. It is hard to account for the British prejudice against them. It has been suggested that it is because of our high standard of living, or alternatively because of the absence of well-wooded country: but these do not explain the fear most people have of them.

In Continental countries with hard and long winters, fungi are dried and pickled and form a staple food while the frosts last; they also serve in place of meat during religious fasts. In all Continental countries fungi are sold in the markets, and many towns have special fungus markets. Usually there is some sort of control, and the number of species allowed to be sold varies from half a dozen to more than three hundred.

Though in Great Britain the chief use of toadstools is as appetizing additions to other dishes, they have a certain food value. There is need of more precise information on this, for many of the old analyses led to extravagant claims. Darwin recorded that the Terra del Fuegians eat no vegetable food except Cyttaria and a few berries, whereas Lettow-Vorbeck recounts that when, during the East African campaign of the War of 1914–18 the difficulties with food had reached a most embarrassing stage, the German troops were able to carry on owing to finding enormous quantities of edible fungi which were to them as manna was to the children of Israel.

There are a number of species which have always had a good reputation as edible, which moreover are easy to identify and which cannot readily be confused with any poisonous forms. For those not making a special study of the subject, it is advisable to learn to recognize some of these, rather than to experiment with others about which all that is known is that they are not among those regarded as poisonous.

The most deadly poisonous species is *Amanita phalloides* (including the two white varieties or closely allied species *A. verna* and *A. virosa*). It is responsible for practically all the recorded deaths from fungus poisoning and the death-rate is more than 50 per cent—indeed, it has been put as high as 90 per cent. There is a characteristic period of quiescence after the fungus is eaten, on an average twelve hours, though it may be as long as forty. Death may occur on the first day, but is usually on the third or fourth day. There are apparently four poisons contained in this species: Amanita hæmolysin (phallin), a glucoside readily destroyed by heat and digestive juices; Amanita toxin with a complicated and indefinite chemical structure; and according to the work of F. Lynen and U. Wieland (1937), phalloidin, which is quickly acting though destroyed by heat, and an additional slower-acting toxin. Death through eating the cooked fungus is apparently due to the heat-resistant Amanita toxin. Cures have been reported by the use of a 'sérum antiphalloidien' prepared at the Pasteur Institute; by intravenous injection with 20 per cent glucose solution; by intravenous injection with 10 per cent sodium chloride solution; by

* Substance of three lectures at the Royal Institution, delivered on February 15, 22 and 29.

administering the finely chopped up stomachs of three rabbits and the brains of seven.

Amanita mappa, formerly considered as very poisonous, is edible but not worth eating. *Amanita muscaria*, which contains muscarin, mycetoatropin and choline, does not cause death in healthy people. The symptoms of poisoning usually simulate alcoholic intoxication, though there are occasionally gastro-intestinal disturbances. *Amanita pantherina* produces similar symptoms.

The remaining species which are in any way dangerous, raw or cooked, are *Lepiota helveola*, *Entoloma lividum*, *Inocybe Patouillardi*, *Boletus Satanas* and *Gyromitra esculenta*, though some other species are very indigestible and consequently may cause disturbance.

Claviceps purpurea (ergot) is a poisonous fungus of another group. The two different types of ergotism, the convulsive and the gangrenous, are now well known. Five alkaloids have been isolated from ergot: ergotinine, ergotoxine, ergotamine, ergotaminine and ergometrine. As its name suggests, ergosterol was first extracted from ergot; histamine also. The use of ergot in childbirth is mentioned by Lonicer in 1582 in the first record of the fungus. At present ergot is the only fungus which figures in the British Pharmacopœia.

Fungi, being without chlorophyll, have a physiology which in many ways is more animal-like than plant-like. Obviously there are two main sources of food, living organisms and dead organic material. Fungi make use of both—they parasitize all kinds of living organisms, and there is no sort of organic matter not liable to attack. But though they are responsible for the greater part of plant diseases and they cause destruction to stored products of every kind, the changes they bring about are not all to our detriment as living organisms. They act as scavengers reducing dead material into substances available for plant life, and moreover prevent the cluttering up of the earth's surface. The action of soil fungi on plant material was overlooked when untreated jute sandbags were filled with sand and even ordinary earth at the outbreak of the present War. The modern compost heap is a contrivance to bring about the breaking down of similar cellulose substances.

Forest trees are subject to attack by larger fungi as well as by microscopic forms. Timber from such trees is unsuitable for most purposes and, moreover, if not properly seasoned, may continue to rot. Fallen logs and stumps have a characteristic flora, and several of the species occur on wooden fences, gate-posts and similar structures; *Lentinus lepideus*, for example, attacks wood pavement blocks, telegraph poles and railway sleepers.

If wood is to be preserved, it must be kept dry or treated with some fungicide. The chief agent of destruction of structural timber is *Merulius lacrymans*, the dry-rot fungus: there are other fungi causing dry rot, but the damage they produce is trivial. If timber is properly seasoned and then kept dry by ventilation so that it never contains as much as 20 per cent moisture, the fungus will not attack it; otherwise damage is almost certain. At the present time, the amount of dry rot in London calls for serious attention. It is easy to understand how houses which have been severely bombed are liable to have their timber affected, but blast has cracked water-pipes with a consequent seepage of water through the walls; leaves and other rubbish have caused overflows which run down the walls; shelters have been constructed so that ventilation and even water-courses have been interfered with; ventilation bricks have been stopped up to prevent entrance of gas; or sand-bags which became rain-sodden propped up against walls, often over air-bricks; houses left unattended, with no heat and leaky roofs; water-tanks and pipes bursting, water-taps left running in requisitioned buildings—all have played their part in bringing about a good deal of unnecessary waste. Furthermore, there is need for some scientific control over new housing plans or we shall have a repetition of the troubles which affected whole building estates after the War of 1914–18.

In addition to causing diseases of trees, microscopic fungi cause disease not only of crops but also of wild plants. The most striking point about the flora of bombed sites is the rapid appearance of special fungus parasites, as for example *Bremia Lactucæ* on groundsel. The idea that disease is a result of civilization is very attractive to some minds—but is entirely false.

Fungi are the main causal agents of disease in plants. The losses in different crops vary normally from 2 to 50 per cent: figures for the U.S.A. for wheat, oats and barley in 1935 due to rust alone were estimated at 277, 185 and 53 million bushels respectively. There are many ways of combating fungus attacks, the most obvious being the use of fungicides. Much depends upon having a thorough knowledge of the life-history of the parasite as well as that of the host plant, for then the fungus can be tackled at its most vulnerable stage.

Some varieties or races of plants are immune to the strain of fungus parasite common in the neighbourhood, and much work has been done in the attempt to breed immune races. But it is frequently overlooked that there is often as much variation in the parasite as in the host. Thus the problem of producing a wheat immune to black stem rust theoretically necessitates the building up of a resistance to 177 physiological races, though, practically, only the local strains present in any one area need be considered.

Less than a century ago, when the parasitic nature of many diseases was beginning to be suspected, fungi were thought to be responsible for many human affections. This was a consequence of Schoenlein's discovery in 1839 of the fungus causing favus, which was immediately followed by Lagenbeck's describing the fungus of thrush, and soon afterwards by Gruby's description of ringworm. With the gradual recognition of the predominance of bacterial diseases and the abundant problems they presented, mycology, except for the obvious dermatophytosis and actinomycosis, has not received the attention due to it, especially in Great Britain. Many of the ring-worm group are able to live parasitically on domestic animals; some are known to live saprophytically on organic debris and others have been reported as capable of infecting living plants. Athletes' toe (Trichophyton spp., Epidermophyton) has become increasingly common in Great Britain during the past few years and is prevalent in certain sections of the Fighting Services. But there are many less obvious diseases which have been studied principally in France and America. That they exist elsewhere is shown by the recent recognition of histoplasmosis (*Histoplasma capsulatum*) in Great Britain. The symptoms of this disease are protean; they may simulate kala azar or pulmonary tuberculosis—and

the prognosis is bad. A recent discovery by C. W. Emmons that small desert rodents constitute an important natural reservoir of *Coccidioides immitis*, the cause of coccidioidal granuloma, is of importance. This disease has been known for about half a century in North and South America and was thought to be soil-borne. The Medical Research Council has recently appointed a committee to report on the situation of medical mycology in Great Britain.

Animals other than those domesticated are also liable to fungal disease. Insects particularly are affected, whole groups of fungi being entomogenous; as, for example, the Laboulbeniales with about 120 genera and 1,500 species, so well monographed by Thaxter. Moreover, it has been shown recently by C. Dreschler that there are a number of species, Entomophthoraceæ and Hyphomycetes, which parasitize nematodes, amœbæ and other small soil inhabitants.

The extent of the damage by fungi to stored products of all kinds is only gradually being realized. The losses in textiles have received most attention and the investigations of the conditions in which cotton and wool become 'mildewed' are influencing the practices of manufacture. The methods of preserving foodstuffs—sterilization, canning, pickling and so on—are chiefly to prevent mould attack, though they also protect them from bacterial contamination.

The outward and visible sign of specific differences in fungi is morphological as in green plants and animals, but this should not mask the fact that a given species growing under definite conditions always acts in the same way and brings about the same results. Can we so harness any species that it will produce results useful to us? What has Nature herself done in this direction?

Armillaria mellea is a common toadstool which causes a good deal of disease in trees but is also able to live saprophytically. It spreads by means of rhizomorphs, strands of compacted mycelium which look somewhat like flattened, branched and anastomosing, black leather bootlaces. If these encounter potato tubers, they reduce them to mush in two or three days. On the other hand, if the rhizomorphs meet the tubers of the Japanese saprophytic orchid *Gastrodia elata*, they penetrate for only a certain distance and are then held in check. An uninfected tuber sends out a dropper and the process is repeated each year until a tuber is formed which is too small to grow. An infected tuber, however, sends out a dropper which produces an inflorescence the following year. It is obvious that the orchid obtains nutriment from the rhizomorphs, which presumably act as conducting strands. It may be that in some such reversal of parasitism we have a clue to the origin of the more typical mycorrhiza or fungus-root. Orchids are the classical example of obligate symbiosis, the seeds not normally germinating unless infected by the fungus present in certain cells of the roots. In modern methods of commercial orchid growing, either the seeds are infected artificially with the appropriate fungus, or its action is replaced by sowing sterilized seeds on a medium containing sugar.

Forest trees have a layer of fungal hyphæ surrounding many of the absorbing rootlets, the fungi concerned being mainly of the toadstool type. Many perennial plants also have mycorrhizas, but it is not yet certain which fungi are concerned: the usual appearance is suggestive of Phycomycetes. Similar associations with fungi occur throughout the plant kingdom.

The association of fungus and alga has resulted in the large homogeneous class Lichens.

Many insects have internal yeasts: indeed, these are supposed to have played a definite part in the evolution of some insect groups. A more obvious harnessing is that of the leaf-cutting ants of South America which, as first described by Bates and amply confirmed since, cultivate fungi of the toadstool type in their fungus gardens. An association in which the fungus seems to be less in subjection is that of bacteria and yeast which are active in various fermented drinks—Mexican tibi, koumiss, kephir, leben, tea cider, ginger-beer plant—some fermenting sugary liquids, others milk.

In addition to these combined masses, which are usually in the form of grains, man in his early history noted that fruit juices or other sugary fluids underwent a change if left for some time: honey-comb washings became mead, grape juice became wine. These much appreciated changes, the work of yeasts, were not to be left to blind chance, and in the course of centuries the conditions controlling the changes and finally the reason for them became known. Nowadays distillers, brewers, many wine growers and cider manufacturers no longer rely on some general supply or on casual wild yeasts, but maintain pure cultures of special strains of the appropriate species which have proved to give the best results in the conditions of production. Here we have the breaking down of organic matter by fungi to give a desired result. It must be stressed, however, that a fungus acts only in a certain way in definite circumstances.

Pasteur's classical researches on fermentation were a direct outcome of the misfortunes that befell France after the war of 1870. It is surprising how often an odd fact he mentioned more or less incidentally has been followed up by later investigations. Thus during the War of 1914–18, German scientific men turned their attention to Pasteur's observations that proteins could be synthesized by yeasts from inorganic nitrogen, including ammonium salts. The fact that yeast, including brewers' yeast, contains a high percentage of protein had long been known and attempts were made to utilize the surplus quantities from brewers until the production of beer was cut by 60 per cent. In 1915, Hayduck announced that he had discovered what he called 'mineral yeast', as a contaminant at a pressed yeast factory. This yeast, which is non-sporing and was afterwards called *Torula utilis*, gave much better yields of protein than did other yeasts and, moreover, produced little alcohol. A yeast product was put on the market, but large-scale production apparently could not be carried on because of lack of sugar.

With the outbreak of the present War, the possibility of a shortage of protein had to be faced, and the problem was allotted to A. C. Thaysen and his colleagues at the Chemical Research Laboratory. Eventually they decided that *Torula* (*Torulopsis*) *utilis* was most likely to prove satisfactory. As the situation developed, it was realized that the post-war feeding of ravaged Europe would be one of the major problems, and that for some time vitamin B deficiency would be an additional danger. An analysis of dried *Torula utilis* showed that as well as 45–50 per cent of a protein only slightly less nutritive than a good animal protein, this 'food yeast' contains the whole known range of water-soluble B vitamins. Further,

it mixes readily with water and with milk and can be used in all sorts of ways. Large-scale manufacture is to be carried out in Jamaica where molasses is abundant—200 gm. of molasses give 50–60 gm. of food yeast. The Colonial Development Fund has granted £150,000 for the erection of the plant and it is estimated that 'food yeast' can be marketed at 6*d*. per lb. Many other parts of the Empire are considering erecting plants for the benefit of the local population. It is understood that in Germany the yeast is again being used with hydrolysed wood as the source of sugar.

At Teddington, a strain of *T. utilis* was developed which will grow better at tropical temperatures than would the normal form. It gives a quicker yield and has less variability in size. Later, a giant strain (v. *major*) was produced by acting on the cells with camphor: the biochemical activities are identical, the variety is stable, its cells are more readily separable and its generative time is considerably less.

Another observation by Pasteur was that in ordinary yeast fermentation a small percentage of glycerine is always produced. During the War of 1914–18, the Germans were short of glycerol for making explosives. Neuberg, in 1911, had begun to publish his studies on the stages leading to alcohol formation by yeasts. When experimenting on aldehyde fixation with sodium sulphite, there was a large increase in the percentage of glycerol. Connstein and Lüdecke successfully applied this to large-scale production: many will remember the wild guesses that were made at the time concerning the source of the enemy's glycerine. They produced 1,000 tons a month by the method, the average yield being 20–25 per cent of the sugar used, and in addition large quantities of alcohol and acetaldehyde were obtained as by-products. It has been said that it enabled the Germans to carry on the war for another twelve months. The Americans, hearing that glycerine was being produced by yeasts, succeeded in devising a couple of similar processes. H. Raistrick and his colleagues, after 1918, used a modified sulphite process at Nobel's factory at Ardeer and increased the yields of glycerine in the fermentation liquor to 35–40 per cent of the weight of sugar fermented. Subsequent improvements in the methods of recovery of glycerine from the fermentation liquors have reduced the cost of fermentation glycerine to a figure comparable with that of soap lye glycerine.

One of Pasteur's statements, "We are convinced that a day will come when moulds will be utilised in certain industrial operations, on account of their power of destroying organic matter"*, in spite of its definiteness, was generally disregarded. However, his favourite pupil van Tieghem established the importance of moulds in the biochemical field. He investigated the method of production of gallic acid from heaps of vegetable matter containing tannin—gall nuts, sumach, tea, etc—watered and allowed to go mouldy. He showed in 1867 that the mould principally concerned is *Aspergillus niger*. The present-day method of production is to inoculate clear tannin extract with this fungus.

It was not until 1893 that the first real advance was made, when Wehmer described the production of citric acid by two species of Penicillium (Citromyces) grown in nutrient sucrose solutions containing calcium carbonate. It has been found that a number of moulds produce citric acid, but the one used on a commercial scale is *Aspergillus niger*. In 1922, Italy produced about 90 per cent of the world's supply of calcium citrate from citrous juices, but within eight years the export had practically stopped because of the commercial production by moulds—10,000,000 lb. annually in the U.S.A. alone. There is now an International Citric Acid Agreement.

The process is a surface fermentation of a nutrient sucrose solution, with a comparatively large amount of mineral acid which prevents the growth of bacteria and most moulds. The solution is seeded with spores of *Aspergillus niger*, and as these germinate the surface becomes covered with a frail pellicle which rapidly develops and, by the end of the fermentation (8–12 days), becomes a fairly thick and deeply intricately folded mat but still quite white. Most of the sugar has by then disappeared from the solution, its place being taken by citric acid practically unaccompanied by other organic acids: the solution is much more acid than good lemon juice. Some of the sugar, however, is converted into fungus starch and some into dextrin. The standard way to recover the citric acid from the fermented liquor is to add milk of lime and heat nearly to boiling point, then filter off the difficultly soluble calcium citrate and wash with hot water.

Another process in which *Aspergillus niger* is used is the production of gluconic acid, the calcium salt of which is of importance in pharmacy. Here the best results are obtained from well-aerated submerged growth, which is most economically accomplished by using rotatory drums.

Moulds are able to build up their normal cell constituents from an amazingly large and varied series of carbon compounds. Moreover, as seen with *Aspergillus niger*, the same species of mould, when growing in slightly different conditions, can produce different substances. Citric acid, oxalic acid, gluconic acid, ethyl alcohol and mannitol, which may be regarded as the breakdown products of the original sugars, are formed by many species.

There are, however, many substances which are built up by mould growth, and for the most part these are highly specific products of a single species, or of a few related species. The chief worker in this field has been Raistrick, who, following on his work on glycerol production, has been engaged with numerous collaborators in investigating the general biochemistry of moulds. The scheme followed has been to use glucose as the sole source of carbon in a synthetic culture medium—usually Czapek-Dox medium. In this long-continued and productive research, about a hundred substances previously unknown to science have been prepared and many of them synthesized. It may well be that some of these will be found useful in some way or other, but their present interest is chiefly in giving us a picture of what happens inside the cell. Mould pigments, simple quinones, polyhydroxy-anthraquinones and hydroxyxanthones, simple benzene compounds, chlorine-containing metabolic products, derivatives of tetronic acid (stimulants of bacterial growth), antibacterial and antifungal substances are included in the products*. It is a matter of phylogenetic interest that the lichen acid physcion (parietin) is formed by sixteen species or strains in the *Aspergillus glaucus* series.

To understand the magnitude of work of this kind one has to take into consideration that in a given

* "Studies on Fermentation". By L. Pasteur. English translation, 1879, p. 261. I am indebted to Dr. J. Yuill for directing my attention to this.

* A wide range of these special chemical compounds was exhibited.

species there are strains some of which are more active, some less; further, that the results differ according to the chemical constitution of the medium and the physical conditions of growth.

Ever since fungi and bacteria were grown on artificial media, it has been observed that in mixed cultures one organism may have no apparent effect on the growth of the other, or it may influence it either favourably or unfavourably. This favourable effect (synergism) may be considered as an aspect of symbiosis; the unfavourable (antagonism) as an aspect of the struggle for existence.

Antagonism is gradually becoming recognized as a factor in plant disease. The fungi which abound in the soil include some species which are able to become parasites and cause destructive root rots. Chemical and physical conditions of the soil determine the amount of a given species, but they also act on the other fungi present, one or more of which may have an antagonistic reaction towards the parasite. Thus the mould *Trichoderma viride*, common in the soil, has an antagonistic effect on the growth of the tree parasite *Armillaria mellea*.

The phenomenon of antagonism has been brought strikingly to public notice following an observation by A. Fleming in 1928. When studying the growth of Staphylococcus on solid media in Petri dishes, he noticed that the colonies underwent lysis in a zone surrounding a growth of Penicillium which contaminated one of his cultures. He grew the Penicillium in broth culture, and found that the filtrate was some two or three times as effective as pure carbolic acid in stopping the growth of Staphylococcus.

For convenience the name 'penicillin' was used in place of the rather cumbersome phrase 'mould-broth filtrate'. Fleming showed that penicillin had a specific action on certain bacteria (Staphylococcus, Streptococcus, Pneumococcus, Gonococcus and the diphtheria bacillus), but that others (*B. coli* and *B. influenzæ*) were not affected. The first practical application of penicillin was the isolation of the insensitive Pfeiffer's bacillus, which in the respiratory tract is usually associated with organisms highly sensitive to penicillin. But Fleming also stated that penicillin had no poisonous effect and that "it may be an efficient antiseptic for application to, or injection with, areas infected with penicillin-sensitive microbes". In 1931, he prophesied that "it is quite likely that it, or a chemical of a similar nature, will be used in the treatment of septic wounds". In the following year Raistrick and his collaborators grew the Penicillium (which Thom identified as *P. notatum*) in a synthetic medium consisting solely of glucose and inorganic salts, and defined the optimum conditions of growth. They acidified the medium slightly, extracted with ether, and on removal of the ether obtained the anti-bacterial substance in a crude form and to it restricted the name penicillin. It was found to be extremely labile. A very definite step had been taken* and sulphonamides were not yet discovered. It remained for H. W. Florey and his collaborators to reveal the outstanding therapeutic properties of penicillin. Florey worked first with lysozyme, another of Fleming's discoveries, and in the search for other anti-bacterial substances produced by micro-organisms, E. Chain and Florey turned their attention to penicillin. A culture of Fleming's fungus was obtained and the penicillin was extracted with amyl acetate. Shaking out the amyl acetate with a buffer solution and evaporating the buffer solution gave a substance which was at first thought to be pure penicillin because it proved to be so active. The results of the clinical trials published in 1940 showed that it possesses unique therapeutic properties which, moreover, because of its non-toxicity, make it of outstanding value in the treatment of war wounds. But the penicillin used in these chemical experiments was only about 1 per cent pure. Several workers here and in the U.S.A. are engaged on research in purifying penicillin; a crystalline sodium salt has been obtained which is substantially pure and is a hundred times more active than the first extractions. It is capable of inhibiting the growth of certain bacteria at a dilution of about 1 : 50,000,000. Penicillin is a complex acid of which the exact structure is not yet known.

Until recently, all the *Penicillin notatum* used, both in the laboratory and in large-scale manufacture, was from Fleming's original isolation. It was indeed a strange chance which led to the contamination of a laboratory culture by an apparently uncommon mould (originally described from decaying hyssop in Norway); and that the laboratory should be that of one who was curious in antibiotic phenomena and who, convinced of the value of his discovery, kept not only the original plate but also maintained the mould in culture. Further, it was fortunate that the original Oxford isolation of crude penicillin contained little if any toxic substances, with the result that Florey and the Oxford team were so soon able to announce almost undreamed-of achievements. This general freedom from association with harmful products incidentally has also characterized 'home-grown cultures' of penicillin.

Penicillin is the most active bacteriostatic substance so far known; but the difficulty of obtaining sufficient quantities and its unstable quality have led to the search for similar mould products, and has also stimulated general research. There are many such products known, but few are sufficiently non-toxic for use. Flavicin from *Aspergillus flavus* and gigantic acid from *A. giganteus* are most similar to penicillin in their chemical and biological properties.

Raistrick and his colleagues have tested many of the compounds they had isolated and all new substances which were obtained. The product of the fermentation of *Penicillium patulum* (originally isolated from sheep dung in France) was considered promising and was sent to W. E. Gye, who is studying the effects of various substances on cancer cells. As he was suffering from a cold, he used it on himself with most satisfactory results. Extended trials show that it is able to cure a promising number of cases of one form of the 'common cold'. It has since been shown that patulin is identical with clavacin and clavatin obtained from *Aspergillus clavatus*, and claviformin, from *Penicillium claviforme* and *Aspergillus giganteus*. It is not surprising that the same chemical substance should be formed by several fungi —indeed, this is what one would expect. What is of greater interest is that it is also produced by *Penicillium expansum*. Van Luijk in 1938, studying the diseases of grasses caused by species of Pythium, found a difference in plants grown in sterilized and non-sterilized soil. He isolated a number of fungi

* "Another point which shows what practical results may be expected from such research is that penicillin, a metabolism product of *Penicillium notatum* is non-irritant and non-toxic, but has a strong though differential antibacterial power." Presidential Address to Section K of the British Association, Ann. Rept. Brit. Assoc., 1936, p. 215.

from the soil and from the air and tested their influence on the growth of Pythium. He found that *Penicillium expansum* was the most markedly antibiotic, and adopting Fleming's procedure, obtained sterilized filtrates: these inhibited the growth of *Pythium debaryanum* at dilutions of 1 : 1,280. He did not isolate the antifungal substance, which Anslow, Raistrick and G. Smith (1943) have shown to be patulin. When the fungus was added to garden soil infected with Pythium, seedlings remained healthy instead of damping off.

Here we seem to have a linking up of different lines of research in such a way that we may expect considerable progress. The recognition of the chemical constitution of a substance produced by a common soil fungus which suppresses the growth of a plant pathogen suggests that greater precision may soon be given to many of the older observations on fungal antagonism of various kinds. Incidentally, it may also have some bearing on the question of natural compost versus chemical fertilizers. There is a difficulty in establishing the growth of antagonistic organisms in the soil; this can be done only by modifying the conditions, and an obvious way to do this is to add manure or compost which favour fungal growth. That the matter is not quite so simple as it appears at first sight, however, may be judged from the fact that Barnum in 1924 showed that the filtrate of cultures of *Penicillium expansum* caused wilting in certain herbaceous plants placed in it.

No more than mention can be made of the production by fungi of fats, ethyl alcohol, lactic acid, vitamins, and enzymes, or of the immense fermentation industries of the Orient.

PLASTICS AND ELECTRICAL TECHNOLOGY

PLASTICS and electrical technology are close allies on the industrial front, with many points of contact, and in recent years meetings have been arranged at which members of the two professions can exchange views and comments on recent developments of common interest. The latest meeting of this kind, arranged by the Plastics Group of the Society of Chemical Industry, was held at the Institution of Electrical Engineers on April 14, when the topics selected were the electrical properties of the newer thermoplastics, radio-frequency heating, and 'tracking'.

In opening the discussion, Mr. H. A. Nancarrow pointed out that in the pure hydrocarbon thermoplastics, poly-ethylene, poly-*iso*butylene and polystyrene, we have arrived at the almost perfect dielectric, in the sense that their power factors are almost vanishingly small, over the entire range of frequency and temperature encountered in electrical practice. In these materials we have the excellent qualities of pure paraffin wax associated with a wide range of mechanical qualities from great flexibility to brittleness. The power factors of the pure materials are, generally speaking, of the order of 0·0003. Much higher values are sometimes quoted, but they are usually due to impurities; either plasticizers added to facilitate extrusion or moulding of the material, or oxidation products, produced when the material has been overheated in air. These materials have made possible many developments in electrical communication at the highest frequencies, where even the smallest power factor, or power loss per cycle, may be very significant. At lower frequencies where higher power factors can be tolerated, thermoplastics like poly-vinyl chloride, which is doing valuable service as a rubber substitute in power cables, and polymethyl methacrylate, well known as 'Perspex', are being widely used. The power factors of these materials are of great scientific interest. They show the characteristic of all polar materials—a high maximum value at a particular frequency or periodic time corresponding with the relaxation time of the molecule. The work of Fuoss and other workers in America on the effect of plasticizers on this molecular relaxation was reviewed, but the discussion showed that though the spade work is progressing well, it has not yet reached the stage where important generalizations are possible.

In opening the discussion on the second topic, Dr. L. Hartshorn remarked that it has recently received a great deal of publicity under such very questionable terms as 'radiotronic' heating and 'heatronic' processes. These newly coined terms seem to be entirely unnecessary. The term 'radio-frequency heating' is satisfactory, but it includes eddy-current heating of metals at radio-frequencies, as well as that of plastics and other insulating materials by the process under discussion, which Dr. Hartshorn suggested should be called 'dielectric heating'. The meeting appeared to be prepared to accept the suggestion. The basic facts have long been known. Any solid or liquid insulating material placed near a conductor which is maintained at a high alternating voltage of high frequency becomes more or less hot. The heat is generated throughout the whole mass of the material, the rate of conversion of electrical energy into heat in any element of volume being proportional to the square of the electric field-strength in that element. The basic experimental facts were forced on the attention of radio engineers in the earliest days of high-power wireless transmitters: insulating supports frequently became so hot as to catch fire, and much research has been needed to discover materials like the pure hydrocarbons discussed by Mr. Nancarrow in which the development of heat is as small as possible, and those which will resist better the action of the heat that is developed. The new ceramic materials are of this class.

The idea of utilizing this generation of heat for industrial purposes seems to have originated in various quarters about fifteen years ago, though it has only quite recently been put into practice on any extensive scale. American patent literature from 1930 onwards describes various schemes for using dielectric heating for sterilizing milk and other foods, killing pests in plant bulbs, drying artificial sponges and tobacco, cementing plywood and safety glass, and leather soles on to shoes, and so on. At first sight it seems curious that the method is still a novelty in industry; no doubt economic factors as well as the technical difficulties have played their part here.

The importance of the process lies in the fact that it makes possible the rapid and uniform heating of thermal non-conductors of any thickness. In a large American plant stacks of plywood 1 ft. thick are said to be heated through a temperature range of 160° F. in five minutes, this rise of temperature being required for the setting of the urea-formaldehyde glues employed in the making of the plywood. The method has also proved valuable in the plastics

industry for the heating of moulding materials as a preliminary to moulding. The uniformly heated material flows better into the mould and gives a more uniform moulding than material heated by a contact method, while the rapid heating reduces the time required for the complete moulding process.

An attractive feature of the process is that it makes possible the selective heating of a mixture or composite structure. Thus in fields of a given strength and frequency, the rates of generation of heat in different materials are proportional to the product of their dielectric constant and power factor. The power factor of plate-glass is very small and almost invariable over the whole range of radio frequencies; that of cellulose acetate rises to a high value at a frequency of the order of 10 Mc./s. Thus if alternate layers of plate-glass and cellulose acetate are placed in a high-frequency electric field, the plastic will generate sufficient heat to be brought to the softening point while little heat is generated in the glass. The prospect of facilitating the manufacture of safety glass in this way is one of the most attractive features of dielectric heating.

Among plastics it seems likely that the process will be limited to materials which show an absorption band, that is, a more or less sharp maximum power factor in the radio-frequency range: other materials would require excessive voltages in order to generate sufficient heat. Thus the heat may be considered to originate in oscillations of the polar groups of the materials under the action of the alternating electric field. The question was raised: Is it possible that such heating at particular frequencies may be associated with special chemical activity, and therefore be of special value in processes like the curing of resins? There appears, however, to be no evidence to suggest that such processes are stimulated by an electric field and selective as to frequency.

The advantages that may be gained by dielectric heating are so great that it may well revolutionize many industrial processes. It is, however, necessary to recognize that it has its limitations. First, as a method of generating heat it is bound to be expensive. In order to get the energy into the form of a high-frequency electric field, it must go through various transformations: low-voltage A.C. to high-voltage A.C.; then to high-voltage D.C. via rectifiers; then via thermionic valves to the final form. Each transformation requires equipment which may be expensive, and valves being high-resistance generators necessarily involve considerable losses of energy. The result is that dielectric heating cannot compete with ordinary electric heating (conductor heating) or steam heating for processes in which these are effective and not unduly slow. There is also the difficulty of avoiding interference with radio communication. This can, of course, be done by adequate screening, but this adds to the cost and may limit the ease of operation of the process.

A more fundamental limitation arises from the fact that the conditions for uniform heating are not always easily realized, and when uneven heating occurs there may be a risk of damaging the material. There is no maximum temperature which cannot be exceeded, like that of the steam in steam heating. In certain conditions the process is an unstable one. Thus if, as is not uncommon, the dielectric constant and power factor of a material increase with rise of temperature, then the effect of a rise of temperature is to increase the rate of heating, so that the action is cumulative. If this occurs throughout the mass, it will become obvious and the voltage will be reduced either by the operator or automatically as the heating proceeds. But if it is local, it may be undetected since it is the interior of the material that is usually hottest. Obviously then the material to be heated must be carefully controlled as to its uniformity and dielectric properties. Uniform heating will then be obtained provided the electric field is uniform. This again is not always a simple matter. A uniform field can be obtained between two plane parallel electrodes large in comparison with their distance apart, but as the distance apart increases in relation to the size of the plates there is a concentration of field near the surface of the metal. Occasionally this may be useful in counteracting the cooling effect of the electrodes; but in other cases it is necessary to have an air gap between the material and the electrodes to avoid excessive heating of the surface layers.

There can be little doubt that the process will lead to important developments in plastics technology. The ability to heat large thicknesses uniformly makes possible the manufacture of laminated material such as is used for gear wheels in thicknesses previously unknown, and should make possible the production of thicker mouldings. The rapid jointing of materials like leather and fabrics with thermoplastic cements should be possible for sheets of any thickness, while the welding of thermoplastics of any thickness also becomes a possibility. The search for plastics of low power-factor which has had such striking successes in recent years may now be followed by one for materials of very high power-factor in some particular frequency range specially suited to dielectric heating.

The last subject discussed was the breakdown of insulating materials by the process technically known as 'tracking'. This is a localized, but progressive, charring, which, starting at one point, spreads more or less rapidly as a tree-like growth right across the surface of the insulator, finally short-circuiting it and carrying so much current that the insulator is destroyed by the heat generated. In opening the topic, Mr. E. Rushton explained that it is essentially a surface phenomenon, which only takes place on insulators which have been in service for some time, and only occurs in a humid atmosphere. That it is a surface phenomenon is shown by the fact that it can be to some extent prevented by coating the surface of the insulator with special varnishes, but there are the most diverse views as to the nature of the process, and correspondingly diverse opinions about suitable tests for the grading of materials for their tendency to fail by tracking.

It is generally agreed that the phenolic resins are on the whole more liable to fail in this way than urea resins, and it was stated that melamine resins are even better than urea ones in this respect; but it was suggested that the difference is more likely to be one of macro-structure than molecular constitution. The final stage of the process is clearly dependent on a heterogeneous surface structure; but how far this is characteristic of the resin itself and how far dependent on the chemical effect of surface moisture under the sustained voltage gradients in the surface is still a matter of conjecture. Stäger has described the process as analogous to the fatigue corrosion of metals, and dependent on the salt content of the materials, which gives rise to mobile ions in the films of water on the surface in a humid atmosphere. These ions moving under the action of the surface

voltage gradients lead to local deposits of salt and local concentrations of field strength, and therefore to local heating, which starts the formation of a conducting track of carbonized material. Once it has started it will inevitably travel down the voltage gradient, for it will behave like a pointed conductor at the tip of which there will always be a strong concentration of field strength and therefore local heating when the surface conductivity is appreciable.

Another view put forward was that tracking is always started by sparking over the surface, the steep voltage gradient required to produce a spark arising where the surface of the insulator becomes partially bridged by patches of relatively high conductivity, leaving narrow gaps of low conductivity to support an undue share of the total voltage. The conducting patches may arise from dirt or irregular wetting as the humidity rises.

Tracking can certainly be deliberately initiated by applying a high voltage and so causing sparks to pass over an insulating surface between electrodes with sharp edges, or alternatively by spraying the insulating surface with salt solution and so causing irregular wetting while a comparatively low voltage is applied; and these methods are used as rapid tests of the tendency of materials to break down by tracking. Their reliability as an index of performance in practice is not, however, universally conceded. A quick test would be of great practical importance in the development of 'anti-tracking' plastics, but a controlled procedure which will reproduce accurately the essential conditions will only be possible when the phenomenon is better understood.

Dr. Haefely somewhat ruefully summarized the immediate practical results of the meeting by saying that, as a manufacturer, he would, under present conditions, have to continue to make the best materials he could, to wait for apparatus for dielectric heating, and to design his electrodes so as to discourage the initiation of tracking.

L. HARTSHORN.

SCIENCE AND ART AT THE ROYAL ACADEMY, 1944

By DR. A. T. HOPWOOD
British Museum (Natural History)

IN 1942 I attempted[1] to explain what I understand art to be. Since some of my gossips later took me to task because neither beauty nor truth were mentioned, it may be well to point out that beauty is not essential to a work of art, and that truth is an ambiguous word often used to mean accurate representation.

Consider, for example, the numerous flower pieces in the present Royal Academy Exhibition; these range from highly finished coloured drawings to mere blobs of paint placed in such a way as to give the impression of flowers. A botanist or a gardener will probably prefer the former, since the flowers are easy to identify, and that makes for self-confidence in the observer, who feels that he understands what the painter is trying to do, though whether that feeling is justified is perhaps another matter. An artist, on the other hand, may well prefer the blobs; he thinks more in terms of harmonies, contrasts and design, and notices how the whole is enlivened by discreet touches of discordant colour, and how by proper emphasis the whole thing is made to hang together. In the popular sense of the word, only the first type of painting is true, whereas in fact both are true. Provided that this ambiguity is recognized, one is justified in the claim that truth is an essential component of art; but it was to avoid any misunderstanding that I spoke of intellectual honesty instead.

With so high a standard in the exhibits, the critic this year is fortunate in his lot. There are numerous items to which one would like to direct attention, but most of them are excluded by the title of this notice. Of those which remain, pride of place must be given to "Night Raid, 1941" by Richard Eurich (No. 710). Although it was painted "for the Nation's War Records", this work has about it a quality which lifts it above the competent journalism of the average war reporter. The canvas is full of incident, it tells not one story but many; the contrast between the hot fiery glow and the cold glare of the searchlights is admirably handled, but the hard white mount is not so well inspired. More than all these is a quality of innocence, as though the artist had approached his subject with the unspoilt mind of a child and recorded the night's events with a simple directness which more sophisticated minds would label primitive. "Antwerp" (No. 17) by the same artist is in a different mood; it was painted before the War began and is one of the Chantrey Bequest purchases; good picture though it is, "Night Raid" is better.

In so far as it is possible for one artist to steal the show, that has been done by A. R. Thomson. Look at his two pictures, "Apple Trees" (No. 97) and "Miss Joan Chapman" (No. 102), which hang a few feet apart in Gallery II. The trees really grow out of the grass; the spraying and the pruning may have been neglected, but the whole picture is redolent of the average farmer's orchard. In complete contrast is the relaxed body of the dancer, whose weight is taken down well and truly to the right foot. Then go round the corner and read the character of the chairman of the London County Council in his portrait (No. 224), and, finally, look at the young airmen having a happy night in the mess before "Going to be Decorated" (No. 754). Such versatility does not appear very often.

As for the purely scientific aspects of the Exhibition, the anatomist should enjoy the portrait of Miss Chapman just mentioned, and medical men Nos. 292 and 746—the titles are too long to quote. The portrait of Sir Henry Dale by Francis Dodd (No. 140) is not convincing, and that of Sir John Russell by Francis Hodge (No. 335) is irritating because the direction of the sitter's gaze, towards the bottom left corner of the frame, continually leads one's eyes away from the centre of the picture and distracts the attention. Here, too, may be mentioned Francis Dodd's charcoal drawing of Sir Charles Sherrington (No. 977) and Alfred Hardiman's bronze, "Study of a Scientist" (No. 1177).

Zoological subjects are few; most of them are horses which, apart from those by A. J. Munnings, P.R.A., are not particularly good. The best is the group to the right of the centre in Munnings' "Winter Meeting" (No. 17). Not only does the necessary foreshortening pose a difficult problem in perspective, but also the design made by the animal's feet is well-conceived; moreover, the horse and its rider are full of life and motion. One of the most curious

paintings is "Bringing up the Horses" by James Bateman (No. 169), in which the dark horse is so good whereas the grey is a pantomime 'prop'. In the Sculpture Gallery, "Shire Horse" by Barbara Waller (No. 1237) is conventional, but still a Shire. "Gazelle" by Alfred Oakley (No. 1243) is also conventional, with horn-buds more closely resembling those of the red deer than those of a gazelle.

Since the entomologist rarely has anything of his own, he may care to look at "Butterfly Tree" by Constance Stallard (No. 867). Neither the butterflies nor the shrub will cause him any difficulty.

Among the pictures of birds are, "Chinese Geese" by Jessie Hodge (No. 566), "Solway Company" (No. 900), "Geese and Mallow" (No. 903), and "The Covey" (No. 904), these last by C. F. Tunnicliffe. All four are illustrative of the difficulty of dealing with pictures of 'scientific interest', for they are so close to Nature that the slightly conventional drawing and not quite accurate colouring are apt to be disturbing rather than sympathetic. That painters approve of them is shown by the fact that Mr. Tunnicliffe's drawings have been purchased out of the Stott Fund, whence one may conclude that the fault lies with the critic and not with the artist.

Another type of problem is afforded by the work of Sidney Lee. This artist's favourite colouring, which inevitably brings to mind the old jingle "Greenery yallery, Grosvenor Gallery", is admirably suited to work in the Pennines—"Over the Hills" (No. 138)—but it does not carry conviction elsewhere, even when, as in "Thun" (No. 109), it is used with caution. Algernon Newton seems to have a similar difficulty: his canal scenes are among the very best of their kind, but when he tries to render "A Yorkshire Landscape" (No. 488) or "September" (No. 483) with the same palette the results are deplorable.

Much good work is to be found in the room devoted to black and white, including a number of architectural subjects. The fact that duplicate prints are often obtainable, with a corresponding increase in the number of red stars on the frame, enables one to estimate the public taste. This year the very attractive "Jenny Wren" by Winifred Austen (No. 1055) is without doubt the most popular.

The Architectural Room is dominated by the immense "Plan of London Communications" which ought to have a special note to itself. Suffice it to say here that, by an ingenious planning of the roundabouts, pedestrian, slow and fast traffic are all kept apart and that, to quote its authors, "the leisurely and carefree conditions of the old market place have been restored, though developed and improved to suit modern life". From the market place one's thoughts turn naturally to the home, only to be disappointed. Two years ago I protested against some houses designed for erection in the Wirral. Since then they have been built and photographed, and their photograph hangs on the Academy wall (No. 1106), to prove that for depressing ugliness there is nothing to surpass them in the back streets of Manchester or Leeds. To the various authors of these and other plans (Nos. 1098, 1102, 1111, 1117) may be recommended the wise words of the Royal Academy Planning Committee, "It is important to avoid the mechanistic character of extreme modernism, with its soulless or even frightening aspect of the merely functional. A more human and friendly character is required for the surrounding scene of the people's life and business."

[1] NATURE, 149, 603 (1942).

OBITUARIES

Dr. C. B. Davenport

DR. C. B. DAVENPORT, who died on February 18 at the age of seventy-seven, was one of the pioneers of genetics in the United States. He was born at Stamford, Connecticut, in 1866, and graduated from Brooklyn Polytechnic at the age of twenty. From then until 1899 he was associated, in various capacities, with the Zoology School at Harvard. In 1899 he moved to Chicago, only to return east in 1904 on his appointment as director of the Carnegie Institution Station at Cold Spring Harbor. It is in connexion with this Station that Davenport will be mainly remembered, for he remained there some thirty years until his retirement, and left it occupying the position of one of the leading centres of genetical research in the world.

An interest in natural variation developed early, and in 1899 we find Davenport publishing a small book, "Statistical Methods", where he outlined the biometrical approach to the collection and analysis of data on variation. With the rediscovery of Mendelism, however, fresh possibilities opened up and he began extensive investigations along these new lines using a variety of animals, especially poultry. The poultry experiments demonstrated Mendelian inheritance for many characters, though with complications in some cases. The results were published largely in the form of two extensive papers, dated 1906 and 1909, in the Carnegie Institution series. It is of interest to note that in the 1906 publication data are reported, from the F_2 of a cross between single-combed Black Minorca and white-crested Black Polish fowls, which supply evidence of linkage between the gene for crest and cerebral hernia on one hand and that for split and reduced comb on the other.

The application of genetics to man also attracted Davenport's attention, and in 1911 he published "Heredity in Relation to Eugenics". In this book is discussed the inheritance of a great variety of human traits from eye-colour, hæmophilia and cancer to insanity, criminality and pauperism. The hereditary aspect is brought out in all cases, though only in some of them do the data indicate a simple type of inheritance. The implications of these findings are discussed at some length in relation to migration (then a most active problem in the United States), sterilization, segregation of the unfit and so on. This interest in human heredity loomed even larger in Davenport's later work, when we find him writing on sex-linkage in man, the inheritance of twinning, the genetical factor in endemic goitre, crime in relation to heredity and other topics of the kind. His interest in the biometrical technique seems also to have at least partially revived in later years.

Davenport occupied a prominent position in contemporary American biology. He was a member of the National Academy of Sciences and served on the editorial boards of a number of scientific journals, notably *Genetics* and the *Journal of Experimental Zoology*. Of the many societies and associations to which he belonged those concerned with eugenical questions form a large part, and his work in this field was appropriately recognized in 1932 when he was made president of the Third International Congress of Eugenics, held in New York.

K. MATHER.

Prof. W. M. Thornton, O.B.E.

WILLIAM MANDELL THORNTON was born in Liverpool in 1870 and had his schooling at the Liverpool Institute. After eight years of practical work with an engineering firm he entered the University College (now the University) of Liverpool, where he worked under Lodge and Carey and graduated in the honours schools of physics and engineering. He was senior lecturer in engineering in the University of Bristol during 1896–98, lecturer in electrical engineering in Armstrong College (now King's College), Newcastle upon Tyne, from 1898, and was appointed to the chair of electrical engineering when this was inaugurated in 1906. On retiring from the chair in 1937, he was elected professor emeritus of the University of Durham.

Thornton took a lively interest in the work of the Tyneside engineers and was elected chairman of the North Eastern Centre of the Institution of Electrical Engineers for the year 1905–6 and again for 1921–22. He was president of the Association of Mining Electrical Engineers in 1920–21 and president of the Institution of Electrical Engineers in 1934–35. In 1920 he was decorated with the Order of the British Empire, and more recently the Greenwell Gold Medal was conferred upon him by the North of England Institution of Mining and Mechanical Engineers for his researches on gaseous and dust explosions in mines.

An account of Thornton's achievements is an indication of the scope and fervour of his mind; so too are some ninety original papers which he contributed to the scientific and engineering journals. His thought moved naturally in terms of physics and mathematics, but his early training taught him to understand the problems of practising engineers; and his great humanity made him eager for the vigorous growth of applied science. His research on gaseous and dust explosions, the work for which he is perhaps most widely known, had its inspiration in a visit which he paid to a colliery where an explosion had occurred. The damage and injury which he saw made an impression which was never obliterated. He described his feelings recently when speaking of it—"Surely we should be able to prevent this". The work he extended later at the suggestion of the Institution of Electrical Engineers and the Medical Research Council with the object of increasing the safety in operating theatres where ether is used as an anæsthetic.

Thornton also investigated with enthusiasm the problems of high-voltage measurement, the operation and design of electrical machines, the theory of dielectrics and the electrical conductivity of bacteria. During his last illness he looked forward constantly to his return to the laboratory.

It is not surprising that as a teacher Thornton could bring to his students the feeling that new discoveries were always within their reach, and, guided by him, undergraduate and postgraduate investigation flourished. His zest for research and his delight in discovery were at once apparent; you went further and knew that the happiness which he communicated arose from something deeper than an untiring intellectual appetite, and that in him the whole man was happy because grounded upon a confident faith.

In spite of his many preoccupations Thornton was always accessible: always ready to listen and understand. All who knew him were proud to feel themselves his friends. "Few, in general estimation, are sincerely praised: few can evoke both wide and deep affection." Of these few Thornton was one.

J. C. PRESCOTT.

Dr. E. C. Scott Dickson

DR. E. C. SCOTT DICKSON, senior lecturer in physics in the University of Manchester, died at his home in Manchester on April 8.

Younger son of Lord Scott Dickson and nephew (by marriage) of Sir James Dewar, Dickson was born at Edinburgh in 1888. He was educated at Edinburgh Academy and Trinity College, Cambridge, where he took the Natural Sciences Tripos. Later he proceeded to the University of Bonn, and worked under Prof. Kayser for two years, taking a Ph.D. degree for research on the ultra-violet fluorescence of the benzols. In 1913 he was appointed demonstrator in physics in the University of Toronto. During the War of 1914–18 he served in India and in Mesopotamia with a battalion of the Highland Light Infantry.

In 1919 Dickson was appointed to a lectureship in physics in the University of Manchester, and continued his work there under Prof. W. L. Bragg and later Prof. P. M. S. Blackett until his death.

During his earlier years at Manchester, Dickson took part in the research work on crystal structure problems under Bragg. But his chief work in Manchester, for which he will be remembered, was as a physics teacher particularly of elementary students. In recent years he had charge of the physics teaching of medical students, and he organized this with characteristic thoroughness and keenness. He gave much time and thought to their interests and was always on the look-out for new ways of interesting medical students in physics and its applications to medicine. Apart from being an able physicist, Dickson had a very wide range of interests. He was exceptionally keen on music. During his student days in Germany he studied singing seriously with an intimate friend of Brahms. At Manchester he took particular delight in giving a special course of lectures on acoustics to a small group of students preparing for the Mus. Bac. degree. He was interested in all the arts and convinced of the value of classics in education, even for scientific men.

On the routine side of the work of the University, Dickson was a valuable member of the Faculty of Science and of the Faculty of Music. His loss will be particularly keenly felt during the period of reconstruction after the War, when such an experienced and wise university teacher and administrator as was Dickson would have rendered invaluable service.

J. M. NUTTALL.

WE regret to announce the following deaths:

Prof. W. E. H. Berwick, emeritus professor of mathematics in the University College of North Wales, Bangor, on May 13, aged fifty-five.

Mr. H. N. Dixon, the distinguished bryologist, on May 9, aged eighty-three.

Prof. Edward B. Mathews, emeritus professor of mineralogy and petrography at the Johns Hopkins University, on February 4, aged seventy-four.

Lieut. G. B. Wilson, information officer, South African Army, formerly director of the Rhodes-Livingstone Institute of Anthropology, Northern Rhodesia, aged thirty-five.

NEWS and VIEWS

Regius Chair of Zoology, Glasgow: Prof. C. M. Yonge

PROF. C. M. YONGE, professor of zoology in the University of Bristol, whose appointment as regius professor of zoology in the University of Glasgow is announced, is one of the most distinguished of the younger British zoologists. Receiving his early training at the University of Edinburgh, he has devoted himself for the last twenty years to the study of the interrelated physiology and morphology of marine animals, especially corals, molluscs and crustaceans. Beginning with his memoirs on the physiology of digestion in Mya (1923), Nephrops (1924) and Ostrea (1926), he has published a long series of admirable papers on the functional morphology of the Mollusca, and later on the remarkable functions of chitin and cuticle in the Crustacea, in relation to moulting and oviposition. His work on corals and their enclosed zooxanthellæ dates from his participation as leader in the Great Barrier Reef Expedition during 1928–29, and was later continued at the Tortugas Laboratory of the Carnegie Institution. In all these studies, his interest has lain in function and adaptation, in the activities of the living animal in relation to its structure and its environment, and he has been at pains to link up physiological and morphological facts. He takes a biological, rather than a physiological or morphological, view of the living animal, thus adding greatly to the significance and interest of his results. In the course of his studies he has travelled widely, visiting many of the principal marine biological stations throughout the world.

In addition to his scientific papers, Prof. Yonge published in 1930 "A Year on the Great Barrier Reef", and collaborated with Mr. F. S. Russell in "The Seas", a fascinating introduction to marine biology. He is an active member of the Development Commission's Advisory Committee on Fishery Research and of the recently appointed Committee on Post-War Fishery Research. While professor of zoology at the University of Bristol, a post which he has filled since 1933, he has been successful in stimulating research by his staff and students, promoting in recent years a co-operative study of the biology of the Bristol Channel. There is no doubt that he will be equally successful at Glasgow, especially with the facilities of the Millport Marine Biological Station close at hand.

Medical Services for India

FOR his address delivered at the Founder's Day Celebrations of the Lady Hardinge Medical College for Women, New Delhi, on March 17, Major-General J. B. Hance, director-general of the Indian Medical Service, took as his subject the need in India for a rapid and wide development of medical services, and he discussed the part which women will play in it. His address may be compared with Dr. Krishnan's presidential address to the Section of Medical and Veterinary Sciences at the Indian Science Congress held in January (see p. 658 of this issue). There is now, said General Hance, complete agreement throughout the world that health is a basic human right. Outlining the conditions required for 'positive health', he said that it is the goal of Indian medicine to provide these for every man, woman and child in India. The task is, as he and Dr. Krishnan clearly show, a formidable one; but it is no less evident that no responsible authority in India is going to shrink from it. The basis of the effort must be, General Hance emphasized, not this or that political philosophy, but "the united and indomitable will of the whole people to place their country on the map of modern civilised progress". Like Dr. Krishnan, he referred to the medical progress made in the U.S.S.R. during the last twenty years and he insisted that this has not been due to the Marxian philosophy, but to the united will of the Russian people. Nor need the cost of the effort required be a deterrent, for Lord Keynes and Prof. A. V. Hill, secretary of the Royal Society, have both reminded us that money is the servant and not the master of policy. The Allied war policy has proved that this can be so, for, if money had governed the prosecution of this War, hostilities would have ended long ago in the victory of the immensely superior financial resources of the Allies.

Certainly the figures quoted by both General Hance and Dr. Krishnan prove that India's medical needs are great and urgent. A nation should have, General Hance said, a minimum of one doctor to every 1,500 of the population. The United Kingdom has one to every 1,000. India has one to every 10,000; it has 40,000 registered doctors to-day and requires 300,000. A similar need of nurses, health visitors, midwives, pharmacists and dentists indicates the magnitude of the task which faces Indian medical education, and this is only part of the whole problem. General Hance stressed the need for emphasis on preventive and social medicine. Tuberculosis is an urgent special problem in India as elsewhere, and half a million beds are required for tuberculous Indians, at least half of whom are women. The care of the blind, of whom there are some two and a half million in India, is another great task. Industrial medicine will become more and more important in India with the increasing pace of industrial expansion. Research and teaching are also essential and must be carefully developed and fostered. For all these tasks the services of medical women will be required and for some of them they are essential. There is a great and inspiring future for the young medical men and women of India to contemplate. There are, as General Hance said, many eager and capable hands reaching out to take up the torch handed on by their elders. They will, as they look out from India over land and sea, be inspired by the similar noble work being done by their fellow workers near at hand in the U.S.S.R. and China and farther away in the Americas. The busiest of them all in the next decade will be those who must work in the suffering lands of a Europe freed at last from famine and war.

Institute for the Study of Animal Behaviour

AT a meeting of the Council of the Institute for the Study of Animal Behaviour held on April 20 two new members of Council were co-opted. The full Council is now: Dr. E. S. Russell (*president*), Dr. R. J. Bartlett, Dr. R. W. Douglas, Dr. J. T. Edwards, Mr. James Fisher, Dr. E. Hindle, Dr. Julian S. Huxley, Mr. F. B. Kirkman (*hon. treasurer*), Dr. W. H. Thorpe, Dr. Arthur Walton, Mr. Alastair N. Worden (*hon. secretary*), and Prof. S. Zuckerman. Arrangements were made to publish a new number of the *Bulletin of Animal Behaviour*, and speakers were chosen for the joint meeting to be held with the Royal Society of Medicine (Section of Comparative Medicine) on June 21, as follows: Dr. C. S.

Myers (instinct), Dr. W. H. Thorpe (learning processes in animals), Dr. F. B. Kirkman (bird behaviour), Prof. D. B. Johnstone-Wallace (grazing habits of beef cattle), and Dr. Arthur Walton (comparative sexual behaviour in the male). It was agreed also that Prof. Samson Wright and other psychiatrists should be invited to speak at this or a succeeding meeting. Future research projects were discussed, especially those in the veterinary field; for example, the individual behaviour of various domestic species, the grazing habits of sheep and cattle, and the utilization of behaviour reactions in supplementing clinical, pathological and biochemical studies of domestic mammals. Certain ornithological studies, suitable for members, were also discussed. It was decided to circulate these projects at an early date. Consideration was given to the matter of research grants, and it was agreed to take steps to try to secure funds for specific observational studies involving domestic animals. Membership of the Institute is open to all interested persons. The annual subscription (12*s.* 6*d.*) includes payment for the *Bulletin of Animal Behaviour*. Communications should be addressed to the Hon. Secretary, Institute for the Study of Animal Behaviour, c/o Zoological Society of London, Regent's Park, N.W.8.

The War-time Social Survey

A PAPER on the "War-time Social Survey" was read at a meeting of the Royal Statistical Society on May 16 by Kathleen Box and Geoffrey Thomas. The War-time Social Survey is the Government social research unit, and has been set up to provide any department with information, needed for the planning and administration of policy, which is not available from other sources. It is concerned with social problems, in the investigation of which it aims at establishing facts and attitudes of the public towards these facts. The method used to achieve these ends may be described briefly as interviewing samples of the general public, or of particular sections of the general public, with a recording schedule devised so that the results of the inquiries made can be expressed statistically. Investigations are carried out by fifty-five trained fieldworkers, all women. The reception accorded to fieldworkers suggests that the public is ready to appreciate the importance of such inquiries and to give all possible help. The proportion of people eventually refusing to be interviewed is about 0·5 per cent in most inquiries. The Survey has had to rely very largely on devising its own techniques for different occasions as they arose. The experience gained by other workers in the field of social research, both in Great Britain and in the United States, has been used, and most members of the research staff, coming as they do from different organizations which have been doing allied work for many years, have had different contributions to make.

The Survey can provide a closer link between the administrator and administered than is normally possible, particularly in relation to the preparation and interpretation of departmental statistics. In each Department of State there has been a large amount of unco-ordinated statistics related to very limited aspects of the department's work. By the extension of the survey method such obstacles can be overcome. Thus the data which it is most convenient for a department to obtain by a return can be supplemented in many ways by sample inquiries and thus assist in making decisions of policy. In this way a most flexible instrument for the compilation of a wide range of statistics can be developed. At the same time each department can remain in close touch with the collection of data, since the Survey normally discusses an inquiry in great detail with the officers concerned before it goes into the field. The experience of the Survey has shown during the past two years that its work has satisfied a real need for a specialist body able to advise on aspects of social inquiry which go beyond the official return, and there is little reason to suppose that this need will disappear when the War comes to an end.

Illuminating Engineering Society

THE annual report for the past year of the Illuminating Engineering Society, presented at the annual meeting held on May 9, directs attention to the formation of new centres in Bath and Bristol, and new groups in Derby, Huddersfield and Stockton-on-Tees. The Society is now organizing its activities through seven distinct areas, each with its own committee which in turn is represented on the areas joint committee. 243 new members have been added to the Society during the past year; the number of meetings held, upwards of sixty, exceeds that in pre-war days. Recent educational efforts include the organization of essay competitions for pupils in schools near Birmingham, and the giving of a series of Christmas lectures on "The Wonders of Lighting" to more than a thousand children in Bradford. The Society has been instrumental in forming a joint committee, with which leading physiologists are associated, to deal with the physiology of vision, and has completed, for the Ministry of War Transport, a special investigation into the brightness and legibility of traffic signs. Three of the series of illustrated lighting reconstruction pamphlets, dealing respectively with "Principles of Good Lighting", "The Lighting of Schools" and "The Lighting of Public Buildings" have recently been issued. The following officers have been elected for the present session: *President*, Mr. E. Stroud; *Hon. Treasurer*, Mr. N. V. Everton; *Hon. Secretary*, Mr. J. S. Dow.

Early Medical Books at Edinburgh

To illustrate a current series of lectures by Dr. Douglas Guthrie on "The Historical Background to Modern Medicine", there has been placed on view a collection of early printed medical books in the Upper Library Hall of the University of Edinburgh. Founded in 1580 as a "Town's Library" three years before the foundation of the University, or "Town's College", the University Library remained the only public library in Edinburgh until the establishment of the Advocates' Library a hundred years later. Naturally it contains many treasures, including a number of works of medical interest from which the present selection has been made. The most important and valuable items in the exhibition are Vesalius's "De Corporis Humani Fabrica" and Harvey's "De Motu Cordis". The beautifully bound copy of the former is the first edition, from the press of Oporinus of Basel, 1543. Beside it lies the fine two-volume edition, printed at Leyden in 1725 by Boerhaave and Albinus. The first edition of Harvey's account of the circulation of the blood is now an extremely rare little book, dated from Frankfurt, 1628. Visitors to the exhibition will have the opportunity of seeing two perfect copies, one of which belonged to Alexander Monro, the third of the dynasty of professors

of anatomy of that name. The first Alexander Monro, when appointed to the chair in 1720, kept a list of his students which is now shown, as also is a printed copy of the first thesis to be presented for the degree of M.D., Edinburgh. It is entitled "De Dolore", by John Monteith, and the date is 1726. Later works on view are the second edition (1800) of Edward Jenner's "Inquiry into the causes and effects of variolae vaccinae", the first British edition of Beaumont's "Experiments and Observations on the gastric juice, etc." (1838), Morton's "Remarks on the mode of administering ether" (1847), and J. Y. Simpson's "Account of a new anaesthetic agent" (chloroform) (1847). Another landmark of medical literature is Lister's "Introductory Lecture", delivered in 1869 when he succeeded James Syme in the chair of clinical surgery at Edinburgh, and with it may be seen a manuscript set of notes of Lister's lectures, in the writing of one of his most distinguished students and successors, Prof. Caird. A feature of the exhibition, and the most spectacular item, is a fine collection of illustrated herbals, including a magnificent copy of "De Historia Stirpium", by Leonard Fuchs, dated 1542, with coloured wood-cuts, and a catalogue of the Physic Garden of Edinburgh (1683), by the first professor of botany, James Sutherland. The exhibition, which has been arranged through the kindness of Dr. L. W. Sharp and the Library Committee of the University, will remain open until June 3.

Rhinology and Folk-Lore

IN a recent paper (*J. Laryng. and Otol.*, 57, 272; 1943) on this subject, Dr. J. D. Rolleston remarks that in contrast with the dearth of popular synonyms for the ear and larynx, the nose enjoys an abundance of such terms, which he suggests is mainly due to the prominent position which the nose occupies in the face. Another explanation of these numerous synonyms is the connexion of a large red nose with chronic alcoholism, though such a connexion has been greatly exaggerated. One of the earliest beliefs connected with the nose is that it is the portal of entry of the life or the soul, as is seen from the well-known passage in Genesis relating to Adam. On the other hand, according to Sir James Frazer, the nose has been regarded by several savage races as the path by which life leaves the body. A popular belief in a close relationship between the size of the nose and the sexual organs in both sexes dates back to ancient times, and seemed at first to be confirmed at the end of the last century by the work of Fliess and others, who under the title of 'reflex neurosis' recorded a number of cases of uterine disease which had been cured by treatment of abnormal conditions of the nose. It now appears that the supposed connexion between the two organs in both sexes has been greatly exaggerated.

The folk-lore connected with sneezing is extremely abundant and dates back to remote ages, as is exemplified by many passages in the Bible, Homer, the Greek anthology, Xenophon and Petronius Arbiter. In accordance with the general rule in medical folk-lore, preventive measures are remarkably scanty in the case of rhinology and are chiefly employed in the management of epistaxis; whereas therapeutic measures are extremely numerous and can be classified under the headings of remedies of human origin, animal remedies, plant remedies, mineral cures, hydrotherapy, charms, patron saints and miscellaneous cures.

William Bartram of Philadelphia: Naturalist and Traveller

THE son of John Bartram, botanist to His Majesty for the Floridas, William Bartram (1739–1823) shared his father's interest in Nature, and in 1773–74 carried out an extensive survey in Georgia and Florida. The results of his "Travels" he communicated in two manuscript volumes to his patron, Dr. John Fothergill, an Edinburgh medical graduate who had settled, and made a fortune, in London. After the death of Fothergill, the manuscripts came into the possession of Sir Joseph Banks, and they are now in the library of the British Museum (Natural History). Through the generosity of the American Philosophical Society and the John Bartram Association, this interesting record, thoroughly annotated by Francis Harper, has just been published (*Trans. Amer. Phil. Soc.*, N.S., 33, 121; Nov. 1943). It gives a picture of the primeval wilderness of the south-east of North America, of the beauties of scenery and the wonders of plants and animals, of the Creek, Cherokee and Seminole Indians, until then largely unspoilt by the 'civilization' of white men. It is true that many of the wonders described by Bartram were regarded with scepticism in later years by those whose authority gave them some claim to pronounce judgment; but it is one of the gratifying features of the investigations of Mr. Harper, who followed the Bartram trails over some ten thousand miles, that the authorities have been confounded and Bartram's accuracy vindicated, even in the much-disputed matters of the painted vulture of Florida and the bellowings of the alligators of St. John's, Florida, so circumstantially figured in the traveller's drawing, reproduced as Plate xiv in this paper.

Railway Signalling on London Transport

ACCORDING to a paper read recently in London by R. Dell before the Institution of Electrical Engineers, the power-signalling installation on the railways of the London Passenger Transport Board now covers 160 miles of double track. There are 3,281 stop signals, 2,726 of which are fitted with train-stops. Track circuits number 4,347 and there are 1,326 pairs of points. Although automatic signals are used wherever possible, 112 signal cabins are in use at junctions or connexions in the track layout. The passenger-train car-miles run each year total approximately 159,150,000. Power signalling has been in use practically throughout the system since it was electrified. The electrification of the District Line and the installation of power signalling commenced in 1904 and was completed by the end of 1905. The London Electric Tube Lines were equipped with power signalling from the start—the Bakerloo and the Piccadilly Lines in 1906 and the Hampstead Line in 1907. The Central London Railway was converted to power signalling in 1913 and the City and South London Railway in 1919. Except for these last two installations, the whole of the signalling system was originally operated on D.C. and track circuits were of the D.C. type with polarized relays in order to avoid improper operation by stray current from the traction system.

In the original installation the signals were all electro-pneumatically operated, with a moving spectacle in front of a fixed light for the tunnels and with semaphore arms in the open. All signals for passenger movements were provided with automatic trainstops. Although they gave remarkably satis-

factory results, the D.C. track circuits were not entirely immune from interference by stray current from the traction system; as a result, practically the whole of these track circuits have been replaced by A.C. equipment. At the same time, many additional safeguards were added to the system. Alternating current is now employed throughout for all signalling circuits as well as for the track circuits themselves.

Recent Earthquakes

DURING the period February 4–April 5, fifteen strong earthquakes were registered by the seismographs at Kew Observatory. The greatest of these were on February 29 and March 9. The shock of February 29 began recording compressionally at 16h. 40m. 22s. G.M.T. from an epicentral distance of 8,900 km., and after a full suite of pulses beginning with *iP* attained a ground amplitude at Kew of 110 μ at 17h. 18m. 53s. G.M.T. On March 9 the shock began recording impulsively at 22h. 13m. 06s. G.M.T. and attained a maximum ground amplitude at Kew of 420 μ at 22h. 43m. 49s. G.M.T. At Toledo (Spain) during February, twenty-four earthquakes were registered by the instruments. The greatest of these was on February 1 at 03h. 28m. 26s. from an epicentral distance of 3,700 km. (Turkey). This shock attained a maximum ground amplitude of 1150 μ at Toledo at 03h. 40m. 44s. Many after-shocks of this earthquake were recorded at Toledo during the month. Earthquakes which registered both at Toledo and Kew occurred on February 1, 4, 5, 15, 20 and two on February 29, the last of these having been mentioned above.

The first shock on February 29 occurred at 3h. 42·0m. G.M.T. Its epicentre has been found by the United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, to have been near lat. 13·7° S., long. 70·6° W., which is in southern Peru. The depth of focus was probably slightly less than 200 km. It was recorded at Kew on the vertical component seismograph with *iP* (dilatation) at 03h. 54m. 33s. G.M.T. and attained a maximum ground amplitude of 22 μ at Kew at 04h. 34m. 38s. G.M.T. At Toledo it was recorded at 3h. 54m. 00s., and attained maximum ground amplitude of 80 μ. The earthquake was recorded at Boulder City, Buffalo, Burlington, Chicago, Fordham, Georgetown, Huancayo, Pasadena, Philadelphia, St. Louis, San Juan, Sitka, Spring Hill and Tucson on the seismographs.

The Night Sky in June

FULL moon occurs on June 6d. 18h. 58m. U.T., and new moon on June 20d. 17h. 00m. The following conjunctions with the moon take place: June 19d. 13h., Mercury 3° N.; June 24d. 17h., Mars 1° S.; June 25d. 02h., Jupiter 1° S. On June 24d. 17h. 38·3m. Mars is occulted by the moon, reappearance taking place at 18h. 54·2m. (for the latitude of Greenwich). Occultation of 308 *B* Leon. occurs on June 26d. 22h. 27·7m. (*D*), but there are no other occultations of stars brighter than mag. 6 during the month. Mercury rises at 3h. 11m. at the beginning of June and at 3h. 38m. at the end of the month. Venus is in superior conjunction on June 27, but is too close to the sun throughout the month to be well observed. Mars, in the constellation of Cancer, sets at 23h. 46m. and 22h. 33m. at the beginning and end of the month respectively. Jupiter, in the constellation of Leo, sets at 0h. 15m. and 22h. 30m. at the beginning and end of June respectively. Saturn is drawing close to the sun and is becoming difficult to observe. It sets at 21h. 17m. at the beginning of June—a little more than an hour after sunset. Summer Solstice commences on June 21d. 13h.

Announcements

DR. W. J. HALL has been appointed assistant director of the Imperial Institute of Entomology as from June 1. Dr. Hall was a senior entomologist in the Ministry of Agriculture, Cairo, during 1920–26, and afterwards entomologist and director of the Mazoë Citrus Experimental Station and superintendent of the British South Africa Company's Citrus Estate at Mazoë.

MR. HENRY CLAY, economic adviser to the Bank of England since 1933, has been appointed warden of Nuffield College, Oxford, in succession to Mr. Harold Butler.

THE Association of Scientific Workers has signed an agreement with the Engineering and Allied Employers National Federation, whereby the latter recognizes the Association as representing scientific and technical staff in the industry.

Two scholarships have been given to the Mining Department of the University of Leeds. The first, to be known as Dr. Walter Hargreaves Scholarship, has been founded with a fund of £1,250, collected by the shareholders of the Briggs Collieries, Ltd., as a testimonial to Dr. Walter Hargreaves on his retirement from the chairmanship of the Company. Dr. Hargreaves has been a member of the Mining Advisory Committee of the University for many years and its chairman for the last twenty years. The second has been founded by the Anglo-Saxon Petroleum Company, which has provided a scholarship of £60 a year, plus fees, tenable in the Mining Department.

THE Progressive League has arranged a series of five lectures on "Psychology and Problems of Society", to be delivered on Wednesdays at 7.30 p.m. beginning on June 7, in the Conway Hall, Red Lion Square, London, W.C.1. The speakers and their subjects are: Prof. F. C. Flugel, "The Psychological Basis of Permanent Peace"; Dr. May Smith, "Some Psychological Problems of Industry"; Dr. E. Glover, "Reactionary Aspects of Present Day Psychology"; Barbara Low, "The Psychology of Propaganda"; Major Emanuel Miller, "Psychiatry in a Planned Society". Tickets are 5*s.* for the course, 1*s.* 6*d.* for single lectures, and can be obtained at the door or from the Secretary of the League, 20 Buckingham Street, London, W.C.2.

THE British Council has been permitted to print a small edition of the *British Medical Bulletin* for sale in the United Kingdom. The primary purpose of the *Bulletin* is to interpret British medicine to the overseas reader who would not normally consult the medical journals published in Great Britain. It contains reviews, abstracts, book notes and a list of the contents of current British medical and cognate journals. Applications for annual subscriptions (21*s.*) or for single parts should be addressed to the *British Medical Bulletin*, 3 Hanover Street, London, W.1.

ERRATUM. In the communication entitled "Gamones from the Sperm of Sea Urchin and Salmon", NATURE, March 4, 1944, on p. 286, col. 1, line 18, for "*p*H less than 4·0" read "*p*H greater than 4·0".

LETTERS TO THE EDITORS

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

Activity of the Phytase in Different Cereals and its Resistance to Dry Heat

WHEAT, oats, barley and rye all contain between 0·18 and 0·26 per cent of phytic acid phosphorus. Wheatmeals and flours also contain an active phytase, and considerable interaction between this enzyme and its substrate may accompany the preparation of wheat for the table[1,2].

It was observed by Mellanby[3] many years ago that oatmeal is more rachitogenic than wheatmeal, and, later, that hydrolysis with acid or germination and malting[4] can remove the anticalcifying properties of oatmeal. Recent work has helped to explain these last two pioneering observations, for it has tended to incriminate phytic acid as the rachitogenic agent in cereals. In trying to account for the difference between oats and wheat in terms of phytic acid, it was found that oatmeal as purchased has a negligible phytase activity. It is accordingly suggested that this lack of phytase may explain Mellanby's results[3]. It is certain that only the merest fraction of the phytic acid in oatmeal could have been destroyed in preparing his puppies' food, whereas much of the phytic acid in the wheatmeals might have gone over to inositol and inorganic phosphorus before the puppies ate it. The lack of phytase in oatmeal explains why little or no hydrolysis of the phytic acid in oatmeal takes place in the making of porridge, even if the meal is left to soak overnight and then brought slowly to the boil.

The lack of phytase in oatmeal as purchased was at first tentatively attributed to the kilning process to which 'green' oats are subjected before being milled. Samples of kilned oats and of the green oats from which they had been prepared were, however, obtained from four well-known Scottish firms. These were ground up and incubated with ten times their weight of water at 50° C. and *p*H 4·5 for varying lengths of time. Two observations were at once made. The first was that the phytase activity even of 'green' oats was never more than a fraction of that of either English or Manitoba wheat. This led to an examination of rye and barley, and the results of all these tests are given in Table 1. It will be seen that the rye phytase was the most active. The inclusion of rye such as this in a wheaten grist would, therefore, tend to increase the amount of phytic acid destroyed in baking the bread, and the destruction in a rye bread must sometimes be very high. Dr. Kent-Jones kindly baked some rye bread from sample 2 according to the German technique[5], and 48 per cent of the phytic acid in this whole rye flour was found to have been destroyed in spite of the short time allowed for the bread to 'rise'.

It might be supposed that the apparent lack of activity of oatmeal phytase is due to this cereal containing a different and perhaps more resistant phytic acid; but this is unlikely, for when oats and wheat were boiled with hydrochloric acid the rates of hydrolysis of the phytic acids of the two cereals were found to be exactly the same (Table 1). Nor can the slow rate of enzymic hydrolysis in oatmeal be attributed to its phytic acid being present in a particularly insoluble form for, although the various samples of oats contained 44–72 mgm. of calcium per 100 gm. as against 29–41 mgm. for the other cereals, at least 75 per cent of the phytic acid in the oats was present as the magnesium and potassium salts, both of which must have been in solution at *p*H 4·5.

TABLE 1. RATE OF HYDROLYSIS OF PHYTIC ACID IN DIFFERENT CEREALS.

Nature of cereal	Phytic acid P. in cereal mgm. per 100 gm.	Hydrolysing agent	Time required for hydrolysis of 50% of the phytic acid
		Phytase in cereal itself at 50° C. and *p*H	
Rye, Sample 1	242	4·5	5 min.
,, ,, 2	217	,,	8 min.
Wheat, English	242	,,	12 min.
,, Manitoba	233	,,	14 min.
Barley	260	,,	43 min.
Oats, Green (N.S.)	233	,,	11 hr.
,, ,, (J.J.)	210	,,	11 hr.
,, ,, (J.I.)	182	,,	13·5 hr.
,, ,, (W.E.)	198	,,	15 hr.
Oats, Kilned (N.S.)	220	,,	30 hr.
,, ,, (J.J.)	218	,,	46 hr.
,, ,, (J.I.)	223	,,	46 hr.
,, ,, (W.E.)	206	,,	40 hr.
Wheat, English	242	Boiling 2*N* HCl	7·1 hr.
Oats, Green (J.S.)	182	,, ,,	7·1 hr.

TABLE 2. THE PHYTASE ACTIVITY OF BRAN (AS MEASURED BY THE DESTRUCTION OF PHYTIC ACID) AFTER THE BRAN HAD BEEN HEATED DRY AND IN WATER AT 90° C.

All samples were incubated for 50 min. at 50° C. and at *p*H 4·5. The bran originally contained 10·3 per cent of moisture and 0·92 per cent of phytic acid phosphorus.

Time of heating at 90° C. (hr.)	% Destruction of phytic acid during incubation	
	After dry heat	After wet heat
0	87	87
½	87	0
1	85	0
2	82	0
5	78	0

The second observation was that kilning, even at temperatures of 260–360° F. for two and a half hours, did not destroy *all* the phytase. It was thought possible that this might be due to the enzyme being resistant to heat once it was dry. This was subjected to test. Some wheat bran was dried over phosphorus pentoxide in a serum-drying plant and afterwards heated in the dry state at 90° C. for ½, 1, 2 and 5 hours. Other samples were dropped into water at 90° C. and maintained there for the same times. The activity of the phytase was then studied by measuring the rate of destruction of the phytic acid in the bran on incubating it at 50° and *p*H 4·5. The results are given in Table 2, and it will be seen that whereas, as expected, the enzyme was completely and instantaneously destroyed in water at 90° C., it suffered no measurable destruction in 30 minutes at this temperature when it was heated dry, and very little destruction even after five hours. Further observations are in progress on the resistance of other enzymes to dry heat.

Our thanks are due to the millers who supplied the oats, to Dr. Greaves for drying the bran, to Drs. Moran and Kent for grinding the cereal grains for us, and to Dr. Kent-Jones for baking the rye bread. One of us (E. M. W.) is in the whole-time service of the Medical Research Council.

R. A. MCCANCE.
E. M. WIDDOWSON.
Department of Medicine, Cambridge.

[1] Widdowson, E. M., NATURE, 148, 219 (1941).
[2] Pringle, W. J. S., and Moran, T., *J. Soc. Chem. Ind.*, 61, 108 (1942).
[3] Mellanby, E., *Spec. Rep. Ser. Med. Research Coun., Lond.*, No. 93 (1925).
[4] Mellanby, M., *Spec. Rep. Ser. Med. Research Coun., Lond.*, No. 140 (1929).
[5] Kent-Jones, D. W., "Modern Cereal Chemistry" (Liverpool: The Northern Publishing Co., 1939).

Production of Gliotoxin by *Aspergillus fumigatus* mut. *helvola* Yuill

IN the Research Items in NATURE of April 29, an account is given of the production of antibiotics by *Aspergillus fumigatus*. To supplement this annotation we submit this short account of our own work with the mould *Aspergillus fumigatus* mut. *helvola* Yuill. An earlier publication[1] has described the isolation of helvolic acid from 2–3-week cultures of this mould grown at 25° C. on a medium containing mineral salts and 4 per cent of glucose.

Discrepancies between the antibacterial activity of the culture medium, particularly during the first few days of growth, and the yield of helvolic acid obtained, suggested the presence of a second antibacterial substance. It was found that whereas the antibacterial activity of a 20–22-day culture is scarcely diminished at all by maintaining it at *p*H 10 for 5 hours at 37° C., this treatment completely destroys the activity of 3–4-day cultures. Since helvolic acid itself is stable at *p*H 10 under these conditions, it is clear that in the early stages of growth a second antibiotic, sensitive to very dilute alkali, is produced.

Investigation showed that the activity of the medium reaches a maximum after 8–9 days, then drops somewhat to reach a minimum after 16–17 days, after which it again rises to reach a fairly constant value after 20–22 days. At this time the mould is usually harvested for the isolation of helvolic acid. To isolate the second antibiotic, 5–6 day cultures are brought to *p*H 10 and immediately extracted thrice with equal volumes of chloroform, the total volume of chloroform being equal to the volume of medium being extracted. The chloroform extract is distilled under reduced pressure and the solid residue crystallized several times from hot alcohol. This process yields long colourless needles of the second antibacterial substance, the weight obtained being, roughly, 30 mgm. per litre of culture medium.

For the isolation of helvolic acid in this laboratory a magnesia column is used[1] and this is eluted with hot water. Under these conditions, the alkali-sensitive material is destroyed. We have identified the second antibiotic as one already described, gliotoxin, first obtained[2] as a metabolic product of the mould *Gliocladium fimbriatum* Gilman and Abbott. Our identification is based primarily on the data of Johnson, Bruce and Dutcher[3], who have investigated the properties of gliotoxin in considerable detail.

Property	Gliotoxin	Data of Glister and Williams
Melting point*	221° C.	218–220° C.
Optical activity	$[\alpha]_D^{25} = -255° \pm 15°$ (0·1% in $CHCl_3$)	$[\alpha]_D^{20} = -254°$ (0·6% in $CHCl_3$)
	$[\alpha]_D^{25} = -290° \pm 10°$ (0·08% in C_2H_5OH)	
% Carbon†	48·08	49·9
% Hydrogen	4·96	4·4
% Nitrogen	8·15	9·5
% Sulphur	19·29	19·3

* In common with other authors we find that this value is obtained only if heating is very rapid.
† Analyses by Weiler and Strauss. Material dried at 50° C. *in vacuo*.

The molecular weight determined by an X-ray method (D. Crowfoot and B. W. Rogers-Low) is 330 ± 8. Johnson *et al.*[3] give 314 as their best value. The absorption spectrum, examined by Dr. E. R. Holiday, is consistent with the findings of these workers[3] that gliotoxin is an indole derivative.

The antibacterial activity of our material has been determined by Dr. M. A. Jennings, of this Department. In serial dilution tests, in which one drop of a 16-hour bacterial culture, diluted 1 : 1,000, was added to 5 c.c. quantities of nutrient broth containing diminishing amounts of gliotoxin, the minimum concentrations required to inhibit growth completely were :

Staph. aureus	1 : 360,000
S. Typhi	1 : 45,000
Bact. coli	>1 : 45,000

The sensitivity depends very much on the size of inoculum; for example, when the inoculum of *Staph. aureus* was increased a thousandfold, the minimum growth-inhibiting concentration was increased eightfold.

In the original publication[1] on helvolic acid, reference was made to fumigacin, an antibacterial substance obtained by Waksman and his collaborators[4] from *Aspergillus fumigatus* (Strain W84). The data then published were sufficient to establish that fumigacin and helvolic acid were not the same. In particular, fumigacin contains 3·7 per cent nitrogen (helvolic acid contains no nitrogen), 62·7 per cent carbon (helvolic acid, 69·1 per cent) and melts at 185–87° C. (helvolic acid, 212° C.). During the course of the present work, however, it has been shown[5] that fumigacin is a mixture of helvolic acid and gliotoxin. In view of this it seems rational to replace the term fumigacin, relating to a mixture of antibiotics, by the separate names gliotoxin and helvolic acid, which refer to chemical individuals. In this laboratory we have been able to obtain gliotoxin from 5–7-day cultures of a strain of *Aspergillus fumigatus* Fres. (Lister No. 982) kindly supplied by Dr. W. H. Wilkins, Mycology Laboratory, University Department of Botany. The mould was grown at 25° C. on Czapek-Dox plus 2 per cent glucose.

Shortly before submitting this note for publication, it was reported that gliotoxin has been obtained from a Penicillium as yet unidentified[6].

One of us (T. I. W.) is indebted to the Nuffield Fluid Research Fund for a grant towards expenses.

G. A. GLISTER.
T. I. WILLIAMS.
Sir William Dunn School of Pathology,
Oxford. May 1.

[1] Chain, Florey, Jennings and Williams, *Brit. J. Exp. Path.*, **24**, 108 (1943).
[2] Weindling and Emerson, *Phytopath.*, **26**, 1068 (1936).
[3] Johnson, Bruce and Dutcher, *J. Amer. Chem. Soc.*, **65**, 2005 (1943).
[4] Waksman, Horning and Spencer, *J. Bact.*, **45**, 233 (1943).
[5] Menzel, Wintersteiner and Hoogerheide, *J. Biol. Chem.*, **152**, 419 (1944).
[6] Johnson, McCrone and Bruce, *J. Amer. Chem. Soc.*, **66**, 501 (1944).

X-Ray Crystallography of Gliotoxin

WE have examined a specimen of gliotoxin prepared by G. A. Glister and T. I. Williams, as above. The crystals are four- and six-sided monoclinic plates elongated along [010], and our evidence on their morphology and optic character agrees very well with the measurements of Dr. W. C. McCrone[1,2].

The crystals gave good X-ray photographs from which the following data were obtained : $a = 18{\cdot}74$ A., $b = 7{\cdot}59$ A., $c = 10{\cdot}36$ A., $\beta = 80°$, correct to about ± 1 per cent; space group $P2$. Density = 1·543 ± 0·01.

Since the space group requires at least two molecules in the unit cell, the crystallographic molecular

weight of gliotoxin plus solvent of crystallization is 678 ± 16, or some submultiple of this. Chemical evidence suggests that the true molecular weight is of the order of half this, while the solvent lost on drying the crystals appears to correspond to the presence of ½ H_2O per chemical molecule of gliotoxin (loss on drying, found 2·14 per cent, calc. 2·68 per cent). The calculated weight of half the crystallographic asymmetric unit, 339 ± 8, agrees very well with the figure 335 required for the formula $C_{13}H_{14}O_4N_2S_2.\frac{1}{2}H_2O$.

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B. W. ROGERS-LOW.

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University Museum,
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May 1.

[1] Johnson, Bruce and Dutcher, *J. Amer. Chem. Soc.*, **65**, 2005 (1943).
[2] Johnson, McCrone and Bruce, *J. Amer. Chem. Soc.*, **66**, 501 (1944).

Formation of Hydrogen Ions in High Concentration by Ordinary Baker's Yeast

IN a previous letter[1] it was pointed out that when glucose is fermented by yeast, the release of hydrogen ions into the external solution can be greatly increased when buffering is avoided and the external potassium chloride concentration is much raised.

Previous fermentation for two and a half hours with 0·6 per cent glucose also assists in the subsequent acid production. After such preparative fermentation in the experiments here considered, 1 part of the yeast is well washed in the standard potassium chloride solution, and then left suspended in 0·5 part, and at a given time 0·1 part of 30 per cent glucose is added, samples of the mixture being taken and centrifuged after definite time intervals. The accompanying table shows the effect of increasing the potassium content in the external fluid, the samples being taken 20 minutes from the beginning of fermentation.

Potassium in centrifuged fluid		*p*H of the centrifuged fluid	Increase of free H ion conc. (allowing for activity correction) (mM./litre)	Decrease of potassium conc. (mM./litre)
At zero time (mgm./100 c.c.)	After 20 min. (mgm./100 c.c.)			
17	9	2·62	3	2
80	39	2·18	8	10
147	88	2·00	11·5	15
330	234	1·77	20	25
1760	1650	1·78	21	28

It will be seen that a *p*H as low as 1·7–1·8 (determined by the glass electrode) is reached when the potassium outside the cells is about *N*/10 with little or no further increase in the hydrogen ion release on increasing the potassium. The rise in the free hydrogen ion concentration accounts directly for much the greater part (about 75–80 per cent) of the potassium absorption after 20 minutes (the period of maximum potassium absorption), the remainder being probably also due to an exchange with hydrogen ion, the latter being slightly buffered by substances released during fermentation. What is of special interest here is the direct exchange of potassium for hydrogen ions, the latter reaching surprising levels. It is noteworthy that throughout the period of observation (up to 60 minutes) no appreciable change in the chloride content of the external fluid takes place.

As previously indicated[1] the source of the hydrogen ions would appear to be pyruvic or phosphopyruvic acid, though phosphoglyceric acid probably contributes also a slight amount. The *p*K values of pyruvic and glyceric acids are 2·5 and 3·6.

Where exactly the pyruvic acid is formed is at present obscure, except that it is almost certainly not formed throughout the yeast cell, but in some small surface region. In the external fluid, though pyruvic acid follows the potassium absorption (in inverse relation), it is present in very small concentration, and if liberated as the free acid, it could account for only a quite negligible fraction of the hydrogen ion concentration. This also applies to the total keto acids outside the cells.

It may be pointed out that free hydrogen ion in concentration indicated by a *p*H of 1·78 (and occasionally somewhat lower), in the presence of about *N*/2 chloride ion, is equivalent to free hydrochloric acid of approximately *N*/50 strength.

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E. O'MALLEY.

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[1] Conway, E. J., and O'Malley, E., NATURE, **153**, 555 (1944).

Fluorescence Spectra of Naphthacene Molecules in Solid Solution of Anthracene with the Variation of Wave-lengths

IN the crystalline state, pure naphthacene scarcely fluoresces, but it fluoresces with characteristic yellow-green light when mixed with anthracene or chrysene. Anthracene containing traces of naphthacene is quite suitable for studying the fluorescence of the latter. By exciting such a crystal by light of various wave-lengths, we have obtained the following results. (1) The positions and the number of the fluorescence bands of naphthacene remain unchanged with the change of wave-length of the exciting radiation. (2) Naphthacene fluoresces so long as the exciting radiation is not of longer wave-length than the longest wave absorption band of naphthacene. Solid anthracene has an absorption band lying at wave-lengths shorter than 400 mμ and fluorescence bands at 403, 422, 438, 445 mμ. Solid naphthacene has absorption bands at 425, 453, 485 mμ. In solid solution of anthracene, there is a red shift of these bands, and in the above crystal we find the absorption bands of naphthacene at 435, 460, 491 mμ. The fluorescence bands of naphthacene are at 498, 533, 574 mμ. They are due to naphthacene, for pure anthracene has no fluorescence bands in this region.

In the crystal mentioned above, naphthacene molecules are found to fluoresce by any radiation equal to, or shorter than, the longest absorption band of naphthacene. Using radiations 460, 475, 490 mμ respectively, we find the naphthacene molecules to fluoresce.

Bowen[1] has suggested that in such a crystal the anthracene molecules absorb light energy, give it to naphthacene and thus it fluoresces. But radiations of wave-lengths 460, 475, 490 mμ cannot be absorbed by anthracene molecules, which do not fluoresce when excited by these radiations. If excited by radiation of wave-length shorter than the longest absorption band of anthracene, both the anthracene

and naphthacene molecules fluoresce. Our experimental results that light of wave-lengths 460, 475, 490 mμ, which cannot be absorbed by anthracene molecules, can produce enhanced fluorescence of naphthacene, is against Bowen's hypothesis.

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[1] NATURE, **142**, 1081 (1938).

MR. GANGULY'S observations, which are in complete accord with those of several other workers on the subject[1], can scarcely be said to refute the idea of energy transfers in crystals. Solid naphthacene fluoresces with its characteristic band emission, though rather faintly; when dissolved in solid anthracene it also fluoresces, as Mr. Ganguly notes, if illuminated by light which is directly absorbed by naphthacene molecules (4350–4000 A.). The vital question in the matter of energy transfer is what happens when shorter-wave light is used. If the mercury line at 3650 A. is used for excitation, the green fluorescence of naphthacene is visible in solid solutions containing only one molecule of naphthacene in 10^5 molecules of anthracene; at 1 in 10^4 this green fluorescence is strong, and above about 5 in 10^4 the green is brilliant while the violet anthracene fluorescence has disappeared. At 3650 A. anthracene absorbs much more strongly than naphthacene; the extinction coefficients in liquid solution are 1600 and 400 respectively, so that unless the ratio of extinction coefficients changes by a factor of about 10^4 in passing from solution to solid, the light must be absorbed by the anthracene molecules.

This being so, an explanation must be found for the emission by the naphthacene and the quenching of the anthracene emission. One possibility is that the anthracene emits its fluorescence (4450–4030 A.) and that this is reabsorbed by the naphthacene, the bands of which are in this region. However, the *maximum* extinction coefficient of naphthacene in (liquid) solution is 12,000[2]; this possibility is likely to be effective therefore only at molar ratios of anthracene to naphthacene of 12,000/1,600 ≃ 10 (again assuming that the solid absorption ratios are not greatly different from those of liquid solutions). Since the maxima of the naphthacene absorption bands do not overlie the maxima of the anthracene fluorescence bands, this ratio must be an overestimate, probably by a factor of 10.

We are therefore forced to assume an 'exciton'[3] mechanism. The electronic energy in an excited anthracene molecule must be mobile and capable of moving from molecule to molecule in the crystal by resonance. In pure anthracene the career of the exciton is terminated by fluorescence at some point. When naphthacene is present in solid solution, the exciton is trapped owing to the lower energy level of the excited state of the molecule below that of anthracene; the excess energy is lost as heat, and the fluorescence afterwards emitted is that of the naphthacene. Liquid solutions (as in benzene) of anthracene containing minute amounts of naphthacene fluoresce like pure anthracene instead of the green of naphthacene, the 'handing on' process being inhibited by lack of molecular proximity and orientation. For this reason impurities in crystals in general often profoundly alter the fluorescence properties while exerting no such effect when the whole is dissolved up in a liquid.

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[1] For example, Dufraisse and Horclois, *Bull. Soc. Chim.*, 1888 (1936).
[2] Clar, *Ber.*, **65**, 503 (1932).
[3] Franck and Teller, *J. Chem. Physics*, **6**, 861 (1938).

Reaction Between Solids

IN reactions between solids the transport of the reactants through the reaction-product is rate-determining if the formation of the new compound on the surface of the reactants proceeds fast enough. The rate is then closely connected with the mobility of the 'reacting constituents', that is, ions and electrons, in inorganic substances. The behaviour of the reaction product as a semi-conductor is indicative of this mobility.

Experimental verification of recent theories[1] on this subject has nearly all been confined to simple reactions between a metal and a metalloid, such as in the corrosion of metals, and has been mainly carried out at temperatures not much above room temperature.

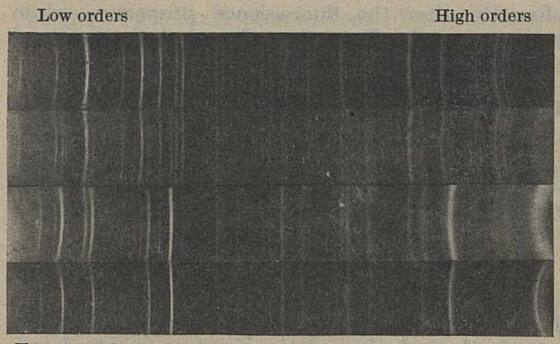
We have investigated the formation of spinel, $MgAl_2O_4$, from magnesia and α-alumina above 1,000° C. This reaction is probably characteristic of others encountered in the refractory and ceramic industries, and also in the production of many metals from their oxides by reduction with aluminium. Unpublished investigations in this laboratory have shown that spinel is an intermediate compound formed during the production of magnesium vapour by reduction of magnesia by aluminium *in vacuo*.

Alumina[2] and magnesia[3] are both 'reduction' semi-conductors[4], that is, substances the conductivity of which increases when heated in a reducing atmosphere (for example, hydrogen) or vacuum. By this treatment they lose oxygen and the excess metal is left behind as positive ions in interstitial positions, electrons being trapped in the ionic field[4]. Very probably the same applies to spinel[5].

If this is so, and if the reaction on the phase boundary proceeds fast enough, spinel should be formed at a higher rate in a reducing atmosphere or *in vacuo* than in air. To check this theory two sets, of four cylindrical briquettes, one inch in diameter and one inch high and each weighing 25 gm., were made up of powdered magnesia and α-alumina (passing 200 mesh, $r \leqq 0{\cdot}037$ mm.) in stoichiometric proportion. The briquetting pressure was 11·4 tons per sq. in. To one set there was added 5 per cent of metallic magnesium powder.

The briquettes containing the magnesium powder (set *a*) were heated to 1,000°, 1,050°, 1,100° and 1,150° C., respectively, in a high-frequency vacuum furnace evacuated to a pressure of 0·1 mm. of mercury and maintained at temperature for one hour. The briquettes of the other set (set *b*) were heated in the same furnace, and under exactly the same conditions of temperature and time as set *a*, but without evacuation of the furnace.

Debye diagrams (copper $K\alpha$) were then made from powder from each briquette and compared qualitatively with those of spinel and the original reaction mixture. In all the magnesium gettered specimens



X-ray powder spectra of the reaction $Al_2O_3 + MgO \rightarrow$ spinel.

	Per cent spinel.
(i) Alumina and magnesia	0
(ii) Alumina and magnesia, baked in air at 1,150° C.	20
(iii) Alumina and magnesia, baked in vacuum at 1,150° C.	65
(iv) Spinel	100

(set *a*), the spinel lines appeared stronger than in the corresponding air-baked ones (set *b*), this fact being perhaps most marked at a reaction temperature of 1,150° C. (see accompanying photograph). Photometer measurements on three lines of these specimens, using a 1 : 1 mixture of spinel and unreacted mixture as standard, showed about 65 per cent spinel in the (*a*) specimen and only about 20 per cent spinel in the air-baked one (*b*).

Using the relation between time and yield for powder reactions, these figures would indicate a more than ten-fold higher 'reaction constant' in the 'reduction' case. Neither the definition of the oxygen pressure and the powder size nor the accuracy of the analysis warrant more than the order of magnitude of this factor to be determined.

We wish to express our gratitude to Mr. W. E. Prytherch, director of research, High Duty Alloys, Ltd., for permission to carry out this work and to publish these results. Our thanks are also due to Prof. P. Gross, who instigated the work and whose advice was available at all times.

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April 6.

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

IN his attempt to establish as Eocene the age of the salt of the Salt Range of the Punjab, Prof. B. Sahni[1] has succumbed to the temptation of generalizing too far from a particular instance. In 1925 I discovered fossil evidence indicating a Cambrian age for the Hormuz Series of the Persian Gulf, and in consequence I became an advocate for a similar age for the Saline Series of the Salt Range. Sahni now wishes to reverse this result and to make the Persian Salt Eocene—but the reaction is not reversible. The Persian salt domes occur in an area which is unquestionably autochthonous and, as they intrude rocks of Middle Cretaceous age in some cases, the salt must be of that age or older. Some of the associated rocks brought up by the salt are of a saline facies, with salt pseudomorph sandstones, gypsum, etc., and the fossil control establishes Cambrian, therefore the presumptive evidence is that the salt is also Cambrian. The map accompanying J. V. Harrison's[2] paper shows the breadth of the normally folded zone and the impossibility of assuming any large-scale thrust faulting. Also the Cambrian, where it appears in normal exposure farther to the north-west, has a similar salty facies.

I have not had personal experience of the Salt Range, but from a study of the literature and from conversations with Gee, Lehner and others, I find that the regional evidence is strongly in favour of a Cambrian age for the Salt Marl group. If Sahni's further work establishes beyond all doubt that the land-plant remains really belong to the salt instead of being caught up by it perhaps during the forward thrusting, then the answer may be that there are two salts, one of Cambrian and one of Eocene age. This would be quite an acceptable solution, and its only unpleasant consequence would be that it would bring to an end what has been a very stimulating controversy. In Persia there are thick deposits of Miocene salt, lagunar conditions locally in Oligocene, Eocene, Cretaceous, Jurassic and Triassic, and there is also Cambrian Salt.

There has been a tendency in the past on the part of many geologists to disbelieve in the possibility of salt masses being as old as Cambrian and still preserved, and Sahni is in good company in this respect. I answered similar criticism from Krejci-Graf[3] and Kossmat[4] in 1938[5]. In this connexion, attention might be directed to the extensive Middle Cambrian Salt deposits of Siberia, and also to lagunar developments in Upper Cambrian, Silurian and Devonian[6].

I hope to be able to send Sahni the samples from Persia for which he asks, and shall look forward to his further publication with great interest.

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PROF. B. SAHNI[1] has anticipated me in publishing conclusive evidence regarding the non-Cambrian age of the Saline Series of the Punjab Salt Range.

In connexion with the researches at present being conducted in the Fuel Laboratories of the Imperial College, regarding the nature, composition and origin of kerogen rocks (oil shales and allied materials) of the world, I had the opportunity of examining in detail, during 1941–42, six specimens of kerogen rocks occurring in association with the Saline Series of the Punjab Salt Range and the salt

deposits of the Kohat region. The five specimens from the Salt Range were collected under the supervision of Mr. E. R. Gee, and the Kohat sample was collected by Dr. A. L. Coulson, both of the Geological Survey of India.

The position and occurrences of the six samples, according to the information supplied to Dr. G. W. Himus, Imperial College, by Mr. Gee and Dr. Coulson are as follows: Sample 1 (Warcha Mandi A): from the Lower Saline Series (in the gorge north of Fathepur Maira). Samples 2 and 3 (Warcha Mandi B1 and B2): from the Lower Saline Series (at the junction of Warcha and Jan Sak gorge). Sample 4 (Kalabagh): from the lower gypsum-dolomite stage of the Saline Series (in a tributary half a mile north-west of Kalabagh). Sample 5 (Makrach): bituminous shales, running among the dolomite and gypsum at the top of Saline Series (on the left side of Nawabi Kar, two and a half miles north-west of Makrach). Sample 6 (Kohat): 'oil shale' occurring in the gypsum capping the salt deposits near Kark.

Presumably the 'oil shales' mentioned by Prof. Sahni now being examined by him are similar to samples 1, 2 and 3.

Besides the two theories mentioned by Sahni, namely, (*a*) the Saline Series in the eastern part of the Salt Range is of Lower Cambrian or pre-Cambrian age, and (*b*) the Saline Series is of early Tertiary age, there is a third theory, (*c*), the Saline Series of the Salt Range is of Cambrian or pre-Cambrian age, but the salt deposits of the Kohat region are of Lower Tertiary age.

The question of the Kohat salt was decided by the discovery of fossil fish and Eocene foraminifera in the gypsum capping the rock salt. Thus the age of the Kohat kerogene shale is also Eocene. This means that there are not only two groups of salt deposits in the area, but also two groups of 'oil shales' of similar composition and nature, lying close to each other but of entirely different age. This conclusion on the very face of it appears improbable.

Sir Edwin Pascoe[2] in 1920 said: "That there should be two important salt-bearing groups, each containing hundreds of feet of salt, of entirely different age, the one Lower Cambrian or older and the other Eocene, occurring within 20 miles of each other (and indeed meeting each other near Kalabagh, A.L.), does not commend itself as probable". Fox[3] correlated the Kohat salt with the salt of the Salt Range on grounds of probability and attributed Cambrian age to both of them. Since then the age of the Kohat salt has been decided, but the salt of the Salt Range is still held to be Cambrian or older.

Not having sufficient field knowledge of the area, I raised the matter of the kerogen rocks with Mr. P. Evans of the Burmah Oil Co. (who also previously had produced evidences[4] of the Eocene age of the Saline Series) and in my communication to him I pointed out that the geochemical and petrological (especially the heavy mineral distribution characteristics) evidences indicate that the oil shales from the two areas are of the same age, suggesting Tertiary age of the Saline Series. Evans stated (March 19, 1943) that he thought the Kohat oil shale to be of Tertiary age, and Makrach and Warcha shales, on the grounds of Cambrian theory of the Saline Series, of Cambrian age; but he was not sure about the age of the Kalabagh samples. He thought it was surprising to find two series of oil shales of entirely different ages, occurring so close to each other, but perhaps not so surprising as the existence of two groups of deposits of the salt, and asked me to refer the question to Mr. Gee.

Further examination of the slides of the respective kerogen rocks decided the question. Down and Himus[5] have reported ill-preserved algæ and spores, and macerated plant debris from the Kohat shale. This was confirmed by me. Warcha and Kalabagh specimens, when examined under high magnification, revealed well-stratified and numerous minute fragments of blackened or carbonized and resinified angiospermous wood, fossil microspores and possibly some cuticles and pollen grains, occurring either in the shale matrix or in the dolomitic marl. The Makrach sample revealed numerous fossilized algal colonies, besides macerated plant remains. Owing to the ill-preserved nature of the specimens, it is difficult to determine the genus, but they resemble the algal bodies described from other kerogen rocks. The microstructures contain well-formed minute crystals of calcite, spherular pyrites and sometimes gypsum crystals formed in the cavities.

The identification of the 'yellow bodies' occurring in the kerogen rocks from various parts of the world as algal remains is now well established, since Blackburn and Temperly[6] convincingly proved that these algal remains do not differ in any material respect from the living alga *Botryococcus Braunii*. The nature of the algal remains in sapropelic deposits has been described by various workers, among them Zalessky[7] in Russia, Thiessen[8] and Bradley[9] in America, C. E. Bertrand and Renault[10] and Paul Bertrand[11] in France, and Edgeworth David[12] in Australia.

The nature of the calcite crystals and the pyrite granules is very characteristic in the fossil alga of all the kerogen rocks I have so far examined. This has also been noted by Bradley[9] and others[13].

Fox himself has pointed out that the occurrence of bitumen and oil in rocks of this area indicates Tertiary age of the deposits. Some have tried to ascribe the occurrence of bitumen and oil in the salt to migration of oil from upper horizons; for example, Nummulitic strata. Examination of the kerogen rocks from the Saline Series of the Salt Range and the Kohat area leaves no doubt that these are composed of the 'Ur-materials' of Pascoe, the mother rocks from which the lighter fractions of oil have migrated to other horizons.

Prof. Sahni is to be congratulated for deciding the second greatest controversy of Indian geology in the same manner as he decided the other great controversy, namely, the age of the Deccan Traps.

A. LAHIRI.

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Imperial College of Science and Technology.
April 17.

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Composition of the Bracken Frond throughout its Growing Season

DURING 1942, the variation in the composition of the bracken frond throughout its growing season was investigated in Perthshire at Ballochraggan, the bracken experimental area of the West of Scotland Agricultural College. A uniform 100 yards square area of hill bracken was chosen on typical Scottish upland soil and from it fronds were taken at intervals throughout the season.

At each sampling a hundred fronds were weighed and the dry matter determined. It was noted that the percentage dry matter increased until the beginning of July and thereafter remained constant until September, when it again increased. It is interesting to note that the date on which the percentage dry matter became constant is approximately that regarded as most suitable for eradication by cutting.

The percentages of nitrogen, phosphorus, potassium, calcium and magnesium were determined in the dry matter and several points were observed.

The percentage of potassium (expressed as oxide) in the dry matter ranged from 5·60 in May to 0·86 in October, which emphasizes the recognized power of bracken to accumulate this element in the frond. It is debatable whether this high concentration is absolutely necessary for the normal metabolism of bracken, but if it is, then the problem of bracken eradication might be further explored by investigating the potassium absorption mechanism of the plant.

Throughout the season the percentages of nitrogen, phosphorus, potassium and magnesium in the dry matter progressively declined, the rate of fall being greater in the early stages. The percentage of potassium decreased considerably more rapidly than the others. On the other hand, the percentage calcium in the dry matter increased steadily until September, after which it decreased slightly, a condition often found in the leaves of plants.

The actual weights of certain elements in a hundred fronds were calculated for each sample, and it was noted that the maximum amounts of dry matter, nitrogen, phosphorus, potassium and magnesium occurred in the fronds about the beginning of August, whereas the maximum calcium did not occur until September. The amounts of dry matter, magnesium and calcium which were lost from the frond at the end of the season were relatively small, being 15·2 per cent of the dry matter, 24·0 per cent of the MgO and 11·9 per cent of the CaO. Conversely, the percentages of nitrogen, phosphorus and potassium lost were relatively great, being 72·8 per cent of the nitrogen, 77·8 per cent of the P_2O_5 and 63·2 per cent of the K_2O. The probable migration of nitrogen, phosphorus and potassium from, and the retention of the calcium and magnesium in, the ageing leaf are in accordance with the general views on such matters.

The rates of absorption are interesting. More than 70 per cent of the phosphorus was taken up before the second week of June, while less than 15 per cent of the calcium was absorbed in the same period. Between 30 and 50 per cent of the nitrogen, potassium and magnesium were absorbed during that time. Some authors have suggested that phosphorus is associated with intense meristematic activity, and the early absorption of P_2O_5 by bracken may be further evidence for this.

When the ratios of the amounts of certain elements absorbed by a hundred fronds at successive stages of growth were compared, it appeared that the only ratio which tended to be constant was the N/K_2O. This relationship has been observed in some other plants and suggests that nitrogen and potassium compounds may be closely associated in the metabolism of the frond.

It is intended to carry this investigation further in 1944 by examining and comparing the composition of rhizomes and fronds throughout the season. This should supply information about the movement of nutrients into the plant from the soil and their distribution between rhizome and frond. It is also hoped to study on similar lines the nutrition of poorly developed bracken and to correlate this with factors of the environment. At the same time the importance of information on the general biochemistry of bracken, about which surprisingly little is known, will be borne in mind.

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The Ishihara Test for Colour Blindness

Vernon and Straker[1] claim that 5·37–9·45 per cent of colour blind men were found in Great Britain, according to district, averaging 7·49 per cent. This is about twice the accepted figure. They suggest the difference is due to use of "a modified form" of the Stilling and Ishihara Tests, which "picks out many of the colour-weak, or anomalous trichromats, as well as the strictly colour-blind".

In my investigation[2], 87 subjects tested with the Rayleigh equation were given the Ishihara Test (8th edition, 1939). They were 14 red-green blind men, 4 red-green blind women, 2 green anomalous men, 13 red-green weak men and 18 red-green weak women, 9 normal men and 27 normal women. The red-green weak have two to four times, and the colour blind five to twenty-one times the modal threshold for distinguishing the red-green variable disk from the standard yellow. The anomalous have a small threshold but a big deviation ($> 3\sigma$); the colour blind a very big threshold but usually a small deviation (whether protanopes or deuteranopes). The anomalous are not true intermediates between colour weak and colour blind[3]. Houstoun's[4] view is confirmed that the colour blind form a separate group in the population, because only 2 per cent of the men or women other than colour blind have more than three times, and only 2 of the 18 colour blind less than six times the modal red-green threshold, while true intermediates were not found.

The accompanying table shows that in the Ishihara Test no colour blind or anomalous subject in this experiment gave more than one reading unequivocally correct in twenty-four plates (the first of the twenty-five plates is always correct and only used to show the subject what to do). Four protanopes were not distinguished from deuteranopes by the test, nor two deuteranopes from protanopes. Moderately colour blind were not consistently distinguished from extreme, nor anomalous from colour blind, and this has been confirmed later with red anomalous, though some lesser deviants make fewer mistakes.

		Frequency of: Correct readings	Double readings	Errors
Extreme C.B.	Prot. (3 ♂, 0 ♀)	1–2	0–1	23–24
	Deut. (3 ♂, 1 ♀)	1–2	0–2	22–24
Moderate C.B.	Prot. (3 ♂, 2 ♀)	1–2	1–5	18–22
	Deut. (5 ♂, 1 ♀)	1–2	3–6	17–21
Green anomalous. (2 ♂)		2	2–8	15–21
R–G– Weak (13 ♂, 18 ♀)	Mode	22	0	0
	Scatter	14–25	0–7	0–8
Normals (9 ♂, 27 ♀)	Mode	21	0	0
	Scatter	14–25	0–8	0–9

On a level of failure of nineteen or less correct in twenty-four plates, the Ishihara Test would have failed 9 of the 31 red-green weak subjects, but not consistently the weakest, and 9 of the 36 normals. Proportions of correct, alternative and 'blank' readings gave no accurate information about degree of weakness, though the test was used in a very strict manner.

Some red-green weak subjects might be dangerous and ought to be failed. The Ishihara Test is not capable of picking them out accurately. A warning to almost the same effect is given in the introduction to Stilling's Tables (17th edition, 1926).

The Ishihara Test is unsatisfactory as a scientific instrument[5]. It also errs on the side of severity, a good fault, but in an undiscriminating way, which is unfortunate, and Vernon and Straker's percentages may be unduly high.

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[1] NATURE, **152**, 690 (1944).
[2] NATURE, **153**, 409 (1944).
[3] Edridge Green, F. W., "The Physiology of Vision", chapter 24.
[4] Houstoun, R. A., "Vision and Colour Vision", 194–199.
[5] Cf. Thomas, G. J., *Amer. J. Psych.*, **56**, 583.

Incidence of Colour-Vision Weakness

Vernon and Straker[1] reported that the incidence of colour-vision defect among recruits for the Royal Navy was least in the north-eastern part of Britain and greatest in the south-western part. They deduced that colour-vision defect may be racially connected with pigmentation.

The colour-vision of the first-year medical students at the University of Glasgow, who represent an educated cross-section of nearly all of the mixture of races in the west of Scotland, was examined with a set of Ishihara cards. Ten men were found colour-defective, out of 138 tested, an incidence of about 7 per cent. The colours of hair and eyes, and the general build, were noted. Five had hair of shades of brown; all five had blue or blue-grey eyes; one was very tall, three were stocky, and one was small and thin. One with black hair had brown eyes and was fairly tall; one with dark hair had hazel eyes and was small and thin. Three with fair hair had blue eyes and were of short stature.

The number is small, but the absence of any association of pigmentation or of physical type with colour-vision defect suggests that other possible causes of Vernon and Straker's interesting results should also be considered. For example, there may be some selection made by the men themselves, especially in the more educated groups, in which the individual who knows that his colour-vision is defective will tend to avoid presenting himself for the Royal Navy. Tests on army cadets at Glasgow have shown an incidence of colour-vision weakness higher than normal; this was found to be caused by the presence of several men who, but for their known colour-vision weakness, would have volunteered for the Royal Navy or the Royal Air Force.

The statistical surveys by Waaler[2] and von Planta[3] cannot be ignored. Waaler at Oslo examined 9,049 boys and 9,072 girls; von Planta at Basel examined 2,000 boys and 3,000 girls. The races are very different, yet the results are in agreement not merely in overall incidence but also in the incidence of each of the two defects, deuteranomaly (including deuteranopy) and protanomaly (including protanopy):

INCIDENCE OF COLOUR-VISION WEAKNESS.

	Males			Females		
	Deuter-anomaly	Prot-anomaly	Total	Deuter-anomaly	Prot-anomaly	Total
Waaler	6·10%	1·91%	8·01%	0·41%	0·03%	0·44%
v. Planta	5·75	2·20	7·95	0·33	0·10	0·43

These results indicate that the incidence of colour-vision weakness in Europe is probably independent of race, and that deuteranomaly and protanomaly are different colour-vision defects, inherited independently. That these two independent defects exist may be the reason[4] why the incidence of colour-vision weakness in females is 0·44 per cent, instead of 0·64 per cent as required by a simple theory of the inheritance of one sex-linked factor; the missing 0·20 per cent represents women of pseudonormal colour-vision, who have inherited both defects.

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April 15.

[1] Vernon, P. E., and Straker, A., NATURE, **152**, 690 (1943).
[2] Waaler, G. H. M., *Z. indukt. Abstammungs- und Vererbungsl.*, **45**, 279 (1927).
[3] von Planta, P., *Arch. f. Ophthalmologie*, **120**, 253 (1928).
[4] Gray, R. C., *Arch. Ophthalmology*, **29**, 446 (1943).

Road Safety and Road Structure

IN his comments on my article "Road Safety and Road Structure" in NATURE of May 20, p. 623, Lieut.-Colonel O'Gorman refers to the use I made of statistics in discussing the road accident problem.

Lest the reader is inclined to place undue emphasis on the secondary effects to which Colonel O'Gorman quite rightly refers, it should be pointed out that the sole purpose of the reference to statistics in the early part of the article was to support the conclusion that, "unless novel methods of prevention were introduced", there would probably be a serious increase in road accidents when traffic took to the highway again after the War.

As this is largely the foundation of Colonel O'Gorman's own praiseworthy efforts to get road accidents studied scientifically, I have felt it desirable to clarify the point.

W. W. DAVIES.

COLD DENSE MATTER

FOR his presidential address to the Section of Physics at the thirty-first Indian Science Congress, held at Delhi in January, Dr. D. S. Kothari took as his subject "Cold Dense Matter". Here the word 'cold' is used in a technical sense as meaning that any free electrons present constitute a degenerate gas—the actual temperatures can range from planetary temperatures to those of the interiors of white dwarf stars. Dr. Kothari's address has now been published, and it gives us a welcome summary of the main features of temperature- and pressure-ionization of matter at high and low temperatures and at high and low densities.

The thermodynamic theory of ionization in gases, though first used in particular applications by Lindemann (now Lord Cherwell), was given its dominating importance in astrophysics by the work of Saha. Saha showed that the dissociation of atoms into ions and electrons is encouraged by reduction of pressure or increase of temperature. But, as Kothari points out, pressure variations are comparatively unimportant in influencing the degree of ionization unless the temperature is of a certain order of magnitude given by the relevant ionization potential; for temperatures much lower or much higher, ionization will be either negligible or complete, whatever the pressure, and we therefore rightly describe Saha's ionization theory as the theory of temperature or *thermal* ionization. In his address, Kothari proceeds to discuss in some detail another kind of ionization, which he calls *pressure* ionization. This occurs in the case of relatively cold matter at high densities, when the atoms are pressed so tightly together that there is room neither for the outer electrons to be in bound orbits nor for them to be associated with particular ions. Kothari sums up the differences between thermal and pressure ionization in three compact propositions:

(i) Thermal ionization occurs in hot or non-degenerate matter; pressure ionization in cold or degenerate matter.

(ii) If, keeping temperature constant, the density be reduced, then the degree of ionization is increased for thermal ionization, and decreased for pressure ionization.

(iii) If, keeping density constant, the temperature be increased, the degree of ionization is increased in thermal ionization but remains practically unaffected in pressure ionization—unless the increase in temperature is so large that degeneracy is removed and pressure ionization passes into thermal ionization.

The discovery by Fermi and Dirac in 1926 of the correct form of quantum statistics to apply to gases had its repercussions on ionization theory: the early simple formulæ require modifications at large densities and low temperatures, where there sets in a 'degeneracy' which we have already mentioned. In addition, at very high temperatures further modifications are required, due to the need to use Einstein's modifications of Newtonian dynamics when the kinetic energy of thermal motion becomes comparable with the rest energy due to mass. The early part of Kothari's address contains a useful complete summary of the various discriminants which determine the different cases that arise at high or low densities or temperatures.

The later portions of his address are chiefly concerned with the applications of these general principles to the particular circumstances of the white dwarf stars and the planets. White dwarf stars were first recognized as configurations with degenerate cores by Sir Ralph Fowler. This theory has been considerably developed by Stoner and Chandrasekhar, and in his address Kothari rounds off these investigations, showing *inter alia* what had previously been assumed outright, namely, that for white dwarfs of mass exceeding a certain small critical mass, the stellar material is completely ionized. The application of the theory to bodies of planetary mass is a piece of original work of great beauty, due to Kothari himself. He shows that if we consider a series of 'cold' bodies of increasing mass, the radius increases to a maximum for a mass about one thousandth of that of the sun, and thereafter decreases; the physical reason is that ultimately increase of mass so increases the central pressure that the atoms suffer such a degree of pressure ionization that they finally occupy a smaller total volume in spite of the increased mass. The value of the radius at the maximum is shown by Kothari to depend to some extent on the chemical composition of the material, and he infers that the observed mass/radius values for Jupiter and Saturn are consistent with their being formed largely of (dense) hydrogen, whereas the terrestrial planets (Mercury to Mars) lie nearer the iron curve. The address concludes with a closely reasoned account of the probable evolutionary history of a body of planetary mass, together with Kothari's own difficulties with his theory.

E. A. MILNE.

MEDICAL EDUCATION IN INDIA

FOR his presidential address to the Section of Medical and Veterinary Sciences at the thirty-first Indian Science Congress held at Delhi in January, Dr. K. V. Krishnan chose "Medical Education" as his subject. Progressive medical educationists in India are not, he said, satisfied with the existing medical educational institutions, and wish to reorganize them in the light of recent trends of Western medical thought. It is now more than a hundred years since the first medical college was established in India and it is time for a stock-taking. India and the U.S.S.R. are the only two countries in the world which still have a dual standard of medical education, and both have decided to abolish it. The U.S.S.R. has already done much to abolish the lower standard. Madras and the United Provinces have already abolished it. Elsewhere in India there are still the medical schools which turn out licentiates with a lower standard of education and the colleges which produce university graduates. In the very near future, Dr. Krishnan hopes, there will be only the medical colleges.

Most of these colleges are not, however, planned according to the principles laid down by Flexner in his "The Idea of a Modern University". India is still producing the "tradesman doctor"; and should go on, as Britain, the United States and the U.S.S.R. have done, to the production of medical men whose ideals are the service of the public, the prevention of disease and the maintenance of health, rather than the cure of illness after it has been allowed to develop.

In the course of his address, Dr. Krishnan makes valuable suggestions for improvements along these lines. The libraries of the medical colleges should be extended and provided with foreign periodicals, text-books should be produced which deal with Indian

problems of health, men with the scientific bent of mind should be attracted to medicine and should be given better facilities for research. Clinical teaching should be improved by the provision of more beds per student and of teachers who emphasize the art of medicine and correct the tendency of students to depend too much on laboratory aids to diagnosis. More Indians should be given opportunities to become deans of medical colleges, and all teaching staff should be debarred from private practice. The teaching staff should, indeed, be specially chosen for the work and should find in it all the elements of an attractive profession. Improvement in the hygiene departments is also needed, and every medical college in a country where two-thirds of the deaths are due to bacteria should have a separate department of microbiology. Qualified men should all spend post-graduate time in hospital work and should also have the opportunity of doing postgraduate laboratory work. There should be adequate schemes for the training of specialists, refresher courses for general practitioners and others and courses in tropical medicine.

Discussing the supply of medical students, Dr. Krishnan finds that very few of them at present choose medicine as a profession for humanitarian reasons. India has not nearly enough medical practitioners. On the basis of 1 for every 1,000 people, which is the standard aimed at in Western countries, India should have at least 400,000, which is ten times the number that she actually has at the moment. It will be a long time before the number of colleges can be increased sufficiently to correct this deficit. Dr. Krishnan advocates instead a system of training medical students in batches or shifts—a system by means of which the U.S.S.R. is increasing the number of medical men without, he says, reducing the standard of education. The Leningrad medical school, he states, is said to train four batches of medical students at one time by a system of shifts "as in a factory", and he would like to see a serious trial of this mass-production of medical men in India. It is not easy to understand how such a system is compatible with Dr. Krishnan's other and excellent ideal of emphasizing the art of medicine.

Two outstanding needs of India are dealt with in some detail, the need for more women practitioners and the need for medical men in the rural areas. India has an even greater need for women than the U.S.S.R., where almost 50 per cent of the practitioners are women. But it is the need for rural medical men that Dr. Krishnan emphasizes. There are 388 million people in India and 95 per cent of them live in rural areas. "Intellectually, financially, physically and physiologically the villager may be said to be 'down and out'." In all rural areas are found the witch doctor, the quack, the *ayurvedic* and *unani* doctors and the allopaths. Everyone agrees that the witch doctor and the quack should be stamped out. Some think that the *ayurvedic* and *unani* systems should be retained, but Dr. Krishnan is among those who would abolish these also. India must make up her mind whether to abolish the allopaths as well. Most of her 42,000 existing qualified medical men are in the towns, which have enough doctors. For the rural areas the urgent need is a band of workers qualified in both medicine and public health, who have had also a training in rural problems and psychology. These men should be specially chosen for their desire to tackle the special job of attending to rural needs, to endure its almost continuous hardships and to go to the country people as friends and not as exploiters of their lot. They should be paid a fixed salary by the Government, with free quarters, and should agree to serve for ten years. Dr. Krishnan does not think there would be any difficulty in finding enough men of the right kind for this beneficent work.

Throughout his address, Dr. Krishnan refers to the interdependence of health control and social and economic problems, and thus alligns himself with progressive medical opinion everywhere. It is evident that, if he were an Indian medical student to-day, he would be found among the 5 per cent whom he mentions who chose the medical profession, not because it pays well, but because it offers a chance of serving their fellow men. His ideals are clearly those of the progressive social medicine advocated by Prof. J. Ryle (*Brit. Med. J.*, Nov. 20, 1943, p. 633) and other recent contributors to the *Lancet* and the *British Medical Journal*. These can perhaps be summed up in Ryle's statement that social medicine is "a logical development from and a direct expansion of clinical medicine, of medicine construed in its best Hippocratic sense and activated by the highest Hippocratic ideal; for 'where there is the love of man there also is the love of the Art' ".

Let us hope that the Government of India will, like the Government of Great Britain, take heed of the sufferings of the humble as well as of the great, and see that India gets the medical men and women whom she needs. If the princes and rajahs and merchants contribute to its finance, as Dr. Krishnan invites them to do, they will live in the future with Rockefeller, Nuffield and all the others whose gifts have led so swiftly and directly to incalculable relief of human suffering.

G. LAPAGE.

THE BLACK REDSTART: A NEW BRITISH BREEDING BIRD

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EXTRAORDINARILY little is known of the process of extension and contraction of range which many animal species periodically undergo. Among British birds, the only two the extension of range of which during the past hundred years has been at all adequately described are the little owl (*Athene noctua vidalii*)[1], an introduced species, and the fulmar petrel (*Fulmarus g. glacialis*)[2].

An opportunity now presents itself to make a year-by-year study of a bird species, the black redstart (*Phœnicurus ochrurus gibraltariensis*), which is evidently at the beginning of the process of colonizing the British Isles, or at any rate their south-eastern corner. The black redstart was not known to breed anywhere in the British Isles before 1923, and has only quite recently begun to spread away from the southern coastline, where it secured its first foothold. In the summer of 1943, black redstarts were present in eleven English counties, five of which held at least ten breeding pairs[3]. It seems probable that but for the restrictions placed on observation by the War, many more breeding pairs would have been discovered.

The first breeding record for the black redstart in the British Isles was in Sussex, where a pair nested in maritime cliffs in 1923 and 1924, and probably

two pairs in 1925[4]. In 1932 a male bird was thought to be breeding in a maritime cliff in the south of England, possibly the same as the original locality[5]. The second locality where the black redstart has been proved to breed in England has only quite recently come to light. It is now known that three pairs of black redstarts nested in the Palace of Engineering at Wembley, Middlesex, in every year from 1926 until 1941, after which apparently increasing disturbance due to the War drove them away[6]. A fourth pair also nested in the same building in 1937. The next extension of range took place in the south-west, where the species has always been common as a winter visitor. Possibly from 1927, certainly from 1929, "a couple or so" of pairs of black redstarts nested annually on the cliffs of Cornwall[7,8]. The first wave of colonization was completed by pairs which nested in Kent in 1930[9] and in Woolwich Arsenal, London, in 1933[10].

The second wave of colonization, which has continued with gathering pace until the present, began with a pair that nested in Cambridge probably in 1936 and certainly from 1937 onwards[11]. In 1939 a pair bred in Ipswich, Suffolk, and birds were seen in the town in each subsequent year to 1942[12,13]. In 1940 occurred the first breeding record for Inner London, when a pair nested in the precincts of Westminster Abbey, and returned to breed in 1941[14]. This followed a period of increasing frequency of advance guards of non-breeding birds (cf. the fulmar[2]): two in 1927[15], two in 1936[16], one in 1938[17], two in 1939[18], six in 1940[19], and three in 1941[20]. At the same time, a tendency to spread into the suburbs also began: one was heard at the White City, Shepherd's Bush, in 1940[19], and in 1941 a pair nested at Wandsworth and males were seen at Hayes and Hillingdon, Middlesex[20]. In 1940 also nesting was first recorded in the Lower Medway valley, Kent, where it seems to have gone on ever since[21].

In 1942 the species seemed to take a big leap forward[22]. Breeding was proved in London (City, Notting Hill, Wandsworth), Cambridge, Whitstable, Kent, and Burlescombe, East Devon. Non-breeding birds were also present in London (more than twenty), Cambridge, Ely, Lowestoft (also in 1941), St. Leonards-on-Sea, Maidstone, Southampton, Plymouth (also in 1941), and even so far north as Sheffield. Altogether, forty-five to fifty non-breeding males were reported from various parts of England in addition to the six pairs proved to have bred. This compares with seven breeding pairs and nine non-breeding males in 1941. The advance of 1942 was maintained in 1943, when the species bred at St. Leonards-on-Sea, Hastings, Dover, the Medway valley, City of London (three pairs), Lowestoft, and Birmingham[3]. Non-breeding birds were present in Southampton, Dover, London, several Greater London suburbs, and Cambridge. The totals for 1943 were ten breeding pairs and twenty-six non-breeding males.

It is most desirable that every effort should be made to chronicle the further spread of the black redstart in 1944 and subsequent years. The British Trust for Ornithology has agreed to sponsor an inquiry, and all records for this and former years that have not been published should be sent to me at 39 South Grove House, Highgate, N.6. A point on which information is especially desired is the plumage of singing males, as it is known that in many cases these are immature and lacking the white wing-patch of the full adult plumage.

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PETROLEUM REFINING AS A CHEMICAL INDUSTRY

IN an address delivered to a joint meeting of the Society of Chemical Industry (Manchester Section) and of the Institute of Petroleum (Northern Branch) on February 4, Dr. F. Kind outlined the way in which it has become possible for petroleum refiners to adjust production to market requirements, irrespective of raw material. The average crude oil contains 20–25 per cent of hydrocarbons suitable for motor spirit. Invention and development of the chemical cracking process has increased the potential yield to 50–70 per cent of the crude oil. In fact it has furnished a means of adjusting production of motor spirit and gas oil, kerosene and fuel oil from any given crude to meet demands. Similarly, development of the process of solvent extraction has made possible adjustment of chemical composition to market requirements.

Quite apart from being the most convenient source for production of all types of liquid fuel, lubricating oil and asphalt, crude oil is by far the largest and cheapest source of hydrocarbons accessible to man. Until recently, however, little use has been made of petroleum as a raw material for chemical purposes, the reason being that the chemical industry needs pure basic materials for syntheses and processes, and it is exceedingly difficult to obtain pure hydrocarbons from petroleum. With the development of cracking and reforming operations, however, a valuable source of pure hydrocarbons became available. The tail gas formed during these processes contains olefins in recoverable quantities, and it is possible to obtain comparatively large amounts of hydrocarbons with two to five carbon atoms, to separate *iso*paraffins from normal paraffins and olefins from paraffins. It is suggested that, using these individual hydrocarbons as raw material, it should be possible to build up higher hydrocarbons of known chemical constitution and in much purer form than that in which they could be obtained from crude oil. Further, it should be possible to build up hydrocarbons with certain desirable properties which are not present at

all in the original crude oil, or only in insignificant quantities. Already, vast quantities of hydrocarbons are being utilized in the production of synthesized aviation spirits and synthetic rubber. Other olefins, mainly ethylene, propylene and amylene, are being employed on a vast industrial scale, also to a lesser extent the paraffins. It may well be in the future that petroleum will be used more and more as a raw material for synthesizing special hydrocarbons, and that petroleum refining may turn more and more into a chemical industry.

In extension of a view held for many years that centres of consumption rather than oilfields are the right location for modern refineries, Dr. Kind advocates their development in Great Britain. They should be adapted to meet the special conditions prevailing and not necessarily modelled on American or Russian plants. Moreover, once established, the petroleum refining industry should refrain from entering the field of chemical industry proper. Two great industries are envisaged, one producing basic raw materials from petroleum, and the other manufacturing solvents, plastics, fibres, etc., from hydrocarbon 'bricks'. Establishment of these industries will not be an easy task, but there are, in Dr. Kind's opinion, few enterprises which offer such a rich reward for endeavour.

THE PERIDINIALES

DURING the cruise of the non-magnetic ship *Carnegie* of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in 1928–29 intensive studies were carried out in the Pacific and North Atlantic Oceans, and, combined with the primary oceanographic investigations, a study was made of the plankton. The simultaneous collecting of samples and taking of hydrographic data afforded exceptional opportunities to study the relations between pelagic organisms and their environment. Among the organisms H. W. Graham selected for special study the difficult group of the Peridiniales, and from a preliminary survey it became evident that no general floristic study was possible in the light of the inadequate knowledge of the group. The peridinian life-histories are incompletely known, so that classification rests upon morphology of the cell, and especially upon the number and arrangement of the complex series of skeletal plates. On this basis, so far as it is known, Lindemann has described a number of genera, which have been utilized as a basis for the present study*. For description of the plate pattern, Kofoid's terminology has been used, though for the plate formulæ abbreviations of the plate names have been found simpler in practice than Kofoid's prime signs. The analysis involves special technique which lies mainly in fixation in formalin, separation of the thecal plates by hypochlorite treatment, and orientation and microdissection in glycerine jelly.

For intensive study representatives of five families of Peridiniales have been selected, with the following main objects in mind: to establish standards for analysis, to acquire a more detailed knowledge of the skeletal structure, to study the variation and to gain some concept of the inter-relationships of the genera and species. Besides the general plate features of the cell, Graham has found the number and arrangement of the plates of the ventral area particularly valuable for distinction of genera, and he illustrates the use of this area, the girdle and the hypotheca for this purpose. Owing to the preliminary establishment of genera on incomplete data as to cell construction, it is obvious that the genera and species of earlier classifications are bound to be considerably modified as study of the group proceeds.

The general discussion of the basis for classification and possible relationships of the genera is followed by a systematic description of the types analysed. The monogeneric family Ceratocoryaceæ receives full treatment, and the more difficult section, including Peridinium with its numerous species and variable forms, is studied with special reference to variability. The illustrations are very clear and well reproduced. There are also extensive tables of data bearing on distribution and environment.

Some of the forms, especially the relatively common *Ceratocorys horrida* and *Goniodoma polyedricum*, have proved valuable in tracing movements of oceanic water masses, as their distribution is closely correlated with temperature, so that records of negative occurrence are of significance.

* Department of Terrestrial Magnetism. Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Captain J. P. Ault. Biology, 3: Studies in the Morphology, Taxonomy and Ecology of the Peridiniales. By Herbert W. Graham. (Publication 542.) Pp. vii+129. (Washington, D.C.: Carnegie Institution, 1942.) 1.50 dollars.

SPECIFIC DIFFERENCES IN PETUNIA

THREE papers by K. Mather, A. J. Bateman and K. Mather, and P. M. J. Edwards, respectively (*J. Genetics*, **45**, 215; 1944), deal with hybrids between *Petunia axillaris* and *P. violacea*. Important conclusions are made regarding the evolution of several characters.

In the first paper, K. Mather shows that *P. axillaris* is self-compatible and that *P. violacea* is a self-incompatible species. Hybridization of the two species shows that the factors *SaSa* of *P. axillaris* do not inhibit the growth of pollen containing *Sa*, but the F_1 hybrids are of two types, self-incompatible S_1S_a and self-compatible S_2S_a. When such plants were crossed with *P. violacea*, seed was obtained, but the reciprocal cross was infertile. Similarly, the backcross to *P. axillaris* gives different results in reciprocal crosses.

Mather suggests that modifying factors (polygenes) influence the expression of the main *S* allelomorphs. Within the species, the mechanism is stabilized and strengthened by selection of polygenes. When outcrosses are made, this polygenic background is altered. On this view the evolution of the incompatibility mechanism takes place slowly by the selection of those polygenes which favour the intensity of the mechanism.

A. J. Bateman provides further evidence that the S_1S_2 factors of *P. violacea* have a weaker effect in individuals with hybrid constitution. In the light of recent work on cytoplasmic influences, the discovery that pollen containing S_1 is mutually affected by previous association with *Sa* requires further investigation.

K. Mather and P. M. J. Edwards consider the inheritance of flower-colour in the above hybrids. They show that there are two main colour genes, *Ww* and *Mm*. *P. axillaris* contains *wwMM* and *P. violacea* contains *WWmm*. The succeeding generations range greatly in colour, which is shown by the

authors to be due to the changed polygene complex; in one case a recessive and a heterozygote were the same white colour in the species hybrid. The authors discuss the effect of selection of polygenes upon in-breeding and outbreeding, genetic isolation and the evolution of species. They contend that the constant effect of natural selection of polygenes plays a large part in retaining the stability of the species and the vital constants of the species.

FORTHCOMING EVENTS

Tuesday, May 30

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. E. R. Davies will read a paper by Dr. L. A. Jones: "Psychophysics and Photography".

Wednesday, May 31

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 1.45 p.m.—Dr. R. W. Holland: "Education To-day and To-morrow", 10: Lecture summing up the Series.

Thursday, June 1

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (at the Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1), at 3 p.m.—Annual Meeting.

Friday, June 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Jack Drummond, F.R.S.: "The Hot Springs Conference and its Bearing on Nutrition in Great Britain".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. W. R. Jones: "Strategic Minerals".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Capt. J. Morris: "Coupled Engine Torsional and Propeller Flexural Vibrations", followed by Informal Discussion on "Methods of Investigation of Engine Vibration".

APPOINTMENTS VACANT

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

AREA REPRESENTATIVE (male or female) in each of the following centres: Birmingham, Cambridge, Cardiff, Exeter, Leeds, Leicester, London, Manchester, Newcastle and Reading—The Medical Adviser and Secretary, Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1 (May 31).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 31).

PSYCHIATRIC SOCIAL WORKER—The School Medical Officer, Shire Hall, Nottingham (May 31).

HONOURS GRADUATE to teach MATHEMATICS and some PHYSICS, at the Burnley Municipal College—The Director of Education, Education Offices, Burnley (May 31).

GRADUATE MASTER FOR MATHEMATICS AND GENERAL SCIENCE—The Registrar, Loughborough College, Loughborough, Leics. (May 31).

LECTURER (man or woman) IN MATHEMATICS—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (June 1).

SPEECH THERAPIST (temporary)—The Director of Education, Education Offices, 32 Dovecote Street, Stockton-on-Tees (June 2).

ASSISTANT MASTER to teach SCIENCE and MATHEMATICS for the Textile Industry in the Junior Technical School of the Bolton Municipal Technical College—The Director of Education, Education Offices, Nelson Square, Bolton (June 3).

TEACHER (full-time) of Day and Evening Classes in MINING and MINE SURVEYING at the Whitwood Mining and Technical College, Castleford—The Director of Education, Education Offices, Castleford, Yorks. (June 3).

TEACHER (temporary, full-time) OF MATHEMATICS, and a TEACHER (temporary, full-time) OF MATHEMATICS AND MECHANICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (June 3).

ASSISTANT MASTER (with Graduate or equivalent professional qualifications) to teach MATHEMATICS AND GENERAL SCIENCE at the Scarborough Technical Institute—The Secretary, Education Offices, County Hall, Northallerton (June 3).

ASSISTANT LABORATORY TECHNICIANS trained in histological and hæmatological techniques—The Professor of Pathology, Royal Victoria Infirmary, Newcastle-upon-Tyne (June 5).

HEAD OF THE BUILDING DEPARTMENT, and a TEACHER OF MATHEMATICS (temporary)—The Principal, Technical College, Church Street, Barnsley (June 5).

GRADUATE ASSISTANT MASTER to teach MATHEMATICS AND SCIENCE, particularly CHEMISTRY—The Headmaster, Junior Technical School and Evening Institute, Eastbourne (June 5).

LECTURER (full-time) IN CHEMISTRY AND PHYSICS in the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool (June 5).

LECTURER (man or woman) IN CHEMISTRY—The Principal, Kingston Technical College, Kingston, Surrey (June 5).

LECTURER (full-time) IN CHEMISTRY—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (June 5).

LECTURER (male or female) IN ENGLISH and GENERAL SUBJECTS in the R.A.E. Technical School—The Headmaster, R.A.E. Technical School, Farnborough, Hants. (June 6).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 10).

STAFF LECTURER IN SCIENCE AND HYGIENE—The Principal, Northern Counties Training College of Cookery and Domestic Science, at Tower House, Tweedmouth, Berwick-upon-Tweed (June 10).

CHIEF AGRICULTURAL OFFICER—The Deputy Clerk of the County Council, Shirehall, Shrewsbury, Shropshire (endorsed 'Chief Agricultural Officer') (June 10).

RESEARCH ASSISTANT (temporary) in the FIELD BOTANY DIVISION of the Ministry of Agriculture of Northern Ireland—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2474A) (June 10).

LECTURER (temporary, full-time) IN PHYSICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (June 12).

APPRENTICE SUPERVISOR by large Engineering works to supervise educational and training schemes for apprentices and young persons (Nottingham district)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2021XA) (June 14).

PROFESSOR OF BOTANY, ASSISTANT LECTURERS IN ECONOMIC HISTORY, GEOGRAPHY, BOTANY and ZOOLOGY, ORGANIZING TUTOR IN ADULT EDUCATION for Derbyshire, and a TUTOR IN PSYCHOLOGY—The Registrar, University College, Nottingham (June 14).

HENRY MECHAN CHAIR OF PUBLIC HEALTH—The Acting Secretary of University Court, The University, Glasgow (June 15).

LECTURER IN DIETETICS in connexion with Course leading to University of London Academic Post-Graduate Diploma in Dietetics—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 17).

METALLURGIST by Firm of Engineers with wide interests (Ph.D., or equivalent, minimum technical qualification)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2286XA) (June 17).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

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

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

LECTURER (temporary) IN GEOGRAPHY—The Registrar, The University, Reading.

TWO MEN with experience in, or qualified for training in use of, Podbielniak and other apparatus for the fractional analysis of gases in the laboratory, for service with Petroleum Company in the Middle East—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 878/6).

DIRECTOR OF RESEARCH—The Secretary, British Iron and Steel Federation, Tothill Street, London, S.W.1 (endorsed 'Director of Research').

SECRETARY to the British Iron and Steel Research Association—The Secretary, British Iron and Steel Federation, Tothill Street, London, S.W.1 (endorsed 'Secretary').

ASSISTANT (male) IN BIOCHEMISTRY at the Courtauld Institute of Biochemistry—The Medical School Secretary, Middlesex Hospital, London, W.1.

GRADUATE ASSISTANT (temporary), with special qualifications in MECHANICAL ENGINEERING, a GRADUATE ASSISTANT (temporary) with First or Second Class Honours or Higher Degree in either MATHEMATICS or PHYSICS, and a well-qualified ASSISTANT (temporary) with trade experience for ENGINEERING WORKSHOP PRACTICE—The Principal, Mining and Technical Institute, Neath.

LECTURER IN MECHANICAL ENGINEERING—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 44: Stress-Strain Data for Vulcanised Rubber under various Types of Deformation. By L. R. G. Treloar. Pp. 12. (London: British Rubber Producers' Research Association.) [284

Report of the Rugby School Natural History Society for the Year 1943. (Seventy-seventh issue.) Pp. 36. (Rugby: George Over, Ltd.) [284

Eyesight and Industry. A Speech delivered by the Vice-Chancellor of the University of Oxford at a Mansion House Luncheon on 22 February 1944. Pp. 12. (Oxford: University Press.) [284

Drawing Office Organisation. (Office Aid to the Factory Series.) (B.S. 1100, Part 9, 1944.) Pp. 36. (London: British Standards Institution.) [15

Leicester Museum and Art Gallery. Thirty-ninth Annual Report to the City Council, 1 April 1942 to 31 March 1943. Pp. 16. (Leicester: Museum and Art Gallery.) [15

Board of Education. Teachers and Youth Leaders. Report of the Committee appointed by the President of the Board of Education to consider the Supply, Recruitment and Training of Teachers and Youth Leaders. Pp. 176. (London: H.M. Stationery Office.) 2s. net. [25

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.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or Pensions may be granted to persons who comply with these conditions. For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

UNIVERSITY COLLEGE OF SWANSEA

(A constituent College of the University of Wales)

Principal: C. A. EDWARDS, D.Sc., F.R.S.

The twenty-fifth Session will open on Oct. 3, 1944.

Courses of study are provided for—

(*a*) Degrees of the University of Wales in Arts, in Pure Science, and in Applied Science (Metallurgy, Engineering, and Metallurgical Engineering);

(*b*) Diplomas of the College in Metallurgy and in Engineering;

(*c*) The training of teachers for elementary and secondary schools;

(*d*) The first medical examination of the University of Wales.

(*e*) The first year of the course for the degree of *Baccalaureus in Architectura*.

(*f*) The Preliminary Part of the scheme of study for the degree of *Baccalaureus in Pharmacia*.

College courses in Pure Science are recognized by a number of medical licensing bodies as constituting a first year of medical study.

Persons who are not desirous of studying for degrees or diplomas may attend selected classes, provided they satisfy the authorities of the College that they are qualified to benefit by such classes.

The College maintains a Hall of Residence for women students.

Entrance scholarships will be offered for competition in April, 1945.

Particulars concerning admission to the College, and of the entrance scholarships may be obtained from the undersigned.

EDWIN DREW,
Registrar.

Singleton Park,
Swansea.

GOVERNMENT OF NORTHERN IRELAND

A vacancy exists for a RESEARCH ASSISTANT in the FIELD BOTANY DIVISION of the Ministry of Agriculture. The appointment will be temporary, and terminable on one month's notice, but is expected to continue for the duration of the present emergency.

Qualifications: Candidates should be graduates (preferably with Honours) in Science or Agriculture. Preference will be given to Candidates having an agricultural background, and to those having Research experience at home or abroad in Agricultural Botany, or knowledge of the Agricultural Seed Industry.

Salary: The scale of Salary attaching to the temporary appointment is £275 per annum, rising by annual increments of £20 to £335, thence by £40 to £375, and thereafter by £25 to a maximum of £600 (for men officers) or £500 (for women officers). A commencing salary higher than the minimum may be paid to a Candidate having special qualifications and experience.

A War Bonus of 19s. a week (men) or 15s. 6d. a week (women) is at present payable.

Applicants should write quoting F. 2474A 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 June 10, 1944.

KING'S COLLEGE of HOUSEHOLD and SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

Temporary Address:
c/o University College, Leicester

Applications are invited for appointment as ASSISTANT LECTURER and DEMONSTRATOR in PHYSIOLOGY, to date from October, 1944.

Applications, together with copies of three testimonials, should reach the Secretary (from whom further details may be obtained) not later than June 10, 1944.

SUNDERLAND EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal:
F. H. Reid, B.Sc., Wh.Ex., M.I.Mech.E.

Applications are invited for the post of HEAD of the PHARMACY DEPARTMENT. Salary scale £500 by £25 to £600, plus War Bonus.

The College is approved by the Pharmaceutical Society of Great Britain for the Chemist and Druggist Qualifying Examination, the Pharmaceutical Chemist Qualifying Examination, and the Diploma in Biochemical Analysis. The College is also recognized by the University of London for the purposes of the B.Pharm. Degree.

Candidates must be Qualified Chemists, possess a degree in Pharmacy, or Science, of a British University, and have had teaching experience.

Forms of Application and further particulars may be obtained by sending a stamped addressed envelope to The Registrar, The Technical College, Sunderland, and forms of application should be returned to the undersigned not later than June 17, 1944.

W. THOMPSON,
Director of Education.

Education Offices,
15 John Street, Sunderland.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)

8 Hunter Street, Brunswick Sq., London, W.C.1

Applications are invited from men and women holding degrees in Physiology or Medicine for the post of DEMONSTRATOR in the PHYSIOLOGY DEPARTMENT, from October 1, 1944, at an initial salary of £250 per annum, with superannuation benefits and war allowance.

Further particulars may be obtained from the Warden and Secretary, to whom applications should be sent by June 9, 1944.

NANCIE MOLLER,
Warden and Secretary.

May, 1944.

KING'S COLLEGE of HOUSEHOLD and SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

Temporary Address:
c/o University College, Leicester.

Applications are invited for appointment as LECTURER IN DIETETICS in connection with course leading to University of London Academic Postgraduate Diploma in Dietetics. Duties will begin in October, 1944.

Applications, together with copies of three testimonials, should reach the Secretary (from whom further details may be obtained) not later than June 17, 1944.

NEWCASTLE UPON TYNE NATIONAL RADIUM CENTRE

A short list of applicants for the post of PHYSICIST to the Newcastle upon Tyne National Radium Centre is now being prepared, and intending applicants who have not yet sent their applications should do so immediately.

Salary will be up to £800 per annum according to experience.

Applications should be sent to Dr. A. W. Sanderson, Secretary, Newcastle upon Tyne National Radium Centre, Royal Victoria Infirmary, Newcastle upon Tyne.

ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH, HANTS

R.A.E. TECHNICAL SCHOOL

Applications are invited for the post of LECTURER (male or female) in ENGLISH and GENERAL SUBJECTS in the above day school, which consists of selected students and has an age range of 16 to 21.

The salary payable is in accordance with the Burnham Scale, but an allowance may be granted for special qualifications.

The appointment will be subject to the provisions of the Teachers (Superannuation) Act, 1925.

Full particulars relating to the appointment may be obtained from the Headmaster, R.A.E. Technical School, Farnborough, Hants, to whom applications should be sent as early as possible and in any case not later than June 6, 1944.

STUDLEY AGRICULTURAL COLLEGE

Applications are invited for the appointment of LECTURER IN BACTERIOLOGY to students preparing for the National Diploma in Dairying. The candidate appointed will also be asked to assist in teaching either elementary Chemistry or elementary Botany to agricultural students.—Further particulars may be had from the Principal, Studley Agricultural College for Women, Studley, Warwickshire.

KING'S COLLEGE, NEWCASTLE UPON TYNE

(In the University of Durham)

DEPARTMENT OF ANATOMY

TECHNICIAN required, mainly for research work; experience in histological technique essential. Applications, stating experience and wage required, should be addressed to the undersigned.

G. R. HANSON,
Registrar of King's College.

BATTERSEA POLYTECHNIC, LONDON, S.W.11

The Governing Body invite applications for the post of full-time LECTURER IN CHEMISTRY. Salary in accordance with the scale for graduate teachers in Technical Schools. Further particulars from the Clerk to the Governing Body—by whom applications should be received not later than June 5.

Physicist wanted: Essential War Work. Age about 30 to 35. First-class academic qualifications and experience in postgraduate research essential. Work would include experience in various research departments of a North London firm specialising in optical instruments for scientific and industrial research and control. For a suitable man, the permanent post of Controller of Research and Development is in view after two years experience. Salary from £500, according to qualifications and experience. Applicants should write quoting A.518XA 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 June 21, 1944.

A week-end course on "Medical and Administrative Problems connected with the Resettlement in Industry of the Disabled (ex-service and civilian)" will be held at the London School of Hygiene and Tropical Medicine on Saturday and Sunday, July 8 and 9. The course is designed for industrial medical officers and other medical practitioners interested in the subject, and the lecturers will include, Dr. Harold Balme, Mr. R. E. Gomme, Dr. E. C. Warner, Mr. R. W. Watson-Jones, Dr. Aubrey J. Lewis, and Dr. Norman Tattersall. Applications, together with the fee of one guinea (and 2s. 6d. if lunch is required on the Sunday), should be sent to the Secretary of the School, Keppel Street, Gower Street, London, W.C.1, before Monday, July 3.

Laboratory Technician, with special knowledge of Pathological Chemistry, required in Clinical Laboratory of the Medical Unit, St. Mary's Hospital, now evacuated to E.M.S. Hospital, Harefield. Salary £3 10s., increments 2s. 6d. per half-year to £4, with possible further increase on up-grading; bonus 2s. 6d. in the £, billeting 11s.; initial total £4 9s. 9d.—Write, Box 1420, c/o White's Ltd., 72 Fleet Street, E.C.4.

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

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

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

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

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

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