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MORALE IN INDUSTRY

IN the subscription by people of all political parties in Britain to the policies of full employment and a rising standard of living, far too little has been said of some of the practical implications of these aims. There is indeed general agreement that total spending must be maintained at a high level, investment in industry scaled up, research encouraged, the quality of management improved and monopolistic restrictive practices rooted out. But it is rare to find any reference to another, and no less indispensable condition, both on economic grounds and by its bearing on the morale of the whole community : namely, the organization and incentives of industry must be so contrived that individual men and women produce as much as they can, putting no limit, conscious or unconscious, on reasonable maximum output. After five years of intense effort and overstrain, it is natural that everyone should look for shorter hours and increased leisure, but it is imperative to realize that in a world so short of consumption goods, houses and utility services and amenities, the maximum output must be forthcoming during these shortened hours of work.

This is, in fact, part of the price to be paid for social security, but it is rare indeed to find the full implications of industrial efficiency, where they touch the worker himself, recognized ; and the broadsheet "Output and the Worker" issued by P.E.P. expounds an aspect of the drive for full production which the dust of the general election in Britain has tended still further to conceal. The causes of limitation of output go deep and involve a complex of mental and physical factors. Lighting and ventilation, and other sources of physical comfort or discomfort, have an obvious effect on output ; but the effect of mental factors such as the fear of unemployment and anxiety about pay may be equally important though less obvious.

The P.E.P. broadsheet, which is based on part of a forthcoming report on industrial relations, and compares the main findings of qualified investigators on this subject, suggests that security of employment alone would remove one of the main brakes on individual or group production. Again, it suggests that production committees, wisely handled, should go some way towards removing another mental obstacle to full production—the sense of antagonism between workers and management, arising from a real or supposed clash of interests. At the same time, by spreading a feeling of greater personal responsibility, these committees might help to mitigate industrial boredom, itself a potent source of restriction.

There is no simple cure for these and other mental causes of restriction, nor can the problem as a whole be tackled successfully by management alone. A joint approach by management and workers is required, and a reconciliation should be sought between their group interests. The broadsheet affords strong support for the view advanced by Prof. H. J. Laski in his "Reflexions on the Revolution of our Time", that with the achievement of a policy

of full employment the trade unions may have new and more positive functions in place of those defensive and sometimes restrictive policies which they have pursued in the past.

The evidence reviewed by P.E.P. in this broadsheet covers experience in the United States, including that of M. E. Dickson, of Whiting Williams, of S. B. Matthewson and the prolonged researches at the Hawthorne Works of the Western Electric Co. in Chicago, as well as the work of S. Wyatt, H. M. Vernon and the well-known series of studies under the Industrial Health Research Board in Britain. Restriction in particular is closely analysed by S. B. Matthewson in "Restriction of Output Among Unorganised Workers", and more recently by F. J. Roethlisberger and W. J. Dickson in "Management and the Worker" (Harvard University Press, 1942).

The present P.E.P. broadsheet is concerned with what may be termed the predominantly mental sources of limitation of output, whether conscious or unconscious. Physical factors, such as lighting, heating, ventilation, humidity and noise may diminish or increase physical fatigue and so affect output. But while bad conditions in respect of any of these factors may reduce output severely, even if conditions are reasonably good further changes in the physical environment may have little effect by comparison with psychological factors which may mask any effect due to the physical factors. It is of course difficult to draw a firm distinction in practice between fatigue and boredom. Physical and mental factors in practice usually interact, and the brilliant investigations of the Industrial Health Research Board into the nature of industrial boredom and its effect on output, which as a result of the increasing importance of repetitive work in modern factory-production has become one of industry's most pressing problems, have indicated that the attitude to work is largely a group phenomenon. Working groups tend to have a predominating tone in this respect, and this tone frequently depends on one or two outstanding personalities, acting as more or less informal leaders to the group.

Similarly, it is difficult to distinguish conscious from unconscious elements, and unconscious or semi-unconscious limitation of output is probably more prevalent than deliberate, organized limitation. That factor in itself may well have had an important influence on the high level of output during the summer and autumn of 1940, and have masked to some extent the injurious effect of the excessive hours worked during a prolonged period in spite of all the evidence of the dangers of such a policy. Fear of unemployment undoubtedly ranks high among the causes limiting output, and so long as mass unemployment is allowed to occur, the widespread belief will persist that there is a definite limit to the amount of work to be done, and that it is therefore in the interest of wage-earners as a whole to share what work is available among as many people as possible. Such reasoning will not be rooted out by mere argument, and there have already been incidents in the transfer of labour from war-time employment which, to say the least, will not help such eradication.

Matters affecting payment, particularly fear of rate-cutting, come next in importance; but while the case against economic factors as a main cause of restrictive practices may possibly be over-stated by Roethlisberger and Dickson, here as in boredom it is a matter of physical and mental factors interacting. Moreover, though a new machine or an improvement in technique could probably have more effect on production than could any improvement in applied industrial psychology, the absolute contribution which could come if we achieve the highest productive potential of working individuals and groups is very great. In addition, when the majority of its members are deliberately or unconsciously giving less than their best, a society is on a very unsound basis.

For these reasons, an improvement in industrial morale stands only second in importance to improvement in industrial technique and equipment. In spite of its defects in morale, industrial efficiency in Britain suffers more from lack of up-to-date equipment and organization than from lack of skill in its operatives; but as we replace obsolete methods and equipment and approach American standards, the importance of morale will increase. Experience of the industrial war effort in Britain, the United States and the U.S.S.R. suggests that utilization of the group interest of the workers themselves is the most important line of advance, and clearly offers great scope for co-operation between management and trade unions. So long as there is a real or supposed gap between the group interests of workers and management, the enlisting of this source of productive energy will remain imperfect, and in spite of the valuable lessons to be learnt from the war-time joint production committees, the scope of such bodies has yet to be worked out in its most effective form.

It must be recognized that there are general features of the industrial situation, independent of trade unionism, which are of governing importance. The total economic situation, as already emphasized, profoundly affects the industrial psychology of the working individual or group. Again, mechanisms of defence which the average worker erects against the trade cycle and the attitude that goes with them persist even when not relevant in a given economic situation. Then there is a long-standing and deep-seated suspicion of authority in all its forms, and particularly as seen in the supervising staff in immediate contact with the worker.

To these features the P.E.P. broadsheet makes no more than passing reference, although their importance is clearly stressed. The central difficulty, however, is nowhere stated in the broadsheet, for all the recognition of the value and the limitations of scientific research in this field. That difficulty is essentially the inevitable opposition which develops between the scientific approach to the human problems of production and the political approach of the administrator trained in the method of accommodation and compromise. The balancing of opinions and the compromise of different points of view, which is the essence of the political process, may be totally at odds with the scientific approach to questions of industrial management. What is required is not the

surrender of scientific principles of accepted accuracy, or the ignoring of established fact, but the combination or integration of both the political and the scientific approach in a solution which satisfies both the scientific and the psychological or political requirements.

On our success in achieving such a solution, the question of morale, industrial efficiency and ultimately a full employment policy largely depend. The point could scarcely have been made better than in the address "Compromise and Integration" which Colonel L. Urwick delivered last February to a joint meeting in Liverpool of the Institute of Labour Management and the Institute of Industrial Administration. The reconciliation of our institutions to the new environment created by science and technology is the great problem of our civilization, and Colonel Urwick demonstrated effectively the challenge involved in using fully the results of scientific knowledge and the immense control it gives us over material things, without sacrificing the freedom of mind which alone makes further scientific progress possible.

Not the least significant part of Colonel Urwick's address is the opening part, in which he stresses the need for precise thinking and for exactness in the use of words. Words are the tools with which men think, and scientific workers would be more effective in the interpretation of their work to the community if they kept that axiom more constantly in mind. In any event it must be regarded if we are to achieve the integration of scientific workers and technicians with each other, and of science and technology with the life of the community. A first step to the new kind of thinking, towards seeing our problems as a single problem, to the integration which will eliminate the confusion into which our civilization has fallen since the industrial revolution, is a clear understanding of the words we use as our tools of thought, and in particular of the distinction between compromise and integration. It is also the first step towards resolution of the conflict between social classes and between private ownership and State bureaucracy.

While a clear understanding of the terms used is a first essential, the light of a great common purpose alive and real in the minds of all the specialists as in that of the community they serve is equally important. Such a purpose must be conceived in terms of the common welfare, not in that of a particular class or section ; and of its nature it implies the participation of all the people for its realization. Such participation in its turn demands not just that the experts understand each other, but that they make their specialized tasks explicit to the people, so that they are understood by and become real to them.

This is impossible, as Colonel Urwick points out, while men try to live their lives in water-tight compartments guided by mutually incompatible principles. We must, he reminds us, restate our philosophy of economic life in terms which can give both specialists and workers a sense of common moral purpose. To do this, to integrate the real wishes of the right and of the left in Britain, we need vision and determination to cut through the verbal formulations, the truculent attitudes, and the clinging to outworn slogans in which those wishes are disguised. Our national spirit of accommodation and conciliation should be exercised in making conflict really constructive, and in inventing and developing true integrations.

The significance of all this in industrial psychology and in management generally, and the challenge offered to constructive thought by the present situation, should need no further emphasis for the scientific worker. But if industrial efficiency and the achievement of the maximum output require a closer integration of the workers and of the management, equally they require a closer integration of industry itself with the needs and purposes of the community as a whole. That will not be achieved merely by scientific research in the field of industrial health and psychology, by the establishment of the most effective conditions for joint production committees, and so on. It is part of the larger task of establishing the dynamic relations between individuals and the organizations they serve in the nation as a whole which really represents what we understand by the term 'morale'. For this we need to call on the civic idealism and spirit of service which the Fighting Forces have already generated in youth. In the schemes for education in citizenship, study circles, discussion and community groups, supported by such national services as the Arts Council of Great Britain, and possibly a national fellowship of service as suggested by Mr. Arthur Bryant, we may be able to elaborate machinery through which democracy can function on the ground-level, and the spirit of accommodation and reason be fostered as against an uncompromising attitude which is so grave a danger to industrial efficiency and to the existence of democracy. Ultimately, industrial efficiency depends on the integration of the purposes of industry with those of the community itself; and for the smooth functioning of our co-operative institutions, whether industrial, professional or cultural, the preservation of their social values, and the establishment of dynamic relations with the community they serve, not merely technical knowledge but also the skilled diagnosis of human situations are vital factors.

TROPICAL PEDOLOGY

The Soils of Equatorial Regions

With Special Reference to the Netherlands East Indies. By Prof. Dr. E. C. Jul. Mohr. Translated from the Nederlandsch by Robert L. Pendleton. Pp. xii+766. (Ann Arbor, Mich. : Edwards Brothers, Inc. ; London: H. K. Lewis and Co., Ltd., 1944.) 7.50 dollars.

THE study of soils in equatorial or tropical countries has been very backward in comparison with that in temperate regions in spite of the great development of agriculture in the low latitudes. What is known is largely due to agricultural officers and chemists who had little time to spare from their routine duties. Unfortunately, much of the information available is for surface soils only, profile studies being rather scarce. Comprehensive studies on trop-

ical soils are thus rare, and one turns with interest to the volume under review for enlightenment on the many pedological problems provided by these soils.

The book begins with an extensive description, with chemical analyses, of most of the rock types occurring in the Netherlands East Indies. The second chapter passes naturally to a consideration of "the active forces of soil formation", that is, climate, both atmospheric and soil. Chapter 3 is devoted to a discussion of the processes of weathering and soil development. The remainder of the volume consists of descriptions of the geology, soils and agriculture of the islands composing the Netherlands East Indies.

In 1930 Dr. Pendleton first made available in English Dr. Mohr's theories of tropical soil development, to which little attention has been paid by soil workers. In a way, this is not surprising, for the symbolic method used by Mohr for soil description is repellent at first sight; for example, one soil discussed has the following designation

$$V(a + b) . (1 + 2) - Ma.NN.ae.3.$$

The various factors represented in this notation and which form the basis of the discussion are parent material, temperature zone, water movement in the soil, whether weathering is aerobic or anaerobic, and finally the stage in the developmental series. In illustration we may give briefly Mohr's conception of the formation of a laterite soil from a basic volcanic ash in tropical lowland; the soil sequence is symbolized as *V.b.*1 — *He.NN.ae.* (1–5). The first stage is the leaching of bases and silica, the latter precipitating at depth to form a tuff which gradually leads to the development of a perched water-table. From the upper layers silica continues to be lost and soon kaolin follows, leaving behind iron oxides, alumina and quartz. The iron oxide gradually ages and the colour of the soil changes through yellowish brown to red, with mottling in the lower parts. Within the water-table the iron rises and is deposited in the form of a pan or crust when it comes in contact with air. This results in its separation from the kaolin. The water-level is gradually raised, the ferruginous layer is moved upwards and the kaolin layer becomes thicker. Eventually the eluvial layer becomes impoverished of silica and kaolin and there is then a differentiation of the iron and aluminium into two layers, the aluminous one being the lower. With soil impoverishment the soil vegetation deteriorates and erosion increases so that the ferruginous layer becomes exposed as a crust. At higher elevations the whole process is much slower and erosion so much greater that if red earths are found, it is assumed that they are really fossil, having been formed near sea-level and afterwards raised to their present position by tectonic movements.

Mohr's analysis of the development of a laterite soil is similar to that given by Campbell in 1917. Later, on the basis of his studies in the Amazon Basin and Cuba, Marbut (1930) showed this particular soil to be a type owing its existence to a high ground water-table, and not at all typical of well-drained sites. From Mohr's account one gets the impression that this ground-water type is the only one occurring in the Netherland East Indies, but since well-drained laterite soils with no ferruginous horizon as visualized by Mohr have been repeatedly described in the Far East (China, Ceylon, the Philippines) it would be strange if none occurred in these islands.

Although the scheme is worked out in detail only for volcanic ash deposits, it should be applicable, perhaps with minor modifications, to soil development on other rocks, for example, granites, gabbros, etc. From Mohr's own descriptions it is quite impossible to tell to what extent it does really apply. The sole criterion used in later parts of the book for establishing the stage of development seems to be the colour of the eluvial layer, that is, whether it is grey, yellow or red. The nature of the parent material, of course, does affect the rate of development and Mohr states that basic igneous rocks give redder 'lixivia' than granites, which tend to give yellowish 'lixivia' although they may become red. Developmental series similar to the above example are also worked out for other parent materials, such as marls and limestones, and for other drainage conditions, for example, impeded and imperfect, the associated soil types including black earths and terra rossa.

The principal value of Mohr's method of classification is that it emphasizes the idea of developmental sequence which is too often ignored in soil studies. It may thus provide a clue to the interrelationship of the red and yellow lateritic earths which are both quite well established now, but the position of which in the general scheme of soil classification is not yet clear.

The part played by organic matter in tropical soil formation is given great prominence and the problem of erosion is fully discussed. In the discussion of erosion, Mohr emphasizes the effect of the different forms of hydrous iron oxide on erodability of soils. In the colloidal state there is mutual flocculation between the iron oxide and clay and organic matter resulting in a pervious system. When, however, the iron oxide is more highly crystalline (gœthite or hæmatite) it does not have a flocculating effect on the clay. When the latter "is poor in bases it is excessively dispersed hence impervious to air and water". Thus juvenile brown earth is pervious, but when saturated with water quite easily erodable. Senile red earth is more difficultly permeable and is less subject to washing off. With alumina the theory is similar. Thus, soils with a low silica-sesquioxide ratio, that is, soils of the warm humid regions, are non-erosive if iron oxide occurs in one or other of the red forms. With regard to the relatively high values reported for organic matter in red and yellow tropical soils, Mohr doubts their accuracy, and suggests that they may be due to carbon dioxide adsorbed on the abundant hydrous iron oxide present in the soils and not to organic matter.

In the second part of the book, a section is devoted to each of the islands or territories under Dutch control. The material in each section includes a brief discussion of the geology, weathering conditions and soil formation, finishing with a description of the agriculture in relation to soils. This part will be of greater interest to agriculturists concerned with tropical crops, and it seems to give a good account of the various practices, with suggestions for improvement.

From the pedological point of view, the main weakness of the book is the virtually complete lack of either adequate profile descriptions or chemical analyses which might substantiate Dr. Mohr's theories. Any theory of tropical soil development must take into cognizance available data from other countries, and this Dr. Mohr has failed to do. There is no reference to the work of Hardy in Trinidad, Joachim in Ceylon, Martin and Doyne in West Africa,

or American studies in the Caribbean and Pacific regions, although Harrassowitz comes in for strong criticism. The book also suffers somewhat from the fact that its original production was protracted (1933–38), so that one finds in the earlier part, for example, that 'kaolin' is the main component of the clay of the various soils, while in later sections 'montmorillonite' takes its place in discussions of the black earths and terra rossa. There are many other points on which the book might be criticized, but this would be unfair since the author was unable to complete the projected revision for the English edition.

Dr. Pendleton has made an excellent translation under considerable difficulties, and the book is well illustrated and beautifully produced; but I would much rather have seen an account of tropical soil formation by Dr. Pendleton himself, for few soil workers have had such a long and varied experience of these soils. A. MUIR.

STUDY OF EARTHQUAKES

Seismology

By Perry Byerly. (Prentice-Hall Geology Series.) Pp. x + 256. (New York: Prentice-Hall Inc., 1942.) 4.65 dollars.

THIS book about earthquakes and their study, by an eminent American professor, living in a State occasionally visited by strong earthquakes, and teaching seismology in a university which introduced the subject to the United States, is a valuable, important and welcome addition to international seismological literature. The book is divided into two parts. The first seven chapters, Part 1, are on the subject of earthquakes and require little technical knowledge. Part 2, entitled seismography, presupposes readers with some preparation in mathematics and physics.

Many perfectly general problems in seismology have already been solved. Excellent summaries of the main theories of earthquake causes at present tenable are given in Chapter 4, while many others have been discarded as quantitatively unreasonable. The author admirably stresses the living nature of the subject and often the reader's imagination is kept alive, and his feet on solid unshaking rock, by queries about the theories (pp. 50–51). A start only has been made with the details of seismology; for example, Prof. B. Gutenberg and others have discovered local variations in the travel-time tables (pp. 210–14) and thus have suggested answers to geophysical questions concerning mountain roots—and the subject bristles with topics for research. Not one of the theories listed in Chapter 4 will enable one to decide in advance the exact focus and time of occurrence of a shock, and it is just these things which engineers and public authorities wish to know if they are to take all precautions for public safety. Can instruments be devised to detect variations in critical material deep underground such as accumulating pressure or variations in temperature and plasticity? It is to details such as sudden changes in these and like functions to which we must look. There are also minor discrepancies in seismology to clear up, such as the differences occasionally met with between mathematically determined epicentres (from readings of seismograms) and the same epicentres determined geologically in the field (p. 26). The old problem, however, of distinguishing cause and effect as between earthquake and geological fault is considered solved by Prof. Byerly, who says (p. 26), "On the whole it seems reasonable in our present state of knowledge to assign *faulting* as the *cause* of all large earthquakes and almost all small ones". A four-figure number is suggested for each earthquake, each successive figure denoting intensity, greatest perceptible distance, lives lost, and damage to property. Such a number would describe the shock in greater detail than the present Modified Mercalli Scale number only. Such suggestions are extremely important in areas comparable with California, where an extensive programme of research is carried out by the United States Coast and Geodetic Survey with the co-operation of thousands of observers.

It is well known that world maps on which are placed dots for earthquake epicentres show definite lanes within which most of the earth's recent earthquakes have occurred. Most seismologists wish to show more than this in a manner which is as little complicated as possible. From time to time various suggestions have been made as to what else to include. Such quantities as intensity and depth of focus have been mentioned, but Prof. Byerly prefers 'seismicity' which includes area shaken, intensity and frequency. This he evaluates for areas in California (map p. 86). Part 1 ends with some new material on a few of the world's great earthquakes.

Part 2 opens with an excellent chapter of forty-eight pages on the mathematical theory of modern seismographs. Most of this space is given to the derivation of the fundamental equations of motion. The operational method for the solution of differential equations is first used to obtain the general equation of the response of a seismograph to an earth acceleration Φ. Free pendulums and damped pendulums are then examined with particular types of Φ. The determination of the constants and the dynamic magnification are dealt with, as is also electromagnetic registration for such as the Galitzin type seismograph. Some notes are given on the Benioff type in which an iron core or armature is used with the coil, on types of suspension and on methods of recording and damping.

Very little space is devoted to the all-important subject of time-keeping, though perhaps it is thought that this deserves a volume to itself. The mathematical theory of elastic waves is covered in twenty-six pages. General equations of motion, waves, reflexion and refraction, Rayleigh and Love waves are examined, and there is a paragraph concerning observations on surface waves. Paths of waves and travel-time curves are dealt with first mathematically in an idealized way and then practically and observationally. There follows naturally a short chapter on the location of epicentres by instrumental methods. The last chapter, on seismograms, covers in a masterly way modern trends from the shaking table experiments of K. Dyk and the analysis of seismograms by integration to the idealized mathematical work on the dispersion of Love and Rayleigh waves.

In so short a book for so wide a field one feels that the author must have had some anxious times pondering what to leave out. Not all topics have been touched upon, and the lists of references at the ends of the chapters have omissions even in the topics discussed in the chapter. It may still be true that there is no royal road to learning, but this book will undoubtedly form a good and sound though limited 'air landing strip in the kingdom of seismo-

logy'. From this strip the applied mathematician or mathematical physicist could easily range the seismological field and find suitable targets for attack with his mathematical weapons. The book would be most useful to university teachers of these subjects who are in search of problems for their advanced and research students. In this case chapter 1 and part of chapter 2 could be omitted.

The format is very pleasing and the printing is bold. The line diagrams are good but the reproduction of the photographic illustrations might be improved in a later edition. There is an adequate index.

E. Tillotson.

TEACHING OF PHARMACOGNOSY

A Text-Book of Pharmacognosy

By George Edward Trease. Fourth edition revised with the assistance of Dr. H. E. Street and E. O'F. Walsh, with Contributions by Dr. R. Bienfang, H. M. Hirst, H. O. Meek and A. H. Ware. Pp. viii+800. (London : Baillière, Tindall and Cox, 1945.) 27*s.* 6*d.*

MR. TREASE can justly claim to be one of the foremost exponents of pharmacognosy in Britain. His work at Nottingham is well known, where he is head of the Department of Pharmacy and responsible for the teaching of pharmacognosy. He is also an examiner in this subject for the Pharmaceutical Society and for the University of London.

Teachers and students will welcome this fourth edition of an already well-used text-book, and those familiar with the previous editions will readily recognize the improvement brought about by a complete revision of the subject-matter. Mr. Trease has gone to considerable pains to incorporate, up to the time of writing, the results of recent research, and also the material the use of which in medicine has been permitted owing to the exigencies of war. The result is a volume packed with useful information presented in an attractive manner and profusely illustrated.

One of the major alterations is the extension of the chapter on cell-structure. To his credit, Mr. Trease has not hesitated to draw upon those who have special knowledge of different aspects of his subject. A good working knowledge of plant histology is essential to success in the higher branches of pharmacognosy, where microscopy is so important in the identification of drugs in powder form. Many students have to approach it equipped only with the botanical training of the standard required for the Pharmaceutical Society's Intermediate Examination. Such students do not extend their knowledge of plant structure in further botanical work except as afforded by pharmacognosy. Teachers of this subject are therefore compelled to devote considerable time to plant histology. Therefore Dr. Street's account of cell-structure, and his well-executed drawings illustrating various types commonly met with, will be much appreciated.

It is questionable whether, with his limited botanical knowledge, the student can appreciate the arrangement of the official drugs of vegetable origin according to the systematic classification of plants. For teaching purposes it appears to be more convenient to classify the drugs themselves according to their morphological nature. Such arrangement enables the student to compare and contrast similar organs both macro- and microscopically and to remember more easily the points of difference for diagnostic purposes. One advantage of the present arrangement is to emphasize that similarity of chemical constituents in drugs does not necessarily imply close phylogenetic relationship.

The publishers are to be congratulated on having been able to produce a work of this magnitude, relatively free from errors, under war-time restrictions of labour and materials.

W. O. Howarth.

ADVANCED ORGANIC CHEMISTRY

Organic Chemistry

By Louis F. Fieser and Mary Fieser. Pp. xii+1091. (Boston : D. C. Heath and Co. ; London : George G. Harrap and Co., Ltd., 1944.) 30*s.*

WITHIN the limits of this treatment the authors have undertaken a survey of the vast field of organic chemistry at the level of students reading for an honours degree in the subject. This ambitious project has been carried through with conspicuous success in a single volume of forty chapters and a little more than a thousand pages. The book is written in a clear and easy style, flowing naturally from one topic to the next. The dual authorship is so effective that it shows little sign of the numerous joints indicated in the preface ; nor would the reader suspect, apart from the statement in the same place, that a large part of the writing of the senior author was done "in trains, planes, hotels, and army camps in the course of more than one hundred trips".

Starting with hydrocarbons and alcohols, the account leads through other common aliphatic types to Chapter 11 on stereochemistry. Following this, chapters on ring formation, rubber, carbohydrates, fats and waxes, and proteins, are succeeded by specialized reviews of microbiological processes, the role of carbohydrates in biological processes, and the metabolism of fats, proteins and amino acids. The next thirteen chapters are devoted to aromatic chemistry, and the work ends with further chapters on dyes, synthetic fibres, synthetic plastics and resins, steroids, isoprenoid compounds, accessory dietary factors, and advances in chemotherapy.

The work affords a valuable and up-to-date treatment of organic chemistry, in which due stress is laid on technological, biological and medical aspects of the subject. Modern theories of organic chemistry are well developed as the book unfolds, and this object has been achieved unobtrusively without an undue display of electronic symbolism to delay the narrative or obfuscate the reader. The text is well documented with a list of reading references at the end of each chapter ; there is a good index ; and the letterpress, diagrams and formulæ are admirably printed. An unusual feature is the statement of the yields obtainable in many of the reactions quoted. With so much to applaud, it would perhaps seem ungracious to suggest that more space could have been allocated to one specific theme at the expense of another—as, for example, to terpenes at the expense of aromatics—but it is difficult to advance any other criticism of moment. Taking it all in all, this work provides one of the best surveys of organic chemistry to be produced in recent years for advanced students of the subject, and it is bound to achieve popularity among this overburdened section of the modern community.

John Read.

LUBRICATION OF METAL SURFACES BY FATTY ACIDS

By Dr. F. P. BOWDEN, J. N. GREGORY
AND
Dr. D. TABOR
Council for Scientific and Industrial Research, University, Melbourne

WHEN surfaces in relative motion are separated by a fluid layer of appreciable thickness, the resistance to motion is due to the viscosity of the interposed layer. This type of lubrication is essentially a problem in hydrodynamics; the friction is very small and there is no wear of the moving surfaces. It is clear, however, that in many practical cases fluid lubrication is impossible. In many sliding mechanisms, or at the beginning and end of a reciprocating stroke, it is difficult for a thick continuous film of lubricant to be maintained, and even in rotating parts the thick film may break down and only a thin film of lubricant may remain. In such cases the friction is influenced by the nature of the underlying surfaces as well as the chemical constitution of the lubricant, and Hardy referred to such a state as 'boundary lubrication'. Boundary lubrication is of great importance in practice, and the nature of the surface film will determine whether serious wear or seizure will take place. The coefficient of friction for really clean metals which have been outgassed in a good vacuum is high and may be[1] about $\mu = 6$. For ordinary unlubricated metal surfaces which are exposed to the air the coefficient of friction is of the order of $\mu = 0{\cdot}5$–1. For metal surfaces lubricated with a boundary film μ is about $0{\cdot}05$–$0{\cdot}15$. This is considerably less than for clean surfaces, but is much higher than for fluid lubrication.

Effect of Chain Length

A systematic investigation of boundary lubrication was first undertaken by Hardy[2], who measured the static friction between surfaces, using homologous series of paraffins, fatty acids and alcohols as the lubricants. Using simple apparatus, he found that the coefficient of static friction decreased linearly with the chain-length of each family of compounds. The friction also depended on the nature of the underlying solid surfaces. He was thus able to show that the friction was a function of separate contributions by the solid surfaces, the chemical series to which the lubricant belonged and the number of carbon atoms in the chain.

Hardy explained these results by a very simple and elegant theory. He assumed that the friction between unlubricated surfaces is due to the surface fields of force. When the lubricant is added, the lubricant molecules orientate themselves at each of the solid surfaces to form a unimolecular adsorbed film. The solids sink through the lubricant layer until they are separated by only the unimolecular adsorbed film of lubricant. Slip then takes place between these adsorbed films, and the efficiency of a boundary lubricant is measured by the extent to which these films can mask the fields of force of the underlying surfaces. Along these lines Hardy was able to explain the linear relationship observed between the friction and the molecular weight for different members of a homologous series.

Later workers on static friction have not, however, fully confirmed these results[3]. Measurements of *kinetic* friction[4] also show that for a given homologous series there is no linear relation between friction and chain-length, but a fairly rapid decrease in the coefficient of friction, μ, to a constant value of about $0{\cdot}1$ as the chain-length increases. With fatty acids this steady value of μ is reached for steel surfaces when the molecular weight exceeds about 100, and for glass surfaces when the molecular weight exceeds about 200.

If the friction is measured with an apparatus in which one of the sliding surfaces possesses an appreciable degree of elastic freedom, the motion may not be continuous but may proceed in a series of jerks. There is an intermittent clutching and breaking away of the surfaces, and the friction, surface temperature, and the area of contact all show violent fluctuations. The nature and extent of these fluctuations naturally depend upon the elastic and mechanical properties of the system, but for given conditions the nature of the motion is profoundly influenced by the nature of the surfaces themselves[5]. With unlubricated metals and other solids, the surfaces are always torn to an appreciable extent and it is clear that the friction cannot be regarded entirely as a surface effect, but must be closely dependent upon the bulk properties of the solids. With mineral oils and many other lubricants the friction is lower, but the behaviour may still be essentially the same as for unlubricated metals. The intermittent clutching and breaking away still occurs through the lubricant films, and marked wear of the surface may still occur. Certain substances, however, are able to prevent this 'stick-slip' motion and allow smooth sliding to take place.

This type of measurement may be used to demonstrate in a striking way the effect of the chain-length of the lubricant. With short-chain fatty acids, for example, the motion proceeds in 'stick-slips' and some wear takes place. When the chain reaches a certain length, smooth sliding occurs, the friction falls and the wear is appreciably reduced. With steel surfaces the transition from intermittent motion to smooth sliding occurs at a chain-length of 5 or 6 carbon atoms, that is, a molecular weight of about 100.

Film Thickness

Langmuir and Schaefer[6] were the first to show that a monolayer of a fatty acid deposited from the Langmuir trough is sufficient to reduce the friction of glass surfaces from about $\mu = 1{\cdot}0$ for clean glass to about $\mu = 0{\cdot}1$. Bowden and Leben[7], working on built-up films varying from 1 to 53 molecular layers, obtained similar results. A monolayer of stearic acid on steel produced the same low coefficient of friction as a multilayer 53 molecules thick. However, the single film was soon worn away, and for effective lubrication capable of withstanding considerable wear it was found necessary to have present a layer of lubricant several molecules thick in order to replenish the surface with fresh lubricant. These experiments also showed that even with the thickest molecular films a certain amount of wear of the metal surfaces takes place. The importance of the first monolayer has also been substantiated by other workers[6,8,9,10].

These experiments were carried out on films deposited on the metal from a surface of tap water, and they may really consist of the calcium soap rather than the fatty acid. A direct estimate of the thick-

ness of the lubricant film may be made in another way. In some recent experiments a known quantity of 0·01 per cent lauric acid in paraffin oil was placed on a clean cadmium surface, and gave effective lubrication. The area covered by the oil was increased until the newly covered regions gave poor lubrication. From these observations it was possible to calculate the amount of lauric acid which was just sufficient to give good lubrication. It was again found that the lubricating film was of the order of 1–2 molecules thick.

With some metals, however, a monolayer of fatty acid is insufficient to provide adequate lubrication even for a single run. This falls in line with the earlier observations[1] on the friction of clean outgassed metals. In the absence of all surface films the friction was very high. With outgassed gold the admission of a trace of fatty acid vapour to the surfaces produced a decrease in friction which grew more marked with time as a thicker lubricating film formed on the surfaces. Similar results were obtained when a trace of oxygen was admitted to the surface of clean outgassed nickel, copper and gold.

It is evident, therefore, that in the lubrication of metals by fatty acids, the first adsorbed layer is, in many cases, responsible for the lubrication observed. This single layer is usually unable to provide adequate protection for the continuous traversals of the same track; for efficient lubrication in such cases an excess of fatty acid must be present to repair the damage caused by sliding. For some metals, however, a single layer is not sufficient to give adequate boundary lubrication even for the first run; a relatively thick film is necessary.

Effect of Temperature

The effect of temperature on the lubricating properties of boundary lubricants is of general interest and importance. In many parts of an engine, high temperatures may be reached in the running parts, and it is necessary to know the way in which this will affect the lubricant. For temperatures above 200° C. the main effect on a mineral oil is that of oxidation[11]. A mineral oil at room temperature will give stick-slip motion and appreciable wear. After heating for some time, the oil may develop oxidation products which will be adsorbed at the metal surface and will improve its lubricating properties; the oxidized oil will now give smooth sliding and reduce the wear. These changes are not reversible on cooling and are due to chemical changes in the oils (and sometimes the surfaces themselves). At higher temperatures after prolonged heating, gumming, corrosion and the production of other deleterious products will cause a deterioration in the lubricating properties.

A very different type of frictional change which is reversible may occur at lower temperatures[12]. For example, a typical 'high quality' commercial lubricant on a steel surface will give smooth sliding and slight wear. On warming the steel surface to 70° C., the motion changes from continuous sliding to stick-slips; on raising the temperature further, the stick-slips increase in size, the friction rises and a corresponding increase in wear takes place. Provided the heating has not been sufficient to cause appreciable oxidation of the lubricant, these changes are completely reversible on cooling. This effect has been investigated for pure substances[7]. For pure paraffins and straight-chain alcohols the transition occurs at the bulk melting point of the compound. For these substances the transition temperature is sharp and clearly defined.

With fatty acids the transition temperature T depends upon the load, speed and the experimental conditions, but it is considerably *higher* than the bulk melting point of the fatty acid. Under the conditions of measurement used by Frewing and Tabor, T for fatty acids on steel was about 70° C. above the bulk melting point. Under the different experimental conditions which obtained in Hughes and Whittingham's experiments[8], T was about 30° C. higher than the melting point. These workers also showed that the frictional properties and transition temperature of fatty acids deposited as a monolayer, or as a monolayer covered with paraffin oil, or as acid in bulk, are essentially the same. These results again show that the first monolayer is responsible for the lubricating properties of the lubricant and for the phenomenon associated with the measurements of T.

Nature of the Underlying Surfaces

Little work of a consistent nature has been carried out on the effect of the underlying metal on the lubricating properties of given lubricants. Hardy made some comparative measurements of the coefficient of static friction μ_s on steel, glass and bismuth surfaces and found that for any given hydrocarbon, fatty acid or alcohol, μ_s for glass is less than μ_s for steel, which is less than μ_s for bismuth. Sameshima carried out some similar experiments on steel, glass and silver surfaces. He found that glass was poorly lubricated, whereas steel was well lubricated, by fatty acids and alcohols. Silver showed an intermediate behaviour.

A more systematic investigation has been described by Hughes and Whittingham[8], who compared the lubricating properties of stearic acid and a commercial oil on various metal surfaces. They showed that for the commercial oil the value of T was very dependent on the nature of the metal substrate. For stearic acid, however, they found that both μ and T were not greatly dependent on the nature of the substrate whether it was of silver, lead, tin, aluminium, cast iron, stainless steel, copper or even copper oxide or copper sulphide. In these experiments, however, they used an upper slider of a fixed metal throughout (steel). This clearly introduced an uncertainty into the interpretation of the results.

A series of experiments has recently been carried out using similar metals for both the upper and the lower surfaces. The lower surface was a flat plate and the slider was hemispherical. Comparatively heavy loads of approximately 4,000 gm. were used and the sliding speeds were slow, *c.* 0·01 cm./sec. The results show that the lubricating properties of the fatty acids depend very markedly upon the nature of the metal. One of the most striking results is that, for unreactive surfaces such as nickel, platinum, silver and glass, fatty acids are scarcely more effective as lubricants than saturated hydrocarbons. These results led to some measurements of the chemical reactivity of the various surfaces with fatty acids under standard conditions. Lauric acid was used and the metal surface heated up to 150° C. with the acid in contact with it. The results at once showed that the metals fall into two distinct classes: (*a*) in which chemical attack is absent or is barely detectable; and (*b*) those for which chemical attack is marked (see table).

EFFICIENCY OF LUBRICATION WITH 1 PER CENT LAURIC ACID IN PARAFFIN OIL COMPARED WITH REACTIVITY OF THE METAL TO LAURIC ACID.

Metal	Coefficient of friction (20° C.)	Transition temperature (° C.)	% Acid* reacting	Type of sliding at 20° C.
Zinc	0·04	94	10·0	Smooth
Cadmium	0·05	103	9·3	,,
Copper	0·10	97	4·6	,,
Magnesium	0·10	80	Trace	,,
Iron	0·15–0·20	*c.* 40–50	,,	Irregular (smooth)
Platinum	0·25	20	0·0	Stick-slip
Nickel	0·28	20	0·0	,,
Aluminium	0·30	20	0·0	,,
Chromium	0·34	20	Trace	,,
Glass	0·3–0·4	20	0·0	Stick-slip (irregular)
Silver	0·55	20	0·0	Stick-slip (large)

* Estimated amount of acid involved in the reaction assuming formation of a normal salt.

As silver, copper and platinum are the only metals that are electropositive to hydrogen, the absence of reaction in the other metals must be due to the presence of a relatively stable oxide film. This is supported by some observations on aluminium. If the surface layer was scraped off so that the freshly exposed metal came in contact with the fatty acid, effective lubrication occurred. Where reaction occurs it is probable that it occurs mainly in two stages: (1) the atmospheric oxidation of the metal, (2) reaction of oxide with the acid. This has been confirmed by Dubrisay[13] in his experiments on the corrosion of metals by solutions of fatty acids in hydrocarbons. It is apparent, therefore, that the major factor in determining the reactivity is not the position of the metal in the electrochemical series but the reactivity of the oxide film and its rate of reformation.

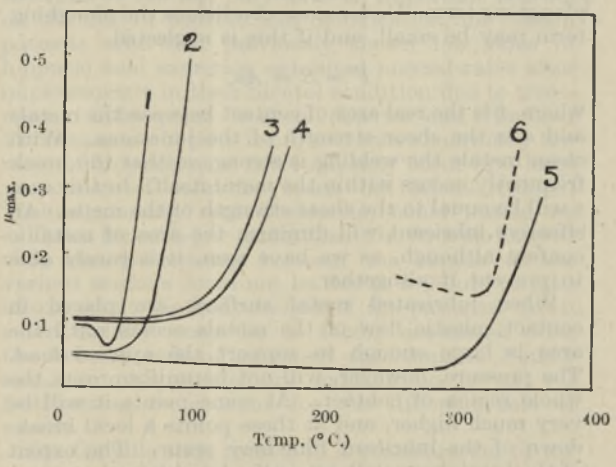
It is not suggested that there is a simple quantitative correlation between the coefficient of friction and the reactivity of the surfaces, but it is clear that those metals which are most effectively lubricated are also those which are most readily attacked chemically by the fatty acid. On the other hand, the unreactive metals and glass are poorly lubricated and give stick-slip motion with relatively high coefficient of friction. Further experiments showed that the less reactive metals, such as iron and aluminium, require a high concentration of lauric acid for the best lubrication. The unreactive metals, however, are not lubricated well even by pure acids unless the acids are solid. The lubrication of chromium and silver is of some practical importance at the present time, and it is interesting to note that neither of these is effectively lubricated by fatty acids.

Lubricating Properties of Metal Soaps

These results show that, under these conditions of sliding, the fatty acids themselves are only effective as lubricants when they react with the surfaces concerned. That is to say, lubrication is effected, not by the fatty acid itself, but by the metallic soap formed as a result of chemical reaction between the metal and the fatty acid. (It is interesting to note that an ester such as ethyl stearate does not lubricate above its bulk melting point on copper and cadmium surfaces. The behaviour on steel, however, appears to be anomalous and is the subject of a further investigation.) This view has been confirmed by several experiments on the lubricating properties of metal soaps. For example, a solution of copper laurate in paraffin oil gives the same frictional properties and transition temperature on copper as a dilute solution of lauric acid in paraffin oil. Further, the transition temperature (about 100° C.) is close to the temperature at which copper laurate begins to soften[14]. In this connexion it is interesting to recall the electron diffraction experiments of Tanaka[15], who found that stearic acid (m.p. 69° C.) on copper loses its high degree of lateral orientation between 120° and 130° C. Similar results for stearic acid on steel have been observed by Beeck, Givens and Smith[16]. More recently, Mr. A. Cowley has carried out some similar (unpublished) experiments with palmitic acid. He finds that a monolayer of palmitic acid (m.p. 62° C.) on cadmium loses its characteristic orientation at about 110° C. Monolayers of cadmium palmitate show exactly the same behaviour on both cadmium and platinum substrates. The softening temperature of cadmium palmitate is approximately 110° C. and frictional measurements show a breakdown at about the same temperature.

Similar behaviour is observed in the lubrication of platinum surfaces by metal soaps. Pure lauric acid, or lauric acid in paraffin, will not lubricate platinum at temperatures above 43° C., which is the melting point of the acid. If copper laurate is deposited from an ethereal solution on a platinum surface, the surface is lubricated up to temperatures of about 100° C., that is, the transition occurs at approximately the same temperature as that observed with lauric acid on copper. If, however, a solution of copper laurate in paraffin is applied to a platinum surface, the breakdown occurs at a much lower temperature and this must be attributed to the increased solubility of the metal soap in the paraffin. It is apparent that the breakdown of the lubricant film may be due either to a direct loss of rigidity by thermal softening or to a dissolution into the superincumbent liquid.

The importance of the physical properties and texture of the lubricating film is shown by experiments on sodium stearate applied to steel surfaces. If the soap is applied as a wet smear, breakdown occurs around 100° C. and is attributable to the ebullition of the excess water which disrupts the lubricating layer. If, however, the soap is applied



EFFECT OF TEMPERATURE ON FRICTION.

1. Solid docosane (m.p. 43° C.) on platinum surfaces. 2. Solid stearic acid (m.p. 69° C.) on platinum surfaces. 3. Solid copper laurate (softening point 110° C.) on platinum surfaces. 4. 1 per cent lauric acid in paraffin oil on copper surfaces. 5. 'Dry' film of sodium stearate (softening point 290° C.) on steel surfaces. 6. Thin film of lead (m.p. 327° C.) on hard steel surfaces.

from an ethereal solution, it retains its lubricating properties up to 300° C., which corresponds to the temperature at which sodium stearate softens and becomes a mobile liquid[14]. The behaviour of long-chain fatty acids on unreactive surfaces is thus similar to that of long-chain hydrocarbons, and to that of thin films of soft metals deposited on hard substrates which lubricate until the melting point of the film is reached. This behaviour again is similar to that of metallic soaps which, as pointed out above, maintain their lubricating properties until the temperature reaches the softening point of the soap. These similarities are shown in the accompanying graph, where it is seen that docosane (m.p. 44° C.) and stearic acid (m.p. 69° C.) lubricate platinum surfaces until they melt; a thin film of lead (m.p. 327° C.) lubricates steel until the melting point of the lead film is reached; sodium stearate lubricates steel until the stearate softens and melts (about 300° C.). Finally, lauric acid in paraffin lubricates copper until the softening point of copper laurate is reached (about 100° C.).

Mechanism of Boundary Lubrication

All our experiments have shown that even with the best boundary lubricants and comparatively light loads, there is some wear and damage of the metal surfaces. The underlying metal is, in fact, torn to a depth which is large compared with the dimensions of a molecule. A large part of the surface may show little sign of damage but, at various localized points of contact, there are definite signs of metallic adhesion through the lubricant film and minute fragments of one metal may be left welded on to the other[17,18,19]. This means that the friction of lubricated metals cannot, in general, be due simply to the sliding of one monolayer over the other; nor, indeed, can it be merely a function of the surface forces as Hardy supposed. It must be greatly influenced by the bulk properties of the metals concerned.

It has been shown that for unlubricated metals the frictional resistance F can be conveniently written

$$F = S + P,$$

where S is the force required to shear the metallic junctions formed at the points of contact and P is a ploughing term. Under some conditions the ploughing term may be small, and if this is neglected,

$$F = S = As,$$

where A is the real area of contact between the metals and s is the shear strength of the junctions. With clean metals the welding is strong, so that the break frequently occurs within the metal itself. In this case s will be equal to the shear strength of the metal. An effective lubricant will diminish the area of metallic contact although, as we have seen, it is rarely able to prevent it altogether.

When lubricated metal surfaces are placed in contact, plastic flow of the metals occurs until the area is large enough to support the applied load. The pressure, however, will not be uniform over the whole region of contact. At some points it will be very much higher, and at these points a local breakdown of the lubricant film may occur. The extent of the breakdown will naturally depend on the nature of the lubricant film. Further, if the sliding speeds are appreciable, it will be aided by local high temperatures developed during sliding. As a result of the partial breakdown of the lubricant film, metallic junctions, large compared with the size of a molecule, are formed between the surfaces. The resistance to motion is then due largely to the force necessary to break these junctions. There will also be some resistance to sliding by the lubricant film itself, and we may write

$$F = A(\alpha s_m + (1-\alpha)s),$$

where A is the area which supports the applied load, α is the fraction of this area over which breakdown of the film has occurred, s_m is the shear strength of the junctions at the metal-metal contact, and s is the shear strength of the lubricating film. With a good lubricant the area over which metallic contact occurs may be very small indeed. Nevertheless, the shear strength of these junctions may be so high compared with that of the lubricant that they may be responsible for the greater part of the resistance to motion.

The main purpose of the lubricant film is, therefore, to reduce the amount of metallic contact between the surfaces by interposing a layer that is not easily penetrated and that possesses a relatively low shear strength. In order to prevent appreciable contact, the lubricating layer must, in addition to being firmly attached to the surface, possess a strong lateral adhesion between the hydrocarbon chains. If the film softens or melts, that is, if the lateral adhesion between the chains falls to a low value, metallic seizure occurs with a corresponding increase in friction and wear. The fact that *solid* films of saturated hydrocarbons are more effective in lubricating unreactive metals than fatty acids above their melting point shows that the strength of the lateral adhesion between the large hydrocarbon molecules is at least as important as the strength of attachment to the surface.

As we have seen, at the loads used in our experiments, fatty acids in themselves are scarcely more effective as boundary lubricants when applied to unreactive surfaces than saturated hydrocarbons. Even when they form well-adsorbed and orientated films on platinum or nickel surfaces, they do not lubricate above their bulk melting points. This means that even the longest-chain fatty acids do not lubricate unreactive surfaces at temperatures above about 90° C. The softening points of metallic soaps, however, are usually very much higher than the melting points of the pure acids. For this reason fatty acids are much more effective as boundary lubricants at heavy loads and high temperatures if they are used in the form of metallic soaps. This may be achieved by applying them to metal surfaces with which they react. The metal soap is then formed *in situ* and is well attached to the surface. In many cases even a monolayer of such a film is sufficient to prevent much penetration and metallic contact; in other cases, however, appreciably thicker films may be necessary. These films maintain their lubricating properties with increasing temperature until the softening point of the soap is reached. At this stage the film softens or melts, and increased metallic contact occurs through it, with corresponding increase in friction and wear. As the soap film loses its lateral adhesion, its linkage to the metal surface also grows weaker, and the breakdown of the lubricant film is often accompanied by its dissolution into the superincumbent oil or excess acid.

If the metal surface is unreactive, the fatty acid will not lubricate above its bulk melting point, and

must be applied as a metallic soap. In such cases the physical texture and the mode of deposition of these films may be very important. The best frictional properties are obtained when the soap film has a close coherent texture, is evenly deposited over the surface and is well adsorbed. These films will lubricate until the softening point of the soap occurs. If, however, the adsorption of the soap to the surface is weak and there is a superincumbent layer of oil present, it may dissolve in the excess oil at a temperature lower than its softening point. If there are solvents present in appreciable quantities in the soap film, violent ebullition may cause them to disrupt the lubricant film. In both cases breakdown of the lubricant film will tend to occur at temperatures below the softening point of the metallic soap.

The softening point of a soap is not clearly defined and may cover a wide temperature range. The actual temperature at which the weakening of the soap film is sufficient to cause an appreciable increase in metallic seizure (and hence in the friction and wear) will clearly depend on the physical conditions of the experiment. With hard surfaces, where the pressures are high, or with extremely slow surface speeds, we should expect the breakdown to be discernible at lower temperatures. This is generally found to be the case—with any given metal and lubricant the transition temperature T is dependent in this way upon the load, speed and shape of the sliding surfaces. At higher sliding speeds the formation of a viscous soap film of appreciable thickness may lead to a hydrodynamic separation of the surfaces. The conditions are no longer those of true boundary lubrication and the friction may fall to a very low value (see the interesting paper by Beeck, Givens and Smith[16] on quasi-hydrodynamic lubrication). The frictional behaviour of these soap films resembles in many respects the lubricating properties of thin films of soft metals deposited on hard substrates. This similarity has already been discussed in earlier papers. One of the most marked differences, however, is that even on rough surfaces a single molecular layer of soap may provide effective boundary lubrication, whereas metal films must be appreciably thicker (*c.* 10^{-6} cm.). The very high tenacity of the soap monolayer and its ability to prevent metallic seizure is, indeed, remarkable.

This view of the role of the lubricating film has been supported by recent work on the action of extreme-pressure lubricants and has led to the development of lubricants which maintain their boundary lubricating properties at very high temperatures.

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BIOCHEMICAL ASPECTS OF MENTAL DISORDER

SOME aspects of the biochemistry of mental disorder were discussed at a meeting of the Psychiatry Section of the Royal Society of Medicine on May 24.

Recent biochemical investigations into mental disorder were surveyed by Dr. G. D. Greville, who opened the proceedings. He dealt in the first place with the excretion of hippuric acid by schizophrenic patients after sodium benzoate administration. Quastel and Wales found, in a routine examination of schizophrenic patients, that a group of eighteen catatonic patients showed without exception impaired rates of hippuric acid excretion. In a group of twenty-seven non-catatonic schizophrenics, all but four gave hippuric acid excretions of the normal value and normal range of variation. Since none of the cases chosen for examination showed signs of renal or hepatic impairment, Quastel and Wales suggested that a metabolic disturbance in the liver might be a characteristic feature of catatonic patients. Strom-Olsen, Greville and Lennon repeated this work with sixty-two schizophrenic patients of whom twenty-eight were considered to be catatonic. They found that only five of the catatonic patients gave abnormally low values of hippuric acid excretion, the proportion being about the same as among non-catatonic schizophrenic patients. Such a finding seemed not to indicate any noteworthy difference between catatonic and other schizophrenic patients so far as benzoate detoxication is concerned. There was agreement, however, that a small but not insignificant proportion (18 per cent) of non-catatonic schizophrenic patients without obvious renal or hepatic disturbance give abnormally low rates of excretion of hippuric acid under the standard test conditions.

Quastel and Wales then repeated their work using an intravenous method of benzoate administration to avoid a possible complication due to faulty absorption of benzoate from the gut and confirmed their original findings. Moreover, they obtained evidence that the clinical condition of the patient at the time of the test may have an important bearing on the rate of benzoic acid detoxication, for certain patients who had previously shown low rates of hippuric acid excretion exhibited normal rates after improvements in their mental condition due to treatment. Subsequent workers (Davies and Hughes; Finkelman *et al.*) have confirmed that abnormally low rates of hippuric acid excretion may occur in a large proportion of catatonic cases, but others (Gildea; Michael, Looney and Borkhovic) could obtain no evidence for such low excretions. Dr. Greville showed that the discrepancy between the results of the various workers could not be due to a failure to take into account the body-weight of the patients. Muscular rigidity may be a factor associated with the lowered rate of excretion according to Finkelman, but no satisfactory explanation is as yet forthcoming to account for the different sets of results.

Dr. Greville then turned to a consideration of the spontaneous hypoglycæmia which sometimes develops in the psychoneuroses and other abnormal mental conditions, and commented upon the development of emotional disturbances, often leading to behaviour of an anti-social character, during the periods of

hypoglycæmia. Hypoglycæmia frequently occurs in children whose ill-behaviour in this condition can often be improved by giving them sweets. He dealt with some of the work on carbohydrate metabolism which has been carried out on psychotic patients by means of glucose tolerance tests, measurements being made in these tests of the rates of appearance and subsequent disappearance of blood-sugar after oral ingestion of glucose. McCowan and Quastel showed that among manic-depressive patients, those exhibiting a high emotional tension gave a high hyperglycæmic index, a term coined by these workers to give a quantitative expression to the divergence between an abnormal and a normal oral-glucose tolerance curve. The patients on recovery showed a low or zero index, the value found in normal mental conditions where there is no complication due to physical factors affecting glucose metabolism in the body.

Gildea and his colleagues, as a result of their work on oral and intravenous-glucose tolerance curves in manic depressive patients, concluded that abnormal oral-glucose tolerance curves leading to a high hyperglycæmic index are largely due to delayed absorption of glucose from the gut. This conclusion is supported by the observation by Davis and Greville that in depressed patients there exists a correlation between the slope of the initial portion of the glucose tolerance curve and the hyperglycæmic index. The lower the initial rate of rise of blood-sugar, the more sustained is the hyperglycæmia. It seems probable that with a constant carbohydrate intake the factor which largely determines the initial stage of a sugar tolerance curve is the rate of absorption of the sugar from the alimentary tract. It thus appears evident that there is a correlation between this rate and the emotional state of the patient.

Dr. Greville finally mentioned recent work (for example, that of Gibbs) on the oxygen consumption of the brain as measured by differences between arterial and venous contents of oxygen, and by the rate of blood flow to the brain. It seems to be clear from the work of Wortis that there is no measurable difference between the rates of oxygen consumption of the brains of normal and schizophrenic individuals. Himwich and Fazekas conclude that cerebral oxygen uptake is normal in a group of undifferentiated mental defectives, but that it is probably reduced in mongolism, cretinism, phenylketonuria, and microcephaly. Little is known as yet of the changes occurring in the brain during the shock therapies commonly used in the treatment of schizophrenia, but there is evidence that marked changes of metabolism do take place. This is clear, for example, in insulin shock treatment, where a large reduction in the arterio-venous difference of oxygen content takes place, while the rate of blood flow is unaffected. It is unreasonable to expect that the cerebral metabolic changes will be identical in all forms of shock therapy, which differ so much in intensity and duration and which are by no means all equally effective.

The biochemical aspects of anxiety were discussed by Dr. D. Richter. He pointed out that the blood of patients with anxiety contains a substance which is absent from normal blood and which exerts a specific action on plain muscle. It has also been shown by Gellhorn and his colleagues that in emotional excitement there is a release of insulin into the blood. This is an effect which can be measured quantitatively, and should help in elucidating the details of the close association between anxiety states and the endocrine balance.

An emotional hyperglycæmia has been frequently reported, but many investigators have failed to confirm this. Dr. Richter has carried out blood-sugar estimations on patients with anxiety states and on normal subjects during air raids at the Neurosis Centre at Mill Hill. About one third of the subjects showed a slight rise in blood-sugar level when exposed to immediate danger, but the rise was never very great. He referred to further work at Mill Hill which showed that serum choline esterase activity is increased in anxiety states and in depression. A rise can also be produced in normal subjects by vigorous exercise or by exposure to low temperatures. The effect is attributed to an increased autonomic activity and is apparently specific for choline esterase.

Dr. Richter observed that during the last few years there has been a tendency to depart from the point of view concerning anxiety states held by Cannon and his associates. In acute emotional states there is a general lability of autonomic control in which many apparently unrelated biochemical factors may be involved. The pattern of responses, instead of being uniform, shows considerable variations in different individuals, and there is little evidence that they serve any useful biological purpose. A variety of biochemical factors may play a part in the onset of anxiety states, as for example, hypoglycæmia, aneurin deficiency or adrenaline release. Anxiety may be a symptom of almost any physical disability to which the individual is unable to adjust. Recent work on patients with 'effort syndrome' has shown how a biochemical lesion causing an impairment of physical efficiency can lead to the onset of an anxiety neurosis.

The discussion was opened by Dr. J. H. Quastel, who commented upon the diversity of results obtained by different workers on the rates of hippuric acid excretion in catatonic patients submitted to a standard test. He emphasized the dependence of these rates on the clinical conditions of the patients, and urged the great importance of close association and co-operation between the psychiatrist and the biochemist in correlating the results of a biochemical test with the patient's mental and physical condition at the time of the test. The lack of agreement between the results of metabolic investigations in the field of schizophrenia may be largely due to the fact that such a field is far from homogeneous and the individual schizophrenic patient shows much variation in mental state and physical condition over a period of time. For progress in such work it is essential to select a small field where there is some approach to homogeneity and to examine cases in such a field periodically. The interesting results of Gjessing on the metabolic changes associated with changes in the mental state are probably due largely to his selection and continuous examination of a small number of schizophrenics conforming to a special group of periodic catatonia which is characterized by repeated attacks of stupor and excitement. Gjessing concludes that the mental disturbance follows directly upon a disturbance of nitrogen metabolism, and suggests that at the time of change of phase a toxic substance is produced which is connected with the disturbance of protein metabolism and which acts in an inhibitive or irritant manner on the central nervous system.

Although there is no convincing evidence, in Dr.

Quastel's opinion, that impaired oxidations in the brain play an important part in schizophrenia, the sensitivity of the cortex to anoxia is such that localized changes may result in abnormal mental manifestations with but little overall change in the brain metabolism. It is important to take into consideration not only the availability of oxygen or of glucose (the main fuel of the brain) to the nerve cell but also that of a variety of other factors, all indispensable for the normal rate of oxidation of glucose in the cell. Among such factors are nicotinamide, aneurin, riboflavin and adenylpyrophosphate. If there is a local deficiency of these substances, or some interference with their activities, the results, so far as the nerve cell is concerned, may be as far-reaching in their consequences as the deprivation of the oxygen or of the glucose supply. The sensitivity of the cortical tissue to anoxia may be a factor concerned with the beneficial effects of shock therapy, but too little is known as yet of the effects of these treatments on the metabolism of the central nervous system to come to any definite conclusion.

Referring to the work on glucose tolerance tests and emotional states, it was pointed out that Lockwood has observed a dependence of the hyperglycæmic index on the affective state as indicated by the psychogalvanometer.

Interesting results are now being obtained with the use of the electro-encephalogram on the connexion between biochemical activities of the brain and its electro-physiological properties. Studies such as these should help to throw light on the manner in which biochemical and electrophysiological phenomena connected with the central nervous system are linked with the mental state.

Dr. R. Benesch referred to work carried out by him in collaboration with Dr. P. Ellinger on certain nicotinamide-deficiency syndromes, namely, pellagra and the acute psychoses of the Cleckley-Sydenstricker type. Ingestion of nicotinamide normally leads to the excretion of nicotinamide methochloride. Benesch and Ellinger have shown that large differences in the basal output of nicotinamide methochloride, and in the output after nicotinamide administration, exist between control subjects and pellagrins as well as acute psychoses with a suspected nicotinamide deficiency. The mental confusion present in such cases clears up after nicotinamide treatment. They further showed that human intestinal flora are capable of synthesizing nicotinamide, so that a diet may inhibit the development of pellagra quite independently of its content of nicotinic acid. Thus the nature of a diet and the type of bacterial flora it encourages in the human intestinal tract are important factors to consider in the development or treatment of nicotinamide-deficiency disorders.

In general discussion it was pointed out that choline esterase is exceptional in presenting an example of an enzyme passing into the blood concomitantly with the development of an anxiety state or of an increased autonomic activity. Its appearance in the blood, however, will not, according to Dr. Richter, invalidate its use as a test for liver function. Further discussion ranged around the association of incipient pellagra with porphinuria and the fact that sulphonal poisoning may produce pellagra-like symptoms.

It was suggested by Dr. Mackenzie that a patient might most profitably be presented for biochemical investigation at a time corresponding to a definite phase of his behaviour, rather than on the basis of his psychiatric classification.

OBITUARIES

Sir Peter Chalmers Mitchell, F.R.S.

Peter Chalmers Mitchell was born at Dunfermline on November 23, 1864, and died in London, as the result of an accident, on July 2, 1945. He was the eldest son of the Rev. Alexander Mitchell, and was educated at Aberdeen Grammar School, the University of Aberdeen, and at Christ Church, Oxford, where he was an exhibitioner. He also studied in Berlin and Leipzig. He became senior University demonstrator in comparative anatomy and assistant to the Linacre professor at Oxford in 1888, and during 1891–93 was organizing secretary for technical instruction to the Oxfordshire County Council. Afterwards he went to London as lecturer in biology at Charing Cross Hospital and at the London Hospital. During this period he carried out various comparative studies mainly on the anatomy of birds, and in the course of this work spent much time at the prosectorium of the Zoological Society. About this time he published his "Outlines of Biology" and "Thomas Henry Huxley: A Sketch of his Life and Work", an outstanding biography which perhaps more than any other of his writings reveals his literary gifts. He also translated Metchnikoff's "The Prolongation of Life, Optimistic Studies" and O. Hertwig's "The Biological Problem of To-day. Preformation or Epigenesis?".

Mitchell will be remembered mainly, however, for his very great services as secretary of the Zoological Society of London from 1903 until 1935. During this period, by a judicious blending of popular and scientific interests, it became the leading zoological society in the world, a great popular and scientific institution, and a model for the many similar societies which sprung up during the twentieth century. Some idea of its progress may be gathered by the fact that between 1903 and 1935 the number of fellows increased from approximately 3,500 to more than 8,000, and the annual number of visitors to the Gardens from approximately 690,000 to more than 2,000,000. During his term of office the Zoo was largely rebuilt, the most notable additions being the Mappin Terraces, Aquarium, Reptile House, Monkey House and Monkey Hill. In addition, he was entirely responsible for the creation of Whipsnade Zoological Park, a monument to his energy, imagination and organizing ability. He himself regarded Whipsnade as his crowning achievement on behalf of the Zoological Society, and there he made his country home after leaving Malaga. His "Centenary History of the Zoological Society of London", published in 1929, contains an excellent account of the growth of the Society and the development of its various activities, including both Regent's Park and Whipsnade.

Apart from his zoological interests, Mitchell devoted much of his time to journalism and for many years was scientific correspondent of *The Times*, a regular leader writer, and that journal's adviser upon scientific matters. He was also chairman of the council of management of the "World List of Scientific Periodicals" from its beginning until 1935, and remained an active member of that organization until his death. He was largely responsible for the preparation of the volume which, in its second edition (1934), gives the titles and standard abbreviations of more than 36,000 periodicals.

After his retirement, Mitchell went to live at Malaga, but in 1937 political events debarred him

from remaining there and he returned to London, when he published "My Fill of Days", a record of his long and interesting life, and in the next year "My House in Malaga". For the last three years he had been honorary treasurer of the Joint Committee for Soviet Aid, which raised considerable sums of money for providing supplies for the U.S.S.R.

Mitchell had a most attractive personality, and with his keen though somewhat sardonic humour was a very persuasive talker. He had a great natural fondness for animals and was for many years president of the Universities Federation for Animal Welfare. He took an active interest in the protection of wild life generally, and was an active member of the Society for the Preservation of the Fauna of the Empire, being president during 1923–26 and afterwards a vice-president until his death.

He was elected to the Royal Society in 1906; in addition, he received numerous academic and public awards, and was knighted in 1929.

EDWARD HINDLE.

Brigadier-General Sir Percy Sykes

BRIGADIER-GENERAL SIR PERCY SYKES, who died on June 11, was an authority on Persia on account of the many years he lived there, his historical writings, and his numerous journeys through it. He also made exacting expeditions in Central Asia. He travelled with a historian's bias which served to people desolate roads and to link dreary adobe ruins or scattered shards of pottery with happier and perhaps splendid days in the past. During much of his travelling life he had the advantage of official status and prestige, but this was less important than the courage and audaciousness with which he flouted the dangers of travels fifty years ago, and the tough body and sturdy health which enabled him to endure hardships of the road and stays in infected Persian towns. No tales of insecurity would deflect him from his purpose, nor would the very real risk of a clash with slave raiders deter him from following a route chosen because it was little known or infrequently used.

Sir Percy's most important journeys were in Eastern Persia, north, central and south. Fifty-two years ago he followed the River Atrek from the shores of the Caspian into the gorges near Bujnurd. This meant crossing the marches between the unruly Turkomans and the Kurdish settlers put there to hold them at bay, and this he did adventurously alone. Many years later he filled in details along this little-known valley, from the prosperous populous headwaters near Kuchan to the uninhabited wastes near the Russian border. On his first journey he also crossed the Lut from Meshed to Kerman. During the next twenty years he filled posts at both these cities, and as he never liked to follow the same road twice he was able to amplify the traverses he made in a regional way.

Farther south Sir Percy crossed Persian Baluchistan on intersecting trails and climbed Taftan, Bazman and Hamant, all of them high enough to provide comprehensive views over hundreds of square miles of unexplored territory. Two of these mountains are young volcanoes standing more than two hundred miles from the sea, and their discovery did something to discourage the fallacy that volcanoes are only to be found close to the sea and to depend upon the breaking in of sea water to the depths of the earth's crust for their activity. He was responsible for many new facts regarding the Jaz Murian basin, and is probably the only European who has penetrated the valley of Ramishk. He had an opportunity of visiting the wind-stricken Seistan depression, where the Afghan Helmand discharges, and on the way added to the knowledge of the eastern rim of Persia which extends four hundred miles south of Meshed past Birjand. As commander of the South Persian Rifles during the War of 1917–18, he had further opportunities for travel and the services of surveyors who extended his mapping.

Apart from the geographical aspect of his work, Sir Percy made noteworthy archæological discoveries in Eastern Persia and studied the manners and customs of the people.

J. V. HARRISON.

SIR PERCY SYKES was a true embodiment of the tradition which makes a British officer posted in the East take interest in every aspect of Nature and life around him. His geographical exploration much exceeded the utilitarian purposes of his official duties. His earliest and most original work, "Ten Thousand Miles in Persia, or Eight Years in Persia" (1902), was very favourably received both in Great Britain and abroad. It contains a great mass of fresh observations on the antiquities, history and ethnology of eastern Persia. The work was continued in a series of reports on the journeys in Khorasan, etc., written in the same vein and published in the *Geographical Journal*. Small notices on the Gypsies, the Parsis and prehistoric remains, which he contributed to such organs as the *Journal of the Royal Anthropological Institute*, *Journal of the Royal Society of Arts*, etc., were also interesting, and often started further useful discussion among the specialists.

Sir Percy was no professional Orientalist but, working with the help of his *munshis*, he easily found in the original sources references to illustrate his descriptions. This is particularly noticeable in his notes on the famous mosques of Meshed. Many curious details on the pilgrimage to this sanctuary are recorded in the memoir prepared by one of his Muslim assistants and published in his translation under the title "The Glory of the Shia World" (1910).

Sir Percy's main interest lay in Persia, and his second book of travel, "Through Deserts and Oases of Central Asia" (1910), written in collaboration with his sister, the late Miss Ella Sykes, had a much more popular form. It summed up the impressions of his journey through Russia in 1915, of his temporary term of office as Consul General in Kashghar and of his hunting expeditions in the Pamir.

More ambitious were his historical works. His two volume "History of Persia" went through three editions (1915, 1921 and 1930) and has been recently translated into Persian. For the earlier periods Sir Percy naturally depended on the contributions of his collaborators, but from A.D. 1600 on the book contains many interesting items on the relations of Persia with Europe and particularly with Great Britain. In the additions to the third impression, the author recorded his personal experiences in Fars during the disturbances which followed the first European War.

The biography of Sir Percy's former chief, the Right Hon. Sir Mortimer Durand (published in 1926), formed a transition to a new field of his studies: in 1940 appeared his two-volume "History of Afghanistan". The book is a useful summary of the great

mass of information found in English publications, and partly in official archives.

In the interval between the two "Afghanistan" books appeared "A History of Exploration from the Earliest Times to the Present Day" (1934). The volume covers a vast field and is particularly helpful in the chapters on Central Asia, the area on which the author ever kept a watchful eye. As a supplement to it came "The Quest for Cathay" (1936), popularizing the data of the Hakluyt series.

If to this enumeration of the principal works we add a number of occasional articles in the *Royal Central Asian Journal*, etc., and prefaces to the joint-effort books and translations, we shall recognize how well Sir Percy employed the leisure hours of his busy official life and the years of his retirement. His contribution to the knowledge of the Middle East and its manifold problems has been considerable and conspicuous.

V. MINORSKY.

Prof. L. I. Mandelstam

PROF. L. I. MANDELSTAM, an outstanding Russian physicist and member of the Academy of Sciences of the U.S.S.R., died in Moscow on November 27, 1944, when at the height of his powers. Mandelstam was endowed with an unusually profound and subtle mind. He was at once a brilliant experimenter, an outstanding theoretical worker, a profound thinker, especially interested in the problems of epistemology and of the philosophy of science, and an outstanding expert in radio-engineering.

Mandelstam was born in 1879 in the south of Russia. He was educated at the University of Strassburg, where he began his scientific career as Prof. F. Braun's assistant; he became a *Privatdozent* in 1907 and obtained the title of professor in 1913. Together with N. D. Papalexi, his life-long collaborator, he carried out in that period a number of physical and technical researches of importance to the new subject of radio-engineering. He was the first to demonstrate the advantages of weak coupling (1904), which has since received wide practical application; he developed the method of the excitation of aerials with a prescribed phase difference (1906), and originated other technical advances.

Mandelstam's characteristic ability to discover deep inner ties between apparently unconnected phenomena soon directed his attention to another branch of physics, namely, optics, and particularly to the problem of the scattering of light, which throughout his life remained of prime interest to him. Mandelstam was the first to demonstrate, in 1907, that the lack of optical homogeneity of the medium is the necessary condition for the molecular scattering of light which is due to radiation of atomic oscillators vibrating with definite phase relationships. This fundamental conclusion cleared the way for establishing the fluctuating nature of scatter; Mandelstam himself followed up this work with a statistical theory of scattering of light on the surface of a liquid (1913). A number of other beautiful researches in optics were carried out during this period.

In 1914, Mandelstam returned to Russia, and his most creative period was the last twenty years of his life, after his election to a professorship in the University of Moscow in 1925 and to the membership of the Academy of Sciences in 1929. Mandelstam's lectures at Moscow were unsurpassed examples of university teaching, in which the borderline between teaching and creative scientific research vanished; not infrequently, during these lectures, problems originated that became later the subjects of scientific investigations.

Mandelstam's researches in the physics of oscillations were now given a new impetus. A master of the classical theory of oscillations, Mandelstam was clearly aware of its limitations and realized the necessity for developing a new 'non-linear' system of ideas and methods, that would be adequate to the new problems suggested particularly by the development of radio-engineering. He and his pupils searched persistently for these new methods, developing a theory of non-linear oscillations which gave fundamental results in the most varied branches of physics: radio, hydrodynamics, aerodynamics, the theory of automatic regulation and others. Mandelstam himself carried out a number of these important researches in collaboration with Papalexi, as for example the discovery of the phenomenon of resonance of the n-th kind, the so-called parametric filter based on this phenomenon, an important generalization of the conception of resonance, and the development of a new type of a generator of alternating current (the so-called parametrical machine).

Proceeding from optical analogies, Mandelstam and Papalexi invented radio interference devices, in particular the radio range-finder, by means of which precision measurements of the velocity of propagation of radio waves in varied conditions were carried out, and a new sphere of radio application developed, namely, radio-geodesy, which is now made use of in the Soviet Arctic regions as well as other parts of the U.S.S.R.

During the same period, Mandelstam and his collaborators carried out important optical investigations. Introducing into optics the conception of the modulation of oscillations, Mandelstam in 1918 came to the conclusion that the scattering of light must be accompanied by a change of frequency, conditioning the fine structure of scattered light. Experimental search for this phenomena led Mandelstam and Landsberg to the fundamental discovery of combinational scattering of light in crystals. Their first publication was dated May 6, 1928, and soon it became clear that the phenomenon discovered by them was of the same nature as the combinational scattering of light in fluids, simultaneously discovered by Raman, announced on March 31 of the same year, and since known as the Raman effect.

In the course of many further researches on the scattering of light, Mandelstam's attention was attracted to the absorption of ultra-acoustic waves. A relaxation theory of this phenomenon, developed by him in 1936, gave rise to a series of experimental researches in this direction.

Of late, Mandelstam's scientific interests turned primarily to the fundamental problems of quantum mechanics. He was the first to deduce the uncertainty relation between time and energy from the general formalism of quantum mechanics, and to reveal the simple physical meaning of this fundamental relation. In a course of his lectures on the theory of measurements of quantum systems, Mandelstam gave an interpretation of the theory unsurpassed in its clarity and depth; in particular, he pointed out the fundamental distinction between direct and indirect measurements of quantum systems, which is of great importance to the further development of quantum theory.

Mandelstam's published works do not do justice

to his many-sided scientific interests. He was generous in imparting his ideas to friends and collaborators, so that much which was really his appeared under another's name. Also, because of the very high standards that he demanded of himself, Mandelstam delayed, especially of late, the publication of his researches. For this reason much of his work will not be generally known until the posthumous edition of his collected works, which the Soviet Government has decreed, is published. His scientific researches earned him the Lenin prize, the Mendeléeff prize and the Stalin prize. For his general scientific and teaching work he was awarded the Order of the Red Banner and the Order of Lenin.

Mandelstam was a man of infinite kindness, possessed of great spiritual and intellectual charm that never failed to impress anyone who came into contact with him. Those who had the good fortune to know him more intimately will always cherish the memory of this scientific worker and man.

P. Kapitza.
A. Joffé.
S. Vavilov.

We regret to announce the following deaths:

Mr. R. W. F. Harrison, sometime assistant secretary to the Royal Society, on July 15, aged eighty-seven.

Dr. J. C. Kernot, an authority on adhesives, on July 6, aged sixty-six.

Lieut.-Colonel J. C. Lamont, C.I.E., sometime professor of anatomy at Lahore Medical College, on June 19, aged eighty.

Prof. W. Makower, O.B.E., formerly professor of science at the Royal Military Academy, Woolwich, on July 7, aged sixty-five.

Dr. Catherine A. Raisin, formerly head of the Department of Geology, Bedford College for Women, University of London, on July 13, aged ninety.

Colonel C. H. D. Ryder, C.B., C.I.E., formerly surveyor-general of India, on July 16, aged seventy-seven.

Dr. Alec Sand, F.R.S., physiologist to the Marine Biological Association since 1935, early in July, aged forty-three.

Mr. F. H. Todd, formerly of the Indian Forest Service, on July 9, aged seventy-one.

NEWS and VIEWS

Prof. George Hevesy, For.Mem.R.S.

Prof. George Hevesy celebrates his sixtieth birthday on August 1 in Sweden, where he is a guest of the Royal Swedish Academy of Science in Stockholm. Members of the Academy have prepared a jubilee volume to mark the occasion. Prof. Hevesy and his family escaped from Denmark to Sweden when racial persecutions in Denmark and the tide of terrorism by the German occupants reached a climax in 1944. Prof. Hevesy is well known especially for his work on isotopes, including the early use of radioactive tracer atoms in investigations on diffusion in crystals and later on numerous biochemical problems, involving among others the study of the metabolism of phosphorus in organisms. His other great field of contributions to modern science is the discovery of the element hafnium, the chemical separation of hafnium from zirconium and the study of the properties of hafnium compounds. The relationship between hafnium and zirconium led him to the problem of the rare earth elements. Later, he developed quantitative analysis by means of his X-ray technique for the study of the geochemical frequency and distribution of numerous elements.

Prof. Hevesy, a Hungarian by birth, has held professorial chairs in Denmark (Copenhagen), in Germany (Freiburg-i.-B.) and from 1934 again in Denmark, where his work has been closely associated with the famous Institute of Theoretical Physics at Copenhagen directed by Niels Bohr. In just recognition of his contributions, he was awarded the Nobel Prize for Chemistry for 1943. He has many ties with scientific men in Britain. For a period beginning in 1911, he worked in the late Lord Rutherford's laboratory when the latter was at Manchester. He frequently visited Britain to attend scientific meetings; and in 1930 he gave the Hugo Müller Lecture before the Chemical Society. A number of British research students worked at his laboratories. Hevesy's many friends in Great Britain and elsewhere will be glad to know that he and his family are well, and will wish him many years of continued successful work and of happiness.

Chair of Geography at Sheffield: Prof. R. N. Rudmose Brown

The retirement of Prof. R. N. Rudmose Brown from the chair of geography at the University of Sheffield at the end of this session marks the official end of nearly forty years of teaching and guiding university geography. His influence on the subject outside his university has been exercised through his being a member at one time or another of all the more important councils and committees which have to deal with geography, as well as through his books. Though he approached the subject from the point of view of a polar explorer and a naturalist, he has always insisted upon the essential unity of its physical and human aspects. His many contacts with French and other Continental geographers may have been the spur which caused him to become as notable a lecturer and writer on the human and economic aspects of his subject as the biological and physical side. His contribution to the recent advance of academic geography has therefore been based on the broadest grounds. This is reflected in his new building for his Department at Sheffield, which is second to none in Great Britain. Planned by him to serve with equal emphasis all the aspects of modern geography, it is a model which will be copied elsewhere in due course. As counsellor, examiner, writer, editor and practical explorer, Prof. Rudmose Brown has had an influence on geography which will endure. His rugged honesty of purpose and direct speech will be missed in many a council chamber, but it is quite certain that his years of retirement will often be interrupted by requests for advice from his younger colleagues, who will continue to be attracted by his wisdom and breadth of vision as well as by his long experience and commanding personality.

Squadron-Leader David L. Linton

Squadron-Leader David L. Linton, who succeeds Prof. Rudmose Brown at Sheffield, is thirty-eight years old, and was well known in British geographical science before the War. He had been

an exceptionally distinguished student at King's College, London; and after a period on the staff of the Geography Department there, he became a lecturer in geography under Prof. A. G. Ogilvie at the University of Edinburgh. His published researches into the relations between land forms and river drainage brought him (jointly with his collaborator, Prof. S. W. Wooldridge) the Murchison Grant of the Royal Geographical Society; and besides other work on geomorphology he has published studies in historical, general and economic geography. His teaching experience is also wide. Before the War he was secretary to the Geography Section of the British Association, and on the Council of the Institute of British Geographers and that of the Royal Scottish Geographical Society. His service with the R.A.F.V.R., in which he won successive promotion to squadron-leader, has been in photographic intelligence, in which he is in charge of a H.Q. Department.

Fellowships for Scientific Research in India

I.C.I. (India) have offered to the National Institute of Sciences of India the sum of 336,000 rupees (about £25,000) for research fellowships in chemistry, physics and biology, to be held at Indian universities or institutions approved by the Council of the National Institute of Sciences, over a period of five to seven years. Each fellowship will be worth 400 rupees per month and will be tenable in the first instance for two years. There is provision for four new fellowships every year during the period 1945–49. In addition, there will be a grant for research expenses to be made to the fellowship holders according to their needs of special apparatus and materials. For this purpose the National Institute has at its disposal an average of 600 rupees per annum for each fellowship. There will be a grant of 13,200 rupees per annum to the National Institute for five years to enable it to pay for administration and the travelling expenses of such fellows of the Institute as may be selected to visit the fellowship holders at their universities or institutions. Appointment to, and control of, the fellowships will be in the hands of the Council of the National Institute, acting on the advice of a special research fellowships committee, representative of various scientific fields and drawn from various parts of India, so as to include any community, the overriding consideration for membership being scientific fitness therefor. The fellowships will be open to persons, irrespective of sex, race or religion, resident or domiciled in India (British India or the States) and less than thirty-five years of age, and will be tenable at any university or institution in India approved by the Council of the National Institute. Fellows will be permitted to do a limited amount of approved teaching or demonstrating.

The aim of the fellowships is to strengthen research in Indian universities and institutions, and it is hoped that the National Institute of Sciences will spread the research fellowships over them in accordance with this aim, but with the overriding consideration of the scientific suitability of the particular university or institution. As Lord McGowan points out in his letter conveying the offer to the president of the National Institute, these fellowships should do something to encourage the advance of science in India and with it the general prosperity of the country; further, they should assist the National Institute in maintaining its position as the premier scientific body of India. The offer is in many ways parallel with that made to British universities a short time ago by Imperial Chemical Industries, Ltd., and, it may be presumed, is inspired by the suggestions made by Prof. A. V. Hill in his recent report on research in India (see *Nature*, May 5, p. 532).

Education in H.M. Forces

An encouraging feature in the latest report of the Central Advisory Council for Education in H.M. Forces (October 1944–March 1945) is the considerable increase in the number of organized classes as opposed to single lectures conducted in Service units (see *Nature*, **155**, 611; 1945). The latter have decreased by some 19 per cent, while the former show the significant rise of 37 per cent. Outside units, the number of intensive schools and conferences also shows a remarkable increase, and it is particularly gratifying that a growing proportion of these schools and conferences are being conducted on a residential basis. It is distressing, therefore, to find that while there is every indication that the demand for intensive courses will increase, there is little likelihood of the demand being met in full unless residential accommodation is made much more freely available. Four university institutions have already lent hostels for whole-time use for regional committee courses, but more help is urgently needed from Service authorities towards the initial cost of reconditioning buildings and also in facilitating the release of suitable premises.

Although the number of occasional lectures in science shows the same downward trend as single lectures in other subjects, the rapid increase in the number of science classes in units is a useful indication of the way in which Service men and women are pursuing their studies with more serious intent; it is noteworthy that there has been a big shift from 'non-vocational' to 'vocational' science. Several background courses in science, lasting a week or a fortnight, have also been held, usually at university centres. One regional committee broke new ground by instituting experimental courses on British industries. The object was to provide unit instructors with background information about the actual structure of some of Britain's major industries and then to discuss some of the problems that the industries would have to face in the future. Lectures were given by specialists on various aspects of the industries considered, while visual and other mechanical aids were used to supplement the teaching and discussion. Visits to works and firms also served to provide the necessary balance between detailed knowledge and general understanding of the broad issues affecting each industry. Other useful work carried out by the Central Advisory Council during the half-year covered by the report was that for soldiers and auxiliaries in hospitals and convalescent homes.

Argentine–British Medical Centre, Buenos Aires

An Argentine–British Medical Centre has been established in Buenos Aires, with the assistance of the British Council, to promote closer relations and to facilitate the exchange of information between the British and Argentine medical professions. The Centre has a Committee of Honour, the twenty-two Argentinian members of which include Prof. José Arce, Prof. Pedro Escudero, Prof. B. A. Houssay and Prof. Alfredo Sordelli. British representatives of various branches of medicine have been invited to join this Committee. On the Executive Committee are the president of the Centre (Prof. Dr. Mariano R.

Castex), the director (Prof. Dr. Antonio Eqües), the secretary (Dr. R. Castro O'Connor), an assistant secretary, three ordinary members, and two representatives of the British Hospital in Buenos Aires. The Centre's library contains a selection of the most important British medical journals and up-to-date text-books. When an inquiry cannot be answered on the spot, the Centre obtains, through the British Council, information, articles and books (or photostat copies) from Britain. Among the activities are distribution of the "British Medical Bulletin" (Spanish edition), supply of medical films, translations from English into Spanish and Spanish into English, and certain facilities for members wishing to subscribe to British medical journals, or buy British medical books. The facilities are available to medical men in the interior of Argentina, who, since they are not in a position to borrow original books and articles, are supplied with photostat copies.

University of London Appointments

THE following appointments have been made in the University of London: Dr. D. H. Hey, since 1941 director of research at the British Schering Research Institute, to the University chair of chemistry tenable at the Imperial College of Science and Technology; Dr. F. C. Benham, to the University chair of commerce tenable at the London School of Economics; since 1931 he has been Sir Ernest Cassel reader in commerce at the School. Mr. D. W. Harding, special lecturer in psychology in the University of Manchester, to the University chair of psychology tenable at Bedford College.

Mr. Raymond Irwin, county librarian of Lancashire, has been appointed to the directorship of the School of Librarianship at University College as from October 1.

The title of reader in bacteriology in the University has been conferred on Mr. J. C. Cruickshank, in respect of the post now held by him at the London School of Hygiene and Tropical Medicine.

The degree of D.Sc. as an internal student has been conferred on the following: Mr. C. R. Bailey (University College); Mr. R. V. Harris (Imperial College of Science and Technology); Mr. G. W. Padwick (Imperial College of Science and Technology); Mr. L. Young (University College and Imperial College of Science and Technology).

The Night Sky in August

NEW moon occurs on August 8d. 00h. 32m. U.T., and full moon on August 23h. 12h. 03m. The following conjunctions with the moon take place: August 2d. 23h., Mars 2° N.; August 4d. 16h., Venus 1° S.; August 5d. 23h., Saturn 1° S.; August 9d. 07h., Mercury 9° N.; August 11d. 06h., Jupiter 4° S.; August 31d. 13h., Mars 0·9° N. In addition to the conjunctions with the moon, Venus is in conjunction with Saturn on August 22d. 04h., Venus being 0·7° S. Only one occultation of stars brighter than magnitude 6 takes place in August; ξ Tauri is occulted on August 4d. 3h. 28·9m. Mercury sets at 20h. 18m. at the beginning of the month—half an hour after sunset—and is not well placed for observation. The planet is stationary on August 5 and 29 and is in inferior conjunction on August 20. Venus is conspicuous in the eastern sky, rising at 1h. 11m., 1h. 22m. and 1h. 50m. at the beginning, middle and end of the month respectively. Mars, in the constellation of Taurus, rises at 23h. 47m., 23h. 20m., and 22h. 54m., at the beginning, middle and end of the month respectively. Jupiter sets about 1½ hours after the sun at the beginning of August and less than three-quarters of an hour after the sun at the end of the month, and is not well placed for observation. Saturn can be seen in the early morning hours, rising at 2h. 37m. and 0h. 56m. at the beginning and end of the month. The Perseid meteors reach their maximum about August 10–12; the radiant is at R.A. 3h., dec. 45° N., close to $\varkappa$ Persei.

Announcements

PROF. H. M. TURNBULL, director of the Pathological Institute of the London Hospital and professor of morbid anatomy in the University of London, has been given the honorary degree of D.Sc. of the University of Oxford.

PROF. A. C. HARDY, regius professor of natural history in the University of Aberdeen and honorary director of oceanographical investigations in the University College of Hull, has been appointed Linacre professor of zoology and comparative anatomy in the University of Oxford, in succession to Prof. E. S. Goodrich.

DR. IRENE MANTON, lecturer in botany in the University of Manchester, has been appointed professor of botany in the University of Leeds, in succession to the late Prof. J. H. Priestley.

MR. A. B. HORNBLOWER, honorary general secretary of the London Natural History Society, has resigned the position he has held for the past sixteen years, owing to ill-health. Mr. H. A. Toombs of the Geological Department, British Museum (Natural History), Cromwell Road, S.W.7, has been appointed to take his place; particulars of the Society's activities can be obtained from him.

THE Minister of Town and Country Planning, Mr. W. S. Morrison, has appointed the following National Parks Committee: Sir Arthur Hobhouse (*chairman*), Lieut.-Colonel E. N. Buxton, Mr. John Dower, Mr. Leonard K. Elmhirst, Mr. R. B. Graham, Dr. Julian Huxley, Mrs. Lindsey Huxley and Mr. Clough Williams-Ellis.

THE following have been elected officers of the Institution of Electrical Engineers for the year beginning on September 30: *President:* Dr. P. Dunsheath; *Honorary Treasurer:* Mr. E. S. Byng; *New Members of Council:* Mr. L. H. A. Carr, Mr. J. G. Craven, Mr. J. Eccles, Mr. H. Faulkner, and Prof. Willis Jackson (members); Dr. J. M. Meek (associate member); Mr. A. F. Plummer (associate).

THE report of the proceedings of the nineteenth conference of the Association of Special Libraries and Information Bureaux, December 9 and 10, 1944, has now been published by the Association, price 6*s*. The report includes the papers presented at the Conference together with summaries of the discussions, the presidential address of Sir Frederic Kenyon, a report of the year's work of the Association, 1943–44, reports on the work of the British Council and on the Inter-allied Book Centre evolved by the Conference of Allied Ministers of Education, with brief notes on the British Union Catalogue of Periodicals and on the National Central Library.

LETTERS TO THE EDITORS

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

Regeneration of Mammalian Striated Muscle

SINCE the classic studies of Volkmann[1] there has been abundant experimental work which shows that, following local injury, mammalian striated muscle is capable of some degree of regeneration. But this regenerative capacity is commonly held to be limited in extent and abortive so far as functional repair is concerned. It can now be stated that, under certain conditions, the regeneration of striated musculature may be much more extensive and complete.

Previous work which has been reported from this laboratory[2] showed that if the main vessels supplying the tibialis anterior muscle of a rabbit are ligatured, the lower half or two thirds of the muscle can usually be effectively devascularized and undergoes complete necrosis except for isolated fibres at the surface and alongside main anastomotic vessels, and some fibres at the lower end adjacent to the tendon. Moreover, it was found that within a few days the necrotic muscle becomes invaded by granulation tissue containing new muscle fibres of embryonic type which stream down from the ends of the surviving fibres in the upper part of the muscle.

Further experiments have now been completed in order to determine the fate of these regenerating fibres. In two rabbits, the tibialis anterior muscle of both sides was effectively devascularized. Two days later the muscles were exposed and bromophenol blue injected into the ear vein to determine the exact extent of the devascularization. In both cases the upper third of the muscle became stained in the normal manner, while approximately the lower two thirds remained unstained, with a sharp line of demarcation between the two parts of the muscle. After three weeks the muscle was resected from one side for histological examination. In each case the original muscular tissue in the lower two thirds was found to have undergone practically complete dissolution, and to be replaced in great part by strands of newly formed fibres extending down from above. The muscle of the other side was removed after three or four months. In one case it was somewhat shrunken and showed histologically patches of fibrosis and fatty infiltration in the lower two thirds, but there was also a considerable amount of mature muscular tissue. In the other case the muscle appeared quite normal to superficial inspection, and was found histologically to be composed of muscular tissue of approximately normal mature structure. It thus appears that in the rabbit the lower half or two thirds of the tibialis anterior can become completely reconstituted after undergoing ischæmic necrosis.

These experiments have provided abundant material for the study of the histogenesis of regenerating striated muscle, and this is now being undertaken. It may be said, however, that the material provides no support for the contention of Levander (recently expounded in *Nature* and elsewhere[3,4]) that in the course of the regeneration of mammalian muscle new muscle elements arise by the differentiation of generalized connective tissue cells; on the contrary, they appear to be formed entirely as outgrowths of pre-existing muscle fibres, thus confirming the conclusions of many other students of muscle regeneration.

Levander's conclusions seem to be based on an erroneous interpretation of the histological picture. In our material we have frequently seen the appearance of isolated 'myoblasts' arranged, as he describes, like a shoal of fish in the granulation tissue. But if these are examined by serial sections, the appearance is found in all cases to be due to the oblique sectioning of long continuous strands which can be ultimately traced without interruption to the stumps of pre-existing fibres. If there has been much distortion of the tissues (as has evidently occurred in Levander's material, in which necrosis was induced by the intramuscular injection of alcohol), the connexion between the young fibres and pre-existing fibres may not be easy to establish without the detailed study of large numbers of serial sections. Levander also supports his interpretation by the appearance of young muscle fibres in the neighbourhood of pieces of muscle transplanted into the subcutaneous tissue. He assumes that the original fibres of the transplant undergo complete necrosis. In fact, we have found that in such transplants some of the muscle fibres at the surface may survive and retain their vitality. Moreover, it should be noted that the outgrowth of new muscle fibres from old fibres proceeds with great rapidity. Their maximum rate of growth is at least 1 mm. a day.

Thus *individual* sections may show newly formed fibres at some distance from the position of pre-existing fibres, suggesting an independent origin. Our experiments do not, of course, exclude the possibility of such an origin, but this can only be established by experiments of a more critical character.

W. E. LE GROS CLARK.

Department of Anatomy,
University, Oxford.
June 11.

[1] Volkmann, R., *Beitr. path. Anat.*, **12**, 233 (1893).
[2] Clark, W. E. Le Gros, and Blomfield, L. B., *J. Anat.*, **79**, 15 (1945).
[3] Levander, G., *Arch. f. Klin. Chir.*, **202**, 677 (1941).
[4] Levander, G., *Nature*, **155**, 148 (1945).

Motor Response from Giant Fibres in the Earthworm

IT has recently been shown[1,2,3] by action potential records from the giant fibres that these form two systems; the two laterals are interconnected and act in unison independently of the median. Since the discharge from either fibre system may produce the sudden end-to-end shortening of the worm, the question arises why the nerve pathway is double. Stough's answer[4,5] that the median giant will only conduct backwards and the laterals forwards is incorrect, for their action potentials can be shown normally to run both ways[1,3].

A new fact emerges, however, for the sensory field of the median giant is found to be mainly from the first forty segments, and for the laterals from the remainder of the worm (at least in the conditions of the experiments). So it is natural to look for a difference in the two motor responses adapted to escape from attack at the head or at the tail respectively. This is the case.

If the worm is on a slippery surface, the giant fibre response when either head or tail is touched is a shortening towards the middle because (from mech-

anics) the centre of gravity cannot move. But if the worm is placed on a damp sack where the setæ can grip, it immediately appears that responses are of two kinds. Either the tail is anchored and the head withdrawn, or the head is fixed and the tail brought forward. The first reaction results from touching anterior to the fortieth segment, the second from the region posterior. The protective significance of these responses and their correspondence with the giant fibre sensory fields is obvious.

One other difference in the two responses is easy to see in *Lumbricus*. The median response is accompanied by a characteristic flattening of the tail, the laterally extended edges of which bristle with large setæ directed forward. This reaction is well adapted to grip the sides of the burrow within which the tail usually rests when the worm emerges at night. In the lateral giant fibre response, the tail becomes thin and round in section; hence the two responses are readily distinguished even on slippery surfaces.

Now when at night the worms are extended on the ground with only the tail region in the burrow, they may easily be touched or seized posterior to the fortieth segment. From what has been said it is clear that they should exhibit the lateral giant response, grip with the head and instantly come out of the burrow. This suicidal response never occurs; the worm always appears to exhibit the median giant response, and this no matter what part of the surface is touched.

Clearly observations in the field show a wider range of central connexions than are commonly found under the conditions of electrical recording. It seems that the presence of the tail in the burrow causes some switching over between the two systems. Either the median normally has potential sensory connexions with the body, posterior to segment forty (as indeed some records actually show[3]), which become functional when the tail is in the burrow, or else this attitude causes the lateral giants to activate the motor system used only by the median when the worm is free on the surface. Further observations are needed to settle these and other possibilities.

W. A. H. Rushton.

Physiological Laboratory,
Cambridge. May 14.

[1] Bullock, T. H., *J. Neurophysiol.*, **8**, 55 (1945).
[2] Rushton, W. A. H., *Proc. Roy. Soc.*, B, **132**, 423 (1945).
[3] Rushton, W. A. H., *Proc. Roy. Soc.*, In the press.
[4] Stough, H. B., *J. Comp. Neurol.*, **40**, 409 (1926).
[5] Stough, H. B., *J. Comp. Neurol.*, **50**, 217 (1930).

Cell Contents of Pus

From our previous studies entitled "Cell Contents of Milk"[1] we arrived at the conclusion that the fat in milk is secreted by a kind of polymorph neutrophil; as a sequel to this we have investigated the cell contents of pus.

The pus was collected from both acute and chronic cases, and we made wet and dry films, staining as before with methylene blue and May-Grunwald-Giemsa respectively.

We found that, as with milk in the wet films, we could divide the cells into the following three groups.

(1) The group formed by a majority of polymorph neutrophil cells, in pus specimens from acute abscesses. Some of these polymorphs were full of vacuoles which resembled, in some cases, the fat droplets in milk, but the size of the vacuoles varied considerably (Fig. 1).

(2) The second group consisted of mononuclears, but in the acute pus there was a noticeable absence of the very large cells we found so easily in the milk and thyroid fluid. Some of the mononuclears in this group contained vacuoles of different sizes, some of them being the size of red blood corpuscles.

(3) In the third group are the small mononuclears. In the chronic abscesses the majority of cells were lymphocytes, which could be seen attached to one or two small vacuoles, similar to the lymphocytes we found in milk (Fig. 2).

In the dry films also we were able to classify the cells, but as in milk, the cells were not in three distinctly different groups, but were linked by intermediate cells.

(1) In the first group were numerous polymorphs containing a large number of empty vacuoles of a uniform size. There were also polymorphs with nuclei which appeared to be under pressure because of the growing vacuoles of different sizes, some of them being almost as large as red blood corpuscles. These vacuoles appeared to be empty, as the material contained in them had probably been dissolved in the alcohol used in the stain (Figs. 3–5).

(2) The second group contained a wide range of mononuclears, and occasionally a very large mononuclear could be found which had a bluish cytoplasm full of empty vacuoles. These mononuclears appeared to be very fragile and a large number of them had been broken by the smear (Figs. 6 and 7).

(3) The third group consisted of lymphocytes, and when the dry smear was made from tuberculous pus, it could be observed that the lymphocytes still retained two or three vacuoles in their cytoplasm (Figs. 8 and 9).

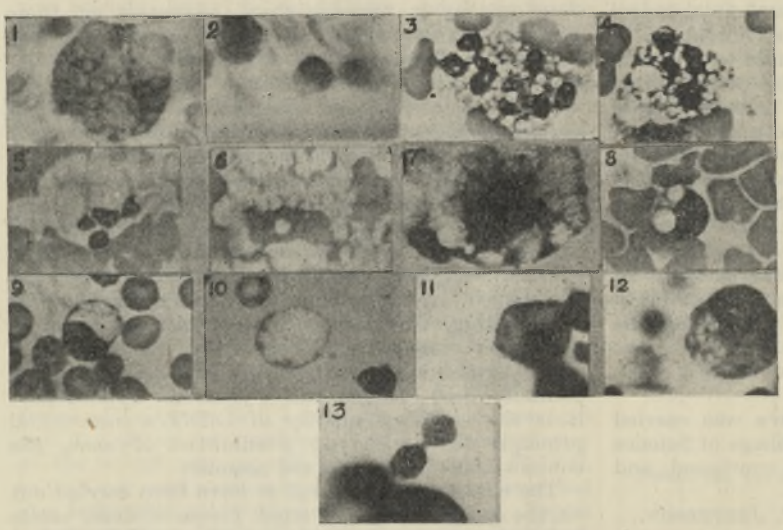
As mentioned above, in all the specimens of pus examined there was a noticeable absence of the huge mononuclear cells we had observed in milk and cystic fluid from the thyroids. This can be explained by the fact that the pus is not sterile, and includes in its composition some very toxic products from bacterial metabolism and from tissue necrosis, which probably interferes with the full development of the cells, and consequently there is an absence of cells of large size. There are also found in the pus some cells which set free portions of their protoplasm, as was observed in milk, and in the same way the liberated portions take on the form of round drops. Some of the free cytoplasmic portions still framed empty vacuoles (Fig. 10).

Having now confirmed the similarity between milk and pus by wet films and dry smears, we studied the histological morphology of different abscesses in different tissues.

In sections of granulomas, stained by hæmatoxylin and eosin, and under oil immersion, we were able to observe a whole range of cells. It was simple to follow the evolution from a polymorph neutrophil to a larger cell which has been described as a 'foam cell' or lipo-macrophagic cell, then to a small mononuclear and finally to cells which are similar to the plasma cells. The cells eventually revert to lymphocytes (Figs. 11–13).

The huge mononuclear cells we have observed in the milk were also found in the granulomas. They are present in the edges of the necrotic tissue and not in the pus itself, and this had not interfered with their development. Occasionally an odd one or two of these extra large cells float into the pus, only to break out and be destroyed when the pus is erupted.

It is clear that these large mononuclears present



WET FILMS. 1. A POLYMORPH FILLED WITH WHAT APPEARS TO BE FAT GLOBULES. 2. A LYMPHOCYTE STILL ATTACHED TO A FAT DROPLET.
SMEARS STAINED WITH MAY-GRUNWALD-GIEMSA. 3, 4. POLYMORPH NEUTROPHILS FULL OF VACUOLES. 5. POLYMORPH CONTAINING LARGE VACUOLES, SOME OF THEM ALMOST AS LARGE AS A RED BLOOD CORPUSCLE. 6. INTERMEDIATE CELL BETWEEN A POLYMORPH AND A MONONUCLEAR. 7. A HUGE MONONUCLEAR FULL OF VACUOLES. 8, 9. LYMPHOCYTES FULL OF VACUOLES. 10. PROTOPLASMATIC REMNANT FRAMING PUS DROPLETS.
FROM GRANULOMA, STAINED WITH HÆMATOXYLIN AND EOSIN. 11, 12, 13. SHOWING THE EVOLUTION OF CELLS IN THE GRANULOMA.

in the granulomas originate from a polymorph neutrophil, for they are only an intermediate stage between the polymorph and the lymphocyte, passing naturally through the stage of mononuclear.

I must thank my technician, Mr. Jeffrey B. Dean, for preparing the photomicrographs.

Conclusions. From our studies of different pus specimens and granulomas we have formed the following conclusions.

(1) The presence of leucocytes is necessary for the formation of pus, and the pus is not produced from the same tissue in which the inflammatory process is present, a fact which is already well known.

(2) The material collected and known as pus is a product of secretion by the polymorph neutrophil.

(3) The cell which secretes the pus is the polymorph neutrophil, which by changing its size and nuclear structure expels its products and becomes a mononuclear, eventually becoming a lymphocyte.

(4) This monoglandular cellular mechanism of pus secretion is similar to the process of milk fat secretion and the process seen in the cystic fluid from the thyroid glands.

F. DURAN-JORDA.

Pathology Department,
Ancoats Hospital, Manchester, 4.
April 23.

[1] *Nature*, 154, 704 (1944).

Heat Injury in Insects

IN an article on the hardening and darkening of the insect cuticle, Dennell[1] pointed out that both tyrosine and tyrosinase are present in the hæmolymph of late blow-fly larvæ (for example, of *Sarcophaga falculata*), but that darkening does not occur unless the blood is exposed or the larvæ treated with various substances. He went on to suggest that this inhibition *in situ* may involve the action of an unidentified dehydrogenase, the destruction of which results in the onset of tyrosinase activity.

It seems opportune, in this connexion, to give a brief preliminary account of some work on heat injury in blow-fly larvæ (*Sarcophaga falculata* and *Calliphora erythrocephala*). It was found that with a sufficiently refined technique employing short (three-minute) exposures, fully grown larvæ could be so injured by heat that although they recovered from heat dormancy and appeared normally active, death occurred within a few days. The basal oxygen uptake of such larvæ, as compared with untreated controls, showed a considerable increase, accompanied by browning of the tissues, from about a day after treatment.

This seems to indicate tyrosinase activity, which would be in agreement with Dennell's suggestion since dehydrogenases might well be affected by heat treatment. Dennell's original suggestion mentions "tyrosine being reduced as rapidly as it is oxidized" and would seem to involve the continuous oxidation of some reducing substrate in the blood. On this basis there is no reason to expect an *increase* of oxygen uptake to result from destruction of the dehydrogenase. However, Dennell informs me in a private communication that his more recent work on the electrode potential of the hæmolymph indicates that no oxidation of tyrosine takes place until the inhibiting factor in the blood is eliminated. From this it would be expected that in larvæ injured by heat no increased oxygen uptake should be observed until darkening occurs, and these later results agree closely, therefore, with the present observations. Hopf[2] mentions the possibility of heat injury producing enzyme activation in the hæmolymph. Whatever the precise explanation, however, the effect seems to be an upsetting of enzyme balance in the tissues.

Preliminary investigation (mainly by supra-vital staining) of the mitochondria of the fat-body of *Calliphora* larvæ seems to indicate that while those of treated larvæ are small discrete globules, those of controls are generally larger and often aggregated into clumps. If further work confirms this difference, it will be a matter of some interest, as it may well be the mitochondria which first suffer injury by heat.

The various theories of heat injury have been reviewed by Belehradek[3], but only the 'enzyme' and 'lipoid liberation' theories need be considered here. The former proposes that heat injury is due to the inactivation or destruction of enzymes, and seems to have some relevance to the present problem, where heating results in an upsetting of enzyme balance. The widely held 'lipoid liberation' theory postulates the 'liberation' of protoplasmic fats as the cause of heat injury. Among more recent work, that of Fraenkel and Hopf[4] on *Calliphora* and *Phormia* larvæ, while not completely supporting the theory, produced some evidence in its favour.

The mitochondria as the possible site of heat injury provide a link between these theories. They are thought to be bound up intimately with enzyme activity (see reviews by MacBride and Hewer[5], and Bourne[6]), and it is also generally agreed that lipoidal

complexes play an important part in their chemical structure (see Bourne, *loc. cit.*). The 'liberation' of mitochondrial lipoids, therefore, might well result in an upsetting of the enzyme systems of an animal and lead to irreversible heat injury. There is evidence in the literature that heat can cause a break-up of mitochondria in a wide range of organisms including plant cells, frogs, fish, guinea pigs and rabbits (see references in Belehradek[3], and MacCardle[7]). It seems possible, therefore, to suggest tentatively that heat injury is due primarily to a break-up of mitochondria and a consequent disruption of enzyme balance. In the case of fully grown blow-fly larvæ, if a dehydrogenase system is truly involved in preserving this balance, its inactivation during heat injury may be through the mitochondria rather than a direct effect of heat.

Part of the work mentioned above was carried out some time ago at the Imperial College of Science and Technology, London. It will be continued, and full details published elsewhere.

G. T. Jefferson.

32 Westgarth Avenue,
Edinburgh, 13.

[1] Dennell, *Nature*, **154**, 57 (1944).
[2] Hopf, *Biochem. J.*, **34**, 1396 (1940).
[3] Belehradek, "Temperature and Living Matter", *Protoplasma Monographien*, 8 (Berlin, 1935).
[4] Fraenkel and Hopf, *Biochem. J.*, **34**, 1085 (1940).
[5] MacBride and Hewer, in Piney's "Recent Advances in Microscopy" (London, 1931).
[6] Bourne, in "Cytology and Cell Physiology" (Oxford, 1942).
[7] MacCardle, *J. Morph.*, **61**, 613 (1937).

Mode of Entry of Contact Insecticides

Investigations now being carried out by us into the use of D.D.T. for the elimination of tsetse (*Glossina* spp.) have led to observations which have a bearing on the mode of entry of some contact insecticides. This problem seems generally to have been considered only in connexion with the usual methods of using contact insecticides, in which the object is to bring the poison, either by spraying or by dusting, into maximal contact with the general body surface of the insect. Mr. Napier Bax has pointed out to us an exception to this, for Tutin[1], so long ago as 1928, does record an observation in which two Carabid beetles and a Cicindelid died after being placed in a dish previously sprayed with an emulsion containing a rape-oil solution of pyrethrum, after the emulsion had dried. Nevertheless, no general attention seems to have been paid to the mere contact of insects with a sprayed surface. Thus Roy and Ghosh[2], discussing as recently as July 1944 various views on the mode of penetration of pyrethrum, and particularly those of Wigglesworth[3,4], record observations which led them to the conclusion that pyrethrum normally enters the insect body through the spiracles.

Our approach has been along the lines of Tutin's observation and therefore somewhat different from the one generally adopted; thus tsetse have been brought into contact with D.D.T.- and pyrethrum-covered surfaces through the feet only, flies being allowed to sit on the prepared surface or held over it with just their feet touching, for various specified periods. Contacts as short as five and even two seconds have proved fatal. One of us (F. L. V.) has demonstrated the presence of particles of D.D.T. on the pulvilli of flies so treated, and from observations on insects with varying degrees of pulvillar development it appears that the action of these poisons is more rapid when the pulvilli are well developed. Death has followed in the case of D.D.T. after intervals of half an hour or more, so that here we cannot completely dismiss the possibility of carriage of the poison to the spiracles from the pulvilli in the flies' efforts to rid themselves of the irritating particles. But death from pyrethrum has been so graphically rapid that no such explanation is tenable; thus repeatedly tsetse given a few seconds contact with the pyrethrum-treated surface have become completely paralysed in the interval between the removal of the fly from the poisoned surface and the handing of its tube to the recorder for marking. This rapid 'knock-down' action of pyrethrum is, of course, well known, but wears off so rapidly that the contact effect has not much practical application; it is the enduring quality of D.D.T.'s insecticidal principle that opens up possibilities of using the contact effect in a practical manner.

The experiments referred to have been carried out on the haired surface of small pieces of dried cattle hide treated with various strengths of D.D.T. (and pyrethrum) combined with various adhesive solutions (such as local gum, serum, wax, resin, etc.) and left to dry; it is therefore unlikely that any emanation entering through the spiracles can be held responsible for the effect, but further experiments are to be carried out. It is also very noticeable, particularly with the slower acting D.D.T., that the first symptoms of actual distress, apart from cleansing movements of the legs somewhat more persistent and continuous than usual, are convulsive movements of the legs, which suggest that their nervous control is the first activity to suffer interference.

Work is proceeding, but these observations do suggest that certain insecticides need not necessarily be applied in such a way as to bring about either penetration of the general body cuticle on a large scale, or entry through the spiracles; but that their action can be equally effective through contact of the feet alone, at any rate in species with well-developed pulvilli.

W. H. Potts.
F. L. Vanderplank.

Department of Tsetse Research,
Shinyanga.
April 13.

[1] Tutin, F., Ann. Rep. Agric. and Hort. Res. Station, Long Ashton, Bristol, 1928, 96.
[2] Roy, D. N., and Ghosh, S. M., *Bull. Ent. Res.*, **35**, 161 (1944).
[3] Wigglesworth, V. B., *Proc. Roy. Ent. Soc. Lond.*, **16**, 11 (1941).
[4] Wigglesworth, V. B., *Bull. Ent. Res.*, **33**, 205 (1942).

Congo Red Fibrin Powder for Experiments on Proteolytic Enzymes

Stained fibrin substrates are sometimes used for experiments on proteolytic enzymes. Grutzner[1] used fibrin stained with carmine to estimate the amount of pepsin in a solution. Carmine fibrin cannot be used for testing for trypsin as the dye is dissolved out of the fibrin by alkalis. The difficulty was overcome by Roaf[2], who as early as 1908 used Congo red instead of carmine. Congo red is not dissolved out of the stained fibrin by hydrochloric acid or by sodium carbonate, and can thus be used for experiments on both trypsin and pepsin. Roaf first used a moist preparation which was preserved in equal parts of glycerol and water to which a little toluene

was added. Later[3] he used Congo red fibrin in the form of a dry powder, in which condition it kept well. Very little attention seems to have been paid to Roaf's work. Cole[4] describes the use of carmine fibrin for an experiment on pepsin but does not mention Congo red fibrin. Hawk[5] suggests the use of carmine fibrin for pepsin and Congo red fibrin for trypsin. These are both moist preparations which have to be preserved under ether or glycerol. The advantages of a dry stable powder which can be used for both pepsin and trypsin are obvious.

About a year ago, unaware of Roaf's work at the time, we prepared a Congo red fibrin powder which has proved very satisfactory for students' experiments on proteolytic enzymes. Our method of preparing the powder is similar to Roaf's method.

The powder has been incubated at 37·5° C. for twenty-four hours in 0·2 per cent hydrochloric acid and in 0·5 per cent sodium carbonate without any of the colour coming out. Incubation at 37·5° C. in 0·05 per cent sodium hydroxide, however, resulted in a faint pink colour at the end of one hour. Peptic digestion gives a blue violet and tryptic digestion a red solution.

Preparation. (1) Wash some fresh fibrin in running tap water for several minutes. Transfer to a beaker of water and heat to about 70° C., stirring at intervals. Strain through muslin and rinse well in running water. (2) Mince the fibrin and put in slightly alkaline Congo red solution (450 c.c. distilled water; 50 c.c. 96 per cent alcohol; 0·2 c.c. 2 per cent ammonia; 2·5 gm. Congo red. 500 c.c. is used for every 100 gm. fresh moist fibrin). Heat to 80° C., stirring at intervals. Strain through muslin and wash in running tap water. (3) Place in a beaker of water which has been made alkaline to phenolphthalein by the addition of 2 per cent sodium carbonate. Heat to about 70° C., stirring at intervals. Strain and wash thoroughly in running tap water until the washings are colourless. (4) Spread the stained fibrin on filter paper and dry in an oven at 60° C. (5) Grind to a powder in a mortar. (6) Cover the powder with acetone and stir at intervals for five minutes. Pour off the acetone, spread the moist powder in a thin layer on filter paper and allow to dry.

About 10 gm. of powder are obtained from 100 gm. of fresh moist fibrin.

D. G. Duncan.
H. Zwarenstein.

Department of Physiology,
University of Cape Town.
March 16.

[1] Grutzner, *Pflüger's Arch.*, **8**, 452 (1874).
[2] Roaf, *Biochem. J.*, **3**, 188 (1908).
[3] Roaf, *J. Physiol.*, **53**, lxvii (1920).
[4] Cole, "Practical Physiological Chemistry", 9th ed., 226 (Cambridge: W. Heffer and Sons).
[5] Hawk, "Practical Physiological Chemistry", 11th ed., 287 and 323 (London: J. and A. Churchill).

Action of Mepacrine on Diamine Oxidase

The observation by Hammick and Chambers[1] that 2-chloro-5-amino-7-hydroxyacridine is a breakdown product of mepacrine found in human urine shows that the side-chain of mepacrine is removed by the scission of a C—N linkage.

In this connexion it seems of interest that the drug has a marked affinity for the enzyme diamine oxidase. Using an acetone-dried preparation of pig's kidney and 5×10^{-3} *M* cadaverine as substrate, we find that mepacrine depresses the oxygen uptake due to oxidation of cadaverine. The inhibition with 10^{-3} *M* mepacrine dihydrochloride was 92 per cent, with 10^{-4} *M* and 10^{-5} *M*, 82 per cent and 45 per cent respectively.

The affinity of mepacrine for the enzyme is only in part due to the presence of the side-chain. In an experiment in which mepacrine was compared with 2-chloro-5-amino-7-methoxyacridine (kindly given to us by Dr. D. Ll. Hammick and S. F. Mason), that is, the compound corresponding to mepacrine without the side-chain, the inhibitions—in 10^{-4} *M* concentration—were 70 per cent with mepacrine and 33 per cent with the amino derivative.

H. Blaschko.
Ruth Duthie.

Department of Pharmacology,
Oxford.
May 7.

[1] *Nature*, **155**, 141 (1945).

Effect of Alpha-Ray Bombardment on Glide in Metal Single Crystals

There are many indications that surface imperfections of the crystal lattice play a marked part in the initiation of the glide that results when single crystals are subjected to stress. Orowan[1] and others have discussed the matter from the theoretical side. From the experimental side, Roscoe[2], working in my laboratory, has shown that a very thin oxide film on the surface produces an increase in the resistance to plastic deformation, which cannot be due to the cohesion of the film, and Rehbinder[3] has shown that very thin surface films of certain substances, applied to single crystals, produce striking effects.

In order to throw light on the part that the surface plays in glide, I have been bombarding stressed single-crystal wires of cadmium with α-rays from a strong polonium source, deposited on the inside of a nickel cylinder 1 cm. long, which is split longitudinally so that it can be made to surround the wire. It was thought that the intense temperature agitation produced by the impact of a particle would, when the particle struck the metal in the immediate neighbourhood of a minute surface crack or dislocation, initiate glide. The α-particles, which penetrate about 0·005 mm. into the metal, cause considerable local disturbance, but under the experimental conditions do not produce appreciable bulk heating. Direct experiment proves that with my disposition the rise of temperature at the axis of the wire does not exceed 0·01° C.

The preliminary results of these experiments show that when a wire is stressed so as to produce a slow creep, of the order of 0·05 per cent per minute, bombardment with α-particles causes the rate of flow to increase to several times the value which obtained before the bombardment—five times in one particular case—although the wire was bombarded over only one third of its length. The wire had been extended by about 1 per cent when the bombardment was initiated. In the case of another wire which had been extended by 2·6 per cent of its length, and was increasing its length at a rate of 0·21 per cent per minute, bombardment increased the rate by about three times.

The greater the preliminary extension which had taken place before the bombardment, the smaller

the effect of the α-particles. After an extension of 3 per cent, when the rate of flow was markedly decreasing owing to the usual hardening effect, the bombardment caused but a small, although definite, change in the rate. With a wire that had been extended by 12 per cent, and was flowing at the rate of 0·7 per cent per minute, bombardment did not affect the rate of flow. Incidentally, this confirms that there is no appreciable bulk heating.

The above figures are given as indications that the effect is considerable : no precise quantitative significance is to be attached to them, since the strength of the source has not been accurately measured nor the inclination of glide plane and glide direction determined. Owing to the destruction of this laboratory during the air attacks, facilities are at present lacking for any such measurements. What the experiments show clearly, however, is that glide on particular planes can be initiated by α-ray bombardment, and hence that initiation of glide takes place from the surface. Once a particular plane is active, glide continues at a rate independent of the surface disturbance, as shown by the fact that bombardment does not affect the rate after large preliminary strain when, presumably, all suitable glide planes are in action. The α-particle bombardment is, then, a useful index to show whether glide is taking place by the activation of new glide planes or is continuing on planes already in action. In this connexion it can also be made to throw light on the mechanism of hardening, as discussed, for example, in a paper by Andrade and Chow[4].

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[1] For example, *Z. Phys.*, **89**, 605, 614, 634 (1934).
[2] *Phil. Mag.*, **21**, 399 (1936).
[3] The papers describing Rehbinder's work were given to me on my recent visit to Russia, but I have mislaid them and hence cannot give the reference. I hope later to write a note in *Nature* describing this very interesting work.
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A New Approach to Relativistic Cosmology

The kinematical part of relativistic cosmology concerns the most general line-element which satisfies the conditions of homogeneity. It has the form

$$ds^2 = d\tau^2 - R^2(\tau)d\sigma^2 \quad . \quad . \quad . \quad (1)$$

where $d\sigma^2$ is the line element of a three-dimensional space of constant curvature $k : 1, 0, -1$.

It is *always* possible to change (1) into the form :

$$ds^2 = \gamma\ (r,t)(dt^2 - dx^2 - dy^2 - dz^2); \quad . \quad . \quad (2)$$
$$r^2 = x^2 + y^2 + z^2$$

The form (2) is more general than (1) and to make (2) equivalent to (1) requires additional restrictions concerning γ. It would seem that the transition from (1) to (2) is purely formal, and that nothing can be gained by a discussion of cosmological problems on the metrical background (2) instead of (1). However, this is not so. To show it we shall formulate some conclusions following immediately from (2) :

1. The light geometry of any cosmological space (in (2)) is identical with that of a Minkowski space.

2. Any cosmological space can be looked upon as a Minkowski space with a non-Minkowski gauging. This is clear if we regard γ as the gauging factor in Weyl's sense. Thus, the most general cosmological space can be pictured as a Minkowski space in which the length of a vector changes by transportation, though in an integrable way.

3. The solution of Maxwell's equations in a cosmological space is identical with that in a Minkowski space. This can be deduced from the gauge invariance of Maxwell's equations, or from the fact that neither f_{kl} nor $\sqrt{-g}\, f^{kl}$ nor the structure of Maxwell's equations contains γ. The radiation spreading through the zero-cone is insensitive to any changes in γ. This simple conclusion seems to be unknown. Until recently papers were written on the solution of Maxwell's equations in a cosmological world. What the authors really found was a solution in a Minkowski space complicated by the choice of a co-ordinate system convenient for the description of motion of particles but very inconvenient for the description of an electromagnetic field.

4. The same holds true for Dirac's equations. They are, like Maxwell's equations, insensitive to the choice of γ. Or, rather, they must be expressed in a form such that they will be gauge invariant in the above sense. Again, papers dealing with Dirac's equations in a cosmological space give results apparently different from the old ones because of an inconvenient choice of a co-ordinate system.

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May 28.

Infra-Red Spectrum of the Night Sky

We photographed the infra-red spectrum of the night sky by means of a spectrograph with two prisms having an aperture of $f/1{\cdot}5$, giving a dispersion of 2000 A./mm. near 8000 A. and of 3000 A./mm. near 10000 A. We used the only infra-red plates we had at our disposal, namely, "800" AGFA plates ; we sensitized them before exposure. A ten-hour exposure made at the end of February 1942 at the Lyons Observatory gave us a spectrum[1] showing :

(1) A broad band without any visible structure, stretching from λ 7400 A. to about λ 8500 A., with a notable fall of intensity beyond λ 8200 A. ; according to the earlier observations made by Cabannes[2], it appears to be the first positive system of the nitrogen bands, the *A* oxygen band and the water-vapour bands.

(2) A very broad band at about 0·97 μ and a line or band about 1·03 μ. Since the limit of sensitivity of the plates we used is normally about 0·85 μ, an image much beyond 0·9 μ is possible only if there is in the night sky an unusually intense emission in this spectral region.

The broad band about 0·97 μ is probably the 0·94 μ water-vapour band. As to the 1·03 μ radiation, we considered two possible origins : either the (0,0) band of the first positive system of the nitrogen bands (wave-length of the head, 1·042 μ) or the forbidden doublet $^2P - {}^2D$ of the N I atom (λ 10410 A.–λ 10401 A.). In fact, on one hand, the (0,0) band of the first positive system can quite well be seen alone in the infra-red region observed because of its strong relative intensity[3] ; the existence of the (0,0) band of the first positive system would fit in with the fact that most of the bands of this system have been found both in the visible and in the distant red[2]. As to the infra-red [N I] doublet, we have just heard through a private letter from an American colleague that its permanent presence in the spectrum

of the night sky has been indicated recently, and that its intensity would exceed that of the green line of [O I]. This fact, important for the physics of the upper atmosphere, confirms the ideas recently expounded by one of us[4], who showed that nitrogen must be found essentially in the atomic state in the upper atmosphere. But it remains possible that the two identifications that we suggest may be simultaneously true; moreover, the two emissions may be bound together by a mechanism one of us has already pointed out[5]: the (0,0) band of the first positive system corresponds to the $B_0 - A_0$ transition of the nitrogen molecule; now the presence of the Vegard-Kaplan bands in the radiation of the night sky leads us to admit the presence of numerous A_0 molecules in the upper atmosphere; through the collision between the A_0 molecules and the ^2P atoms we can have the following process:

$$\underset{6{\cdot}14\text{ v.}}{A_0} + \underset{3{\cdot}56\text{ v.}}{^2P} \rightarrow \underset{7{\cdot}32\text{ v.}}{B_0} + \underset{2{\cdot}37\text{ v.}}{^2D}$$

9·70 v. 9·69 v.

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Feb. 19.

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Behaviour of Ultra-Violet and Daylight Rays in the Solar Cycle

When graphs are constructed, for the sunspot cycle 1933–44, of the annual averages both of ultra-violet and of daylight rays, they are found to have a decisive *minimum* at the sunspot *maximum*, of 1937–38, and the drop from maximum to minimum of the daylight curves is approximately twice as large as that of the ultra-violet curves. This drop of the rays received at the time when the sun has its highest activity, as shown by the maximum number of spots, suggests that the rays emitted from the sun are in part absorbed in their passage to the earth by some agency which fluctuates with the sun's activity and is most effective at the time of maximum sunspots. The ionization of the upper air due to ultra-violet rays is a probable agency in producing this effect.

While the daylight rays show an inverse relation to the sunspot curve and have a period the same as the sunspots, the ultra-violet rays exhibit two weak maxima on either side of its minimum and the curve appears to have a double period in the solar cycle. An explanation of these observations can be given on the following lines.

As regards the daylight rays, if they are not subject to any large fluctuations on emission from the sun, but are impeded in their passage to the earth by an agency of period like that of the sunspots, such as ionization of the upper air, they will have a single period in sympathy with the solar cycle. If, on the other hand, rays such as ultra-violet rays coming from the sun are subject to sunspot activity and fluctuate with it, and if these rays generate the fluctuating ionization already referred to, which at the same time acts as an absorbing agent, then the ultra-violet rays received on the surface of the earth would at first *increase* with growing sunspots; but at an early stage in the cycle the impeding ionization would reduce their intensity and a point would be reached when they would begin to *diminish* and continue to do so as far as their minimum when ionization is greatest; after which a reverse action would ensue, the rays would *increase*, due to reduction of ionization, and at a later stage they would diminish as their emission from the sun fell off, and two weak maxima would be presented one on each side of the droop of the curve. Thus the single period of the daylight rays coinciding with the period of the solar cycle would be explained by the emission of rays nearly constant over the solar cycle, while the double maximum of the ultra-violet rays would occur if the rays are not emitted uniformly but are subject to a fluctuation in sympathy with the sun's activity.

One result of this point of view is that at an early stage and again at a later stage in the solar cycle the received daylight and ultra-violet rays should move in opposite directions. In the latter part of the solar cycle of 1933–44 this comes out clearly, daylight rays increasing and ultra-violet rays decreasing simultaneously.

At the present time, sunspots are a minimum and there will probably be a rapid increase in their number in the next three or four years. These years will be of the highest interest in verifying or, if necessary, modifying the conclusions derived from the observations made during the solar cycle of 1933–44.

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Inverse Binomial Sampling

In a recent communication discussing the application of the sampling method described by Haldane[1], Tweedie[2] states that the method was described as a technique for using hæmocytometers. This is not so. Hæmocytometers are designed for estimating the population density per unit volume, and the method under discussion is adapted for estimating the incidence of an attribute in a population consisting of members possessed of that attribute and members not possessed of it. This is an entirely different problem. The method, which has been in use in this Laboratory for a considerable time, and has proved of great value, was designed for estimating the incidence of certain abnormal forms of erythrocytes in blood films, this incidence often being as low as 0·2 per cent. By using this sampling technique, increased accuracy is obtained at these low incidence levels, and a saving of time and labour occurs at high incidence levels.

As both Haldane and Tweedie indicate, the method has much wider applications than to haematological estimations, but it does not extend to the hæmocytometer type of sampling.

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Geology of the Nubian Sandstone

THE manner of formation of the famous Nubian sandstone has been a matter for controversy for a century. This may be partly attributed to its wide geographical distribution (extending over 30° of longitude and 20° of latitude)[1], its great vertical range (ranging from Palæozoic to Mesozoic), lack of fossils in its greater part, monotony of its lithological characters, and the difficulties entailed in the investigation of almost inaccessible localities in which it outcrops. The problematical unfossiliferous sands and sandstones in representative localities of the Eastern Desert of Egypt and in south-west Arabia were recently examined[2,3], using some of the more recent technique of sedimentary petrology.

Field observations, comprising (*a*) the upward transition from sands to clays to limestones, on a large scale, especially in the Cretaceous Nubian Sandstone; (*b*) the lateral extension and constancy of its sandy beds over large areas and the regular stratification; (*c*) the presence of water-ripple markings with a ripple index of 8·4; (*d*) the presence of a current-bedding similar to that described by McKee[4], with horizontal and inclined laminæ at 26° with the horizontal; (*e*) the presence of bands of transported quartz pebbles of spherical and discoidal shape (their sphericity ranges between 1·00 and 0·57 with 76 per cent of the pebbles having a sphericity which lies between 0·80 and 0·60); and (*f*) the regular surface of contact between the pre-Cambrian and the Nubian Sandstone, indicate that the sandy facies of the Nubian Sandstone of the different ages represent beach and off-shore shallow marine deposits of a sinking peneplained land-mass, excluding the possibility of an æolian origin or their formation under fluviatile, lacustrine, deltaic or estuarine environment.

Mechanical analyses of some eighty samples of the sandy facies showed that the sediments are remarkably uniform and are very well sorted. This sorting suggests either a beach or a dune formation. The histograms given by the Nubian Sandstone, however, are similar to those of modern beach and near-shore shallow-water sands (giving what we may term a 'one-bar' histogram, in which the percentage of the largest fraction is more than 60 per cent and differs from the other percentages by at least 25 per cent, using the Wentworth scale) and are different from those of recent dunes (which may be termed 'two-bar' histograms, in which the difference between the percentages of the largest two fractions does not exceed 25 per cent). This may be taken as a further indication of the marine origin already inferred for the sandy beds.

The mineralogy of some seventy samples from the sandy facies (and of some intercalated clayey and calcareous beds at Khashm-el-Galala, south of Suez) showed that post-depositional dissolution of the minerals was at a minimum (perhaps noteworthy in the light of work in other parts of the world), notwithstanding the old age of the deposit, and the presence of etched grains and certain authigenic minerals. This conclusion is based on the following observations: (1) the presence of the same minerals in the same abundance in the various lithological varieties; (2) the presence of fresh grains of the easily hydrolysed hornblende and augite in the formation; (3) the presence of etched and unetched grains of garnet side by side in the same hand-specimen; (4) the presence of etched staurolite and etched colourless epidotes in the sealed and stabilizing media of the clays and limestones, denoting that the etching is not, in the present case, a criterion of post-depositional changes. This question of post-depositional changes in the Nubian Sandstone is, at present, under detailed investigation.

The mineralogical study showed also that the formation is, in the main, composed of the same minerals in the same abundance both in a vertical and horizontal sense, which prohibited zoning and thereby correlating the formation on a large scale. This lateral uniformity of the mineralogy of the formation in the localities examined points to wind transportation, because such uniformity seems to be a criterion of marine sediments carried by wind[5]. The frosting of most of the quartz grains and their spherical and rounded nature lend evidence for the suggestion; the marine environment previously inferred was not given enough time to polish the grains. The detrital minerals have been mostly carried by wind, but they must have been deposited and redistributed under water.

It is, therefore, necessary to abandon the conclusions of Walther[6] and of Fourtau[7], who advocated an æolian (continental) origin for the Nubian Sandstone, a conclusion which gradually crept into some of the general works on stratigraphy[8] and which is held by some of the more recent and leading workers[9,10] on the stratigraphy of the Middle East countries.

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An Endodermal Phellogen in the Stem of *Paederia foetida* Linn.

DURING the course of an anatomical study of *Pœderia fœtida*, a twining shrub of these parts, belonging to the family Rubiaceæ, we found that the phellogen originates in the stem, not in the sub-epidermal layers of the cortex as in most dicotyledons, but in the endodermis. We have seen this in a large number of sections, cut free-hand as well as on the microtome, from various collections of the material made at Dacca. The endodermis itself is a clear and unmistakable layer easily recognized by the presence of the Caspary bands on its radial walls and forming a continuous cylinder enclosing the stelar tissues. After the first tangential division of its cells the inner layer functions as the phellogen, and the outer, together with the whole of the cortex and the epidermis, is sloughed off as cork formation advances. We would like to know if a similar condition has been noticed in any other plant and what may be the causal factors leading to it. This observation is recorded here in the hope that it will attract the attention of other plant anatomists.

We are, of course, aware of instances where the

TRANSVERSE SECTION OF STEM OF *Pæderia fœtida* SHOWING TANGENTIAL DIVISION OF CELLS OF THE ENDODERMIS. (× *c.* 220)

phellogen is formed in the epidermis, cortex or pericycle, as also a couple of cases of interxylary cork formation and one of cork formation on the endosperm. It is also well known that in *Quercus suber*, the cork oak, the cork cambium first arises in the epidermis, but, due to the frequent strippings of cork, it may later arise in tissues lying considerably deeper, even as far down as the secondary phloem. The case of *Pæderia* is, however, quite different, for here the cork cambium arises at the very outset in the endodermis and is recognizable while the stem is still quite young. The cork which it forms is permanent and there is no deeper-lying phellogen differentiated afterwards unless the stem is wounded.

The accompanying photomicrograph shows the tangential division of the endodermal cells into two layers, of which the inner is to function as the phellogen.

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April 21.

Synthesis of Adenosine Triphosphate by an Enzyme System from Ischæmic Muscle

WHILE investigating the changes in phosphates of muscle in tourniquet shock, Bollman and Flock[1] have confirmed and amplified our previous finding (Green)[2] by showing that the adenosine triphosphate content of rat muscle falls progressively after clamping of the limb to reach a very low level at the time (four hours) at which, when both limbs are involved, fatal shock develops after release. They conclude that "this type of shock is definitely not due to ATP washed out of the muscle because ATP is destroyed during the occlusion and its decomposition products appear to be relatively non-toxic". In our opinion, the results of Bollman and Flock[1] only allow the conclusion that tourniquet shock is not due to a sudden release of adenosine triphosphate into the circulation on removal of the clamp. We never considered it likely that this was the mechanism, since a single dose of adenosine triphosphate injected intravenously produces acute symptoms and not the gradual merging into a shock-like state seen in ischæmic shock and after injection of adenosine triphosphate by routes other than the intravenous[2].

Extensive studies have shown the difficulty of detecting chemically the presence of adenosine triphosphate or its breakdown products in the blood of rats following the injection of lethal doses. Failure to detect it in the blood of rats during ischæmic shock is not therefore proof that it plays no part in the syndrome.

The problem was tackled at another angle. It was postulated[2] that resynthesis of adenosine triphosphate might occur in the limb muscle after release of the clamp, and that it would escape continuously from the damaged muscle cells and leave the limb. Bollman and Flock's conclusion would only be justified if there were evidence of the failure of the enzyme systems of ischæmic muscle to resynthesize adenosine triphosphate. Accordingly we studied the activities of isolated enzyme systems from the normal left- and the ischæmic right-leg muscles of six rats. The findings were precisely similar in each instance.

COMPARISON OF ACTIVITIES OF ENZYME SYSTEMS FROM NORMAL AND ISCHÆMIC RAT MUSCLE.

	Age of enzyme preparation	Normal muscle	Ischæmic muscle
Transmutation: Phosphopyruvic acid P/ml.	2 days	0·038	0·037
	8 days	0·036	0·035
	3 weeks	0·031	0·032
Resynthesis of adenosine triphosphate P 7′/ml.	2 days	—	0·037
	8 days	0·031	0·028
	3 weeks	0·012	0·013
Deamination: % NH_2–N of added adenylic acid	1 day	79·9%	79·2%
	2 days	80·8%	79·7%

A: Transmutation and Resynthesis: Normal muscle and muscle taken from below unreleased clamp after four hours application. Enzyme solutions made up to correspond to 2 gm. of fresh tissue per ml.
B: Deamination: Tissue residue from corresponding preparations *A* treated according to Lohmann and Schuster (ref. 6). Bicarbonate extracts corresponding to 1 gm. of fresh tissue per 3 ml.

As will be seen in the table, the resynthesis of adenosine triphosphate from muscle adenylic acid and phosphoglyceric acid, involving the transmutation of the latter compound into phosphopyruvic acid (Baranowski)[3], as well as the activity of Schmidt's[4] muscle adenylic acid deaminase, were of the same intensity with enzymes prepared from both ischæmic and normal muscle. This strict parallelism held true, not only for fresh, but also for enzyme preparations which had been stored in the refrigerator for different lengths of time.

Since the enzyme systems responsible for the resynthesis of adenosine triphosphate are intact in ischæmic muscle, why, as Bollman and Flock[1] have shown, does the adenosine triphosphate content of the muscle remain at a low level for a considerable time after removal of the clamp? The reason may be that though the synthesis of adenosine triphosphate will begin once the oxygen supply and ionic concentrations are approaching normal levels, the damaged muscle is unable to store the adenosine triphosphate produced. Such a hypothesis would account not only for the continued low adenosine triphosphate content of the damaged muscle, but also for the slow development of the shock-like state which develops after the release of the tourniquet and which strongly resembles the state following the intramuscular injection of adenosine triphosphate.

Bollman and Flock[1] found that muscle fibres, which have been damaged by vascular occlusion for

four hours, take several days to return to normal, and we should not expect the adenosine triphosphate content to reach the normal level before the contractile element of the muscle fibres has been restored (Szent-Györgyi)[5].

These experiments throw no direct light on the role of adenosine triphosphate in ischæmic shock, but they do show that it cannot be ruled out as a possible factor.

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H. N. GREEN.

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May 15.

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Amœbiasis in Durban

IN Durban there is a reversal of the customary incidence of amœbiasis. It is generally stated that an indigenous population is less susceptible to this disease, but in Durban the native African is much more liable than the European or Indian to acute, fulminating amœbic dysentery. In Europeans the condition is usually chronic, with an accent on the vague manifestations. When there is dysentery in Europeans it is usually of the 'walking' type, whereas in Africans the patient is prostrate. Examination of the stool in African cases shows the cytology of an acute bacillary dysentery, without macrophages, but with myriads of large, actively motile, hæmatophagous trophozoites of *E. histolytica*. In fact, as many as 150 parasites have been counted in a single high-power field. The amœbæ are so motile that they are streaked out often with a tail of dragging detritus. The customary distinction between ecto- and endoplasm is not clearly seen in fresh preparations, for the granular material moves into a pseudopod almost as quickly as this is formed, and it is only in older specimens that clear ectoplasm is obvious.

Amœbiasis in Africans has a high morbidity and mortality, for in 1944 there were 1,203 proved cases at King Edward VIII Hospital, with 198 deaths.

Opinions differ as to the reason for this 'racial' susceptibility. The African has been incriminated as the source of amœbiasis here, but rather is it the reverse, for the African is probably meeting a new disease, judging by the severity of the infection.

This manifestation of amœbiasis is probably due to a number of factors: (1) Contact between a susceptible race and a race with a high host-parasite equilibrium. (2) The nature of the African diet, particularly in urban areas and under war-time conditions. This diet is almost exclusively carbohydrate, which is definitely conducive to infection. It may be that there is a sub-clinical intestinal pellagra rendering the bowel wall particularly susceptible to invasion. (3) In rapid passage from individual to individual the amœba gains virulence. (4) The insanitary conditions in which the detribalized native lives around the towns offering employment. The parasite may in part be water-borne, for there is always an exacerbation when the local streams begin to run after the rains. Possible vectors such as flies and cockroaches are numerous, and there can be no doubt that direct transmission takes place. Vegetables as a medium are not important; for the African under town conditions gets little of these.

Further work is being done on this problem, and will be reported in due course.

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May 7.

An Illusion of Size

I READ Dr. Loewenstein's letter[1] with the above title with great interest and began by repeating the tests which he describes. I took a bright nickel threepenny piece (1944) and polished it; I took also a very dull one which was minted during 1937. I placed them on a black background and at once saw, as Dr. Loewenstein states, that the older one appeared the larger.

Being somewhat puzzled by this observation, I measured the two coins and this is what I found: diameter angle to angle, old coin 3·075 mm., new coin 3·060 mm.; diameter, flat to flat, old coin 3·01 mm., new coin 3·00 mm.; surface, inside raised edges, old coin 2·72 mm., new coin 2·66 mm. Thus in each case the older coin is the larger. These measurements were made with ordinary engineer's gauges. The accuracy was, however, sufficient to establish the fact that the old coin is in certain respects physically larger than the new one. An examination of coins minted in the year 1938, 1939, 1941, 1942 and 1943 indicated that the change in size occurred in between 1939 and 1941. I tried to obtain a coin for 1940 but without success.

Two 1937 coins of the same size were now selected, a dull one and a polished one, and these were placed as before on a black background. With perpendicular lighting the dull one appeared to be either the same size or slightly smaller than the bright one, presumably due to retinal irradiation produced by the latter. With oblique lighting, on the contrary, the dull one sometimes appeared to be slightly larger than the bright one. This seemed to be due to the bright reflexion from the raised edge of the polished coin being somewhat smaller (since the light was reflected from the outside of the raised edge on one side of the coin and from the inside of the raised edge on its other side) than the matt reflexion from the raised edges of the unpolished one. Very careful adjustment of the oblique lighting had to be employed in order to obtain this effect, for otherwise the coins appeared the same size, or the dull one the smaller as with perpendicular lighting.

So far as I can see from these experiments, it is unlikely that the effect described by Dr. Loewenstein is a psychological one. It is either due to an actual difference in size of the two coins or to the way that light is reflected from them. It would be interesting to know if in his experiments Dr. Loewenstein measured the coins to see whether or not they were identical in size.

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[1] *Nature*, **155**, 672 (1945).

COLOUR SENSITIVITY OF THE FOVEA CENTRALIS

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LAST year, one of us (E. N. W.[1]) demonstrated that a small central area of the fovea was unable to discriminate blue-green colours and, in other ways also, appeared to have the characteristics of the tritanopic form of colour-blindness. The observations were made with small painted test spots suitably fixated on the foveal centre. The results aroused considerable interest and led to correspondence in *Nature*[2,3,4,5], in which it was pointed out that König[6], some fifty years ago, had noted that his foveal centre was tritanopic: his observation, however, did not appear to have been generally accepted[7].

A full description of the colour vision of any retinal area requires the measurement of the luminosity curve, the spectral mixture curves and the hue discrimination curve for that area. From data of this type it should be possible to derive information about the spectral sensitivity curves of the retinal receptors and, in the case of the central fovea, to compare these curves with corresponding results for other retinal areas.

The results described below were obtained with the colorimeter previously developed by one of us (W. D. W.[8]) with which colour matching, hue discrimination and luminosity measurements can all be made. The test and comparison fields formed the two halves of a small circular field which, in most of the observations, subtended about 20′ of arc: some measurements were also made with 12′ and 15′ fields. The exit pupil of the apparatus as normally used is about 1 mm. diam., but for most of the final observations the system was modified to permit a larger pupil, about 2 mm. diam., to be used. The observer's head was fixed by a dental impression mouthpiece in such a way as to bring the exit pupil of the apparatus on to the optical axis of the observer's eye. The brightness of the field was of the order of 100 photons, although various brightness levels were used from time to time, and at the violet end of the spectrum the level was necessarily lower.

König's observation that colour matching in the foveal centre could be carried out with only two matching stimuli was confirmed, and Fig. 1 shows the dichromatic coefficient curves for the spectrum for W. D. W., using matching stimuli of wave-lengths 0·65 μ and 0·46 μ. The units of the stimuli were so chosen as to be equal in the match on a yellow at wave-length 0·5825 μ, and the values for the red (r) and blue (b) coefficients in any match were adjusted to bring $r + b = 1$. For the advantages of this type of unit system, reference may be made to previous papers[9,10]. It will be noticed that, with the matching stimuli used, all the spectral colours could be matched by positive mixtures of 0·65 μ and 0·46 μ. At wave-lengths shorter than 0·46 μ, the ratio of red to blue in the mixture increased; this corresponds, in trichromatic vision, to the increase in the amount of red required to match the violet radiations. The increase also means that there are pairs of wave-lengths on either side of some point between 0·45 μ and 0·46 μ (the exact wave-length of the minimum of the red curve, or the maximum of the blue, is difficult to determine) which match each other in colour quality. These matched wave-lengths may be determined by drawing a horizontal line such as AB in Fig. 1 and finding the wave-lengths at which the line intersects the red curve.

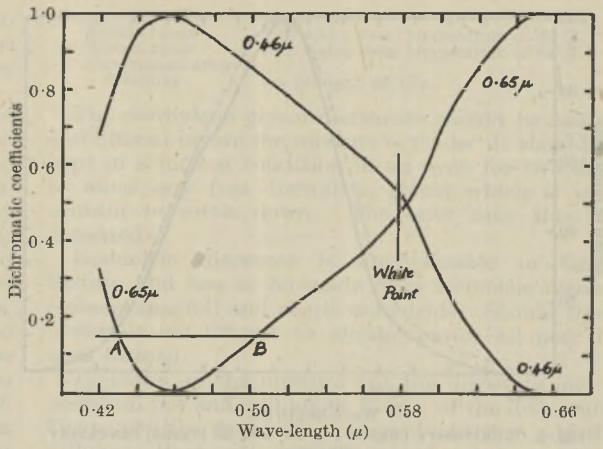

Fig. 1. DICHROMATIC COEFFICIENT CURVES FOR W.D.W. White point at 0·578 μ. A and B, spectral colours which match each other.

The fact that vision is dichromatic implies (see Pitt[10,11], for example) that all stimuli, homogeneous and heterogeneous, can be matched by the appropriate mixture of the two matching stimuli and also, therefore, by some monochromatic radiation. In particular, there is a neutral point in the spectrum at which a white of some defined quality can be matched by the spectral radiation at that point. With a white stimulus having a colour temperature of 4,800° K., the neutral point for the central fovea was located at a wave-length of 0·578 μ. This is a mean value obtained from direct matches between the white stimulus and a radiation from the spectrum, and also from matches between the white and a mixture of the matching stimuli, 0·65 μ and 0·46 μ. Direct observation, supported also by the coefficient curves, indicated a second neutral point in the region of 0·41 μ, but the brightness at which the observations could be made was too low for the point to be determined with certainty.

The luminosity curve was recorded by measuring the energy at wave-length λ required to match a comparison field of constant brightness and quality. The inverse of these energy values plotted against λ then yields what is generally known as the equal-energy luminosity curve. The curve so obtained for the 20′ field is shown in Fig. 2, with a curve for a 2° field drawn for comparison. In making the observations, a red comparison field was generally used to assist foveal fixation. No great difference between the two curves is apparent, although at the short wave-lengths the luminosity values for the smaller field are only about half those for the larger field, while in the region of 0·61 μ a slight hump is revealed. At lower brightness levels, a more pronounced hump has been previously recorded[12] with a 2° field and a small peak with 20′ fields[13].

The coefficient curves can be converted from the unit basis of Fig. 1 to luminosity units by measuring the relative luminosities, L_R and L_B, of the amounts of 0·65 μ and 0·46 μ required to match 0·5825 μ, the wave-length chosen to define the units of the matching

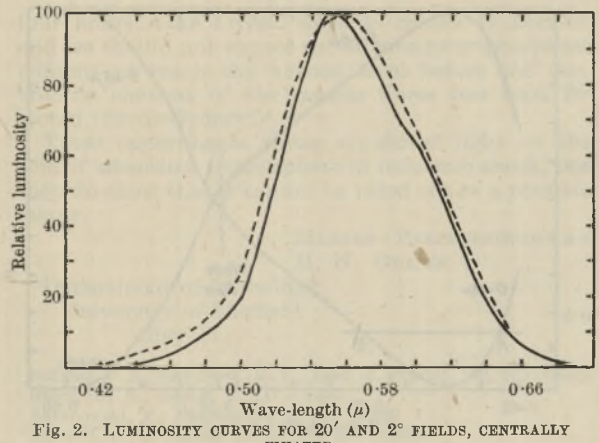

Fig. 2. LUMINOSITY CURVES FOR 20′ AND 2° FIELDS, CENTRALLY FIXATED.
Continuous curve, 20′ field. Broken line, 2° field.

stimuli. A mean value for the ratio L_R/L_B was obtained as 0·73/1·00. If the coefficients, r and b, at any wave-length λ are then multiplied by 0·73 and 1·00 respectively, the relative amounts of 0·65 μ and 0·46 μ, in luminosity units required to match λ, are obtained. The ordinate of the equal-energy luminosity curve at wave-length λ can then be divided into two parts, representing the amounts, in luminosity, of 0·65 μ and 0·46 μ required to match the amount of λ present in the equal-energy spectrum. Repetition of this calculation at intervals through the spectrum then yields the spectral mixture curves shown in Fig. 3.

Since these curves are expressed in terms of matching stimuli which produce all-positive mixture curves, and since, as reported below, 0·65 μ and 0·46 μ are located at points in the spectrum where the change of hue with wave-length effectively vanishes, there is some justification for assuming (though it is not proved) that 0·65 μ and 0·46 μ each stimulate only one of the two receptor units which must exist in the central fovea. If this is so, then the curves in Fig. 3 represent the spectral sensitivities of the two receptor systems responsible for colour perception at the fovea. It should be pointed out, however, that this argument rests on certain assumptions with regard to the nature of the receptors, and further work is necessary before a definite conclusion can be reached. Nevertheless, two features of the

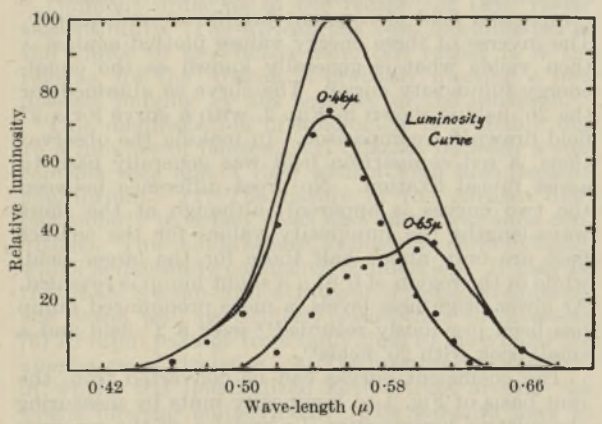

Fig. 3. LUMINOSITY AND SPECTRAL MIXTURE CURVES FOR 20′ FIELD, CENTRALLY FIXATED.
Continuous curves as determined by W.D.W. Circles, spectral mixture curves for E.N.W.

curves may be noted: (*a*) the 0·46 μ curve corresponds quite closely to the 'green' curve given in most of the derivatives of the fundamental response curves of the Young–Helmholtz theory (for a summary of these curves see Walters[14]). This similarity was also reported by König[6]. (*b*) The 0·65 μ curve is irregular in shape, but reaches a maximum value at about 0·60 μ. Because of this irregularity, the curve differs from the fundamental red response curve as usually derived; this deviation was again noted by König, although he gave no indication of the nature of the difference. The maximum near 0·60 μ provides added support for the existence, under some conditions, of the peak in the luminosity curve in that region[12], support which is the more significant because it does not depend upon any very obvious peak in the luminosity curve from which the mixture curves were derived.

The hue discrimination curve (Fig. 4) was recorded by illuminating one half of the field with monochromatic light of wave-length λ and the other half by light of wave-length λ + Δ λ. Δ λ was increased until a difference in hue could just be detected when the brightness of the two halves of the field was

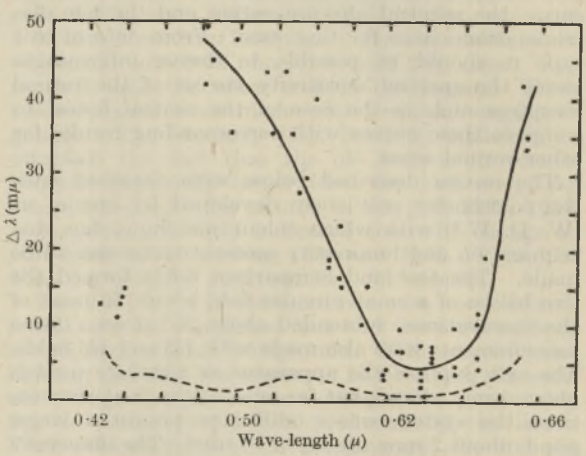

Fig. 4. HUE DISCRIMINATION CURVES.
Continuous curve, for 20′ field. Broken curve, for 2° field.

equalized. The value of the just noticeable wave-length difference Δ λ was then plotted at the wave-length $\lambda + \frac{\Delta\lambda}{2}$ to give the observations recorded in Fig. 4. As will be seen from the individual observations shown in the diagram, the spread of the measurements was considerable. This was probably due to the difficulty in fixating the field correctly, and also to the inherent difficulty of observation with such a small field. The shape of the curve is very different from that for normal vision with a 2° field[15], but it does correspond to the probable discrimination of the tritanope[11], who appears to have reasonably good discrimination in the yellow part of the spectrum, but very poor discrimination in the blue-green. In the neighbourhood of 0·46 μ there is an effective discontinuity in the curve, since the change of hue with wave-length falls to zero at this point. Observations in this region have little meaning, since if λ were set at, say, 0·44 μ, then on increasing the wave-length of the comparison field to λ + Δ λ, the quality of the light will tend to become different until λ + Δ λ reaches 0·46 μ, but beyond this point the qualities will tend to approach one another again. With λ at

shorter wave-lengths, for example, 0·42 μ, a discriminable step could be observed before 0·46 μ was reached, although the observation was difficult owing to the low intensity.

The results given here represent experimental data which unequivocally confirm König's original statement that the central fovea is dichromatic and tritanopic. It is difficult to explain why his observations were received with such doubt for so many years, unless the reason lay in the difficulty of locating the small test field on the fovea and maintaining it in that position for more than a very short time. With the test fields used in the present experiments, any deviation from direct fixation immediately caused a breakdown in the matches obtained; whether this would have been true with still smaller fields it is impossible to say without further experiment. Prof. H. Hartridge's observations and those of one of us (E. N. W.) with painted test fields suggest that it may not be so. With regard to Prof. Hartridge's conclusions[5] about the dichromatism of retinal areas other than the central fovea, it is likely that colour matching experiments may confirm this provided the test field is of suitable size, yet we believe that the characteristics of the central fovea differ significantly from those of the retinal areas in its immediate neighbourhood. Experiments are in progress to investigate this question.

We wish to express our thanks for the continued support of the Medical Research Council.

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ESTER WAX: A NEW EMBEDDING MEDIUM

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IN view of the many disadvantages of paraffin wax as an embedding medium, a search was made among natural and synthetic fatty acid esters for a more suitable material. No single substance was found which had all the necessary requirements, but a mixture was finally produced using diethylene glycol distearate as the main ingredient. A complete account of this work will be published elsewhere.

A formula suitable for most types of tissue is as follows:

Diethylene glycol distearate	82 gm.
Ethyl cellulose, low viscosity	4 ,,
Stearin	5 ,,
Ricinoleic (octadecanediol) diacetate	9 ,,

The following are among the physical characters of this mixture:

Melting point	48° C.
Section range	4–20 μ at a room temperature of 66° F.
Ribbon range	4–15 μ at a room temperature of 66° F.
Compression after flattening	7·6 per cent at 10 μ.

The diethylene glycol distearate should be heated and filtered before the mixture is made. It should be kept in a molten condition in an oven for two days to allow any free diethylene glycol which it may contain to settle down. The ester may then be decanted.

Ricinoleic diacetate is unobtainable in Great Britain and has to be made from ricinoleic alcohol (octadecanediol) and acetic anhydride. Should these materials be difficult to obtain, castor oil may be used instead.

To make up the mixture put the diacetate into a porcelain pot and add about 15 gm. of the distearate. Heat until the distearate is melted and then add the cellulose. Heat until this is dissolved and then add the rest of the distearate and the stearin. The cellulose dissolves only at a high temperature (approximately 100° C.) and solution should take place with the minimum possible of the two other solids present.

Ester wax is soluble in most alcohols, ethers, esters, ketones, hydrocarbons, chlorinated hydrocarbons and natural oils. The following have been found suitable as clearing agents as well as solvents:

Dioxan.
Ethylene glycol mono ethyl ether ('Cellosolve').
Ethylene glycol mono butyl ether.
Diethylene glycol mono butyl ether.
Cedarwood oil.

As with paraffin wax, a pre-embedding bath of solvent and ester wax is recommended before placing the specimen in ester wax. The time which each specimen requires is the same as when using paraffin wax.

L-pieces are recommended for block-making, and as the block is cooling with the specimen in it the hollow which is produced in the centre due to shrinkage should be filled in with drops of molten ester wax. Rapid cooling of the block by placing it in, but not submerged in, cold water, produces a slightly better block than one cooled at room temperature.

Ester wax is harder than paraffin wax, and in trimming, thinner cuts should be made to prevent chipping. A one-sided razor blade is most suitable.

Sections should be cut at a slower speed than for paraffin wax sections. If cut too slowly poor ribboning results; if cut too fast the sections will crinkle considerably. The crinkles will go when the sections are flattened, but even then the fewer the better. Experience soon indicates the correct speed.

The most important property of ester wax is that of 'ribbon staining'. Instead of flattening on water, as with paraffin wax, ester wax sections may be flattened on stain solutions which easily penetrate the wax and stain the sections. The stain is then drained off, the slide irrigated with water to remove the excess stain, and the sections may then be dried in an oven. To make this clearer the steps are as follows:

1. Flood an albumened slide with methylene blue solution; Loeffler's formula full strength or diluted up to 1 in 10,000. A weak solution is preferable because of the later removal of excess stain which dries on the slide.

2. Lay the ribbon on the stain solution and flatten in by placing the slide on a warm plate or on the surface of warm water at about 40° C. until the wrinkles in the wax disappear.

3. Drain away the excess staining solution. Lower the slide below the surface of distilled water in a petri dish. Gently agitate the slide until it is quite free from methylene blue, and then raise it out of the petri dish with the sections on it. Drain away most but not all of the water. Place the slide in an oven at about 40° C. until dry. *It is important to dry at this temperature or slightly higher or the sections will be wrinkled.* After one hour or even less, the sections will be dry enough for dissolving the wax, differentiating, and counter-staining.

The sections or ribbons may be flattened on water if preferred and treated as paraffin ribbons.

Removal of wax may be done in xylol, which will dissolve the wax without dissolving the methylene blue. It does not dissolve the ethyl cellulose very quickly, however, and a mixed solvent of xylol, ethylene glycol mono ethyl ether ('Cellosolve'), and ethyl acetate is recommended. Should the sections have been stained progressively to a point at which no further extraction of methylene blue is necessary the following mixture is suitable :

'Cellosolve'	10 per cent
Ethyl acetate	45 „ „
Xylol	45 „ „

The wax will be removed in about five minutes and the sections may then be transferred to pure xylol, and mounted with balsam in the usual way.

Generally sections are overstained and differentiated in a mixture similar to the above but with a greater proportion of the stain solvent—'Cellosolve'. In some cases pure 'Cellosolve' alone may be needed to remove the methylene blue from the tissues. Extraction is stopped by placing the slide in the 10 per cent 'Cellosolve' mixture.

Sections can be counter-stained in erythrosin or eosin dissolved to saturation in the following :

'Cellosolve'	20 c.c.
Ethyl acetate	40 „
Xylol	40 „

This process takes place simultaneously with differentiation of methylene blue or other stain and with the removal of wax. Sections may first of all have part of the wax removed in the 10 per cent 'Cellosolve' mixture, or in pure 'Cellosolve' if heavily overstained with methylene blue, and then may be transferred to the counter-stain. In this the tissue will continue to lose a trace of methylene blue and any remaining wax will be dissolved. When staining is satisfactory the slide is placed in a lower 'Cellosolve' mixture (10 per cent or less). This will prevent any further extraction of methylene blue and will also slightly intensify the erythrosin staining. Finally the slide is transferred to pure xylol, and mounted in balsam.

Clean differentiation of both stains and perfect control throughout all operations are the principal advantages of the method. Other stains may be employed, but methylene blue and erythrosin have, up to the present, been the most satisfactory.

To prevent the methylene blue fading the sections should be mounted in 'Sira' (Stafford Allen & Co., London) and not baked. Such preparations will last for years.

The general outline of the method has been given above. In practice the following solutions are found to cover any combination of wax removal, differentiation of the first stain and application of the counter-stain which may be required :

	1	2	3	4	5	6	7	8
'Cellosolve' ..	–	–	5	10	20	40	80	100
E. acetate ..	–	–	47	45	40	30	10	–
Xylol ..	100	100	48	45	40	30	10	–

No. 5 should have erythrosin to saturation.

The following reagents are not usually supplied by the general chemical supply houses, but may be obtained from the sources given : diethylene glycol distearate (Messrs. A. Boake Roberts, "Ellerslie", Buckhurst Hill, Essex) ; ricinoleic alcohol (octadecanediol) (Imperial Chemical Industries, Stockton-on-Tees) ; ethyl cellulose, low viscosity (Messrs. J. M. Steel, Kern House, Kingsway, London).

THE BRITISH COUNCIL

THE last annual report of the British Council, which covered the year ending March 31, 1944 (see *Nature*, **155**, 58 ; 1945), well indicated the importance of the work of the Council, not only in the war effort but also for the establishment of cultural relations in times of peace. The Council's work in making British contributions to science better known abroad and promoting contacts between British men of science and those of other countries, particularly since the establishment of its Science Department four years ago, has become so important that the tenth anniversary of the inauguration of the British Council in July 1935 should not be passed unmarked by scientific workers.

The present moment is therefore appropriate to recognize the work of its Science Committee and its Pure Science Panel, of both of which Sir Henry Dale is chairman, as well as its Panels for Medicine, Engineering and Agriculture. One of the earliest activities of the department was the publication of a four-page illustrated newsletter, *Monthly Science News*, in which accounts of research are presented in a form intelligible to non-scientific readers. Translated into French, Spanish, Portuguese and Arabic and reprinted in seven different countries, this has now a monthly circulation of 65,000. Compiled in collaboration with learned societies, professional bodies and the scientific and technical Press, *Science Comment*, a monthly compilation of abstracts and reviews started in 1943, is circulated to universities, libraries, etc., and scientific workers overseas to keep them informed of important publications in the scientific and technical field. A section has recently been added dealing with scientific films. The publication is used by booksellers as a valuable indication of British scientific publications likely to be in demand and in introducing technical and scientific periodicals to a wider overseas public.

Much has been done by the Council to enable British men of science to keep in touch with fellow-workers in other countries in the same field ; the exchange of papers and specimens has been maintained and an ever-increasing number of requests for scientific information reaches the Council. Much material for *Nature* has been transmitted by the British Council. To facilitate the work in France, a scientific adviser has been appointed to the recently opened office in Paris. Scholarships are awarded by the Council to enable promising students to visit the United Kingdom and learn of British methods ; since 1939 more than six hundred students have been brought from the Dominions, Colonies and many other countries.

During the War, some three hundred short-leave courses have been arranged at universities, technical

colleges and other institutions in Britain for about ten thousand members of the Dominions and U.S. Forces, and under the Professional Contacts Scheme a large number of scientific and professional men in the Dominion and Allied Forces have been put into contact with their opposite numbers in Great Britain and with appropriate professional bodies. The secretary of the Engineering Panel, Prof. S. J. Davies, also acts as consultant to the Council; his section seeks to promote a better knowledge of the status and the achievements of British engineering and of the engineering qualifications granted by British universities and the major British engineering institutions.

The Medical Department's *British Medical Bulletin* is now in its third year, with editions in English, French, Spanish, Portuguese and Turkish, and its reputation is steadily being extended now that a limited number of copies are available by subscription in Britain; a similar arrangement is being developed elsewhere, supplementing the previous restriction to medical editors, teachers, investigators and libraries. On the suggestion of a Swedish professor of medicine, the English edition is reprinted in Stockholm. The present edition exceeds 12,500 copies, and more than three hundred foreign medical periodicals are regularly received in exchange. Requests for copies of papers, bibliographies and general information on medical subjects now form an important part of the work, and this and other services have led to many requests for small supplies of new drugs for research purposes and for new or improved types of medical instruments and apparatus of British manufacture. The Department also acts as an agent for the supply to foreign laboratories of standard bacterial cultures, sera, etc., and has made a start on a programme of medical films, with commentaries in several languages, intended primarily for overseas medical audiences.

The chairman of the Medical Panel is Sir Edward Mellanby; of the Engineering Panel, Sir William Larke; and of the Agricultural Panel, Dr. J. A. Scott-Watson. Mr. J. G. Crowther is secretary of the Science Committee and director of the Department.

Even without taking account of the general educational work of the Council, there can be no mistaking the value of the contribution of scientific collaboration which the British Council has unobtrusively made during the last ten, and especially the last four, years.

SOME BRITISH WORK ON NUTRITION

NUTRITION is the theme of vol. 2, Nos. 10 and 11 of the *British Medical Bulletin*. The issue opens with an article on nutritional science in medicine by Sir Edward Mellanby. Sir Edward pleads for an international agreement on the optimum composition of bread and other cereal foods which form such a large proportion of the normal diet. The Health Section of the League of Nations has prepared the way for this kind of agreement by working out the international standardization of vitamins and by setting up standards of nutrition in terms of common foods. Discussing bread, Sir Edward says that British men of science consider that it should be made of flour containing as much of the wheat grain as can be physiologically absorbed, that is to say, the whole grain except the outer coarse bran; some North American workers, on the other hand, favour the old type of low-extraction, and white flour with the addition of vitamins known to be present in the wheat grain. The health of the consumer, said Sir Edward, and not the milling or other interests concerned, should control the composition of bread.

This question was raised during a discussion of the nutritional value of bread held by the Nutrition Society last February (see *Brit. Med. J.*, 379, March 17, 1945). The matter was also debated in the House of Lords (see *Lancet*, 320, March 10, 1945; *Brit. Med. J.*, 393, March 17, 1945). During this debate Lord Horder and others strongly criticized the Government's decision last January to use for the national loaf flour of 80 per cent extraction instead of the flour of 85 per cent extraction adopted in 1942. Both the medical journals vigorously discussed this national question in leading articles.

If the composition of bread is vitally important as a basic nutritional factor in health and disease, the importance of other factors is revealed by various expert articles in the issue of the *British Medical Bulletin* under notice. These articles discuss protein metabolism, minerals, nutritional factors in dental disease, the physical, chemical and microbiological determination of vitamins and water metabolism. Dr. S. S. Zilva's article on vitamin C criticizes much of the recent literature about this vitamin. He concludes that so far there is no convincing evidence that vitamin C has an influence on any condition other than scurvy. "It is true," he says, "that synthetic *l*-ascorbic acid has its advantages in certain cases of human disease, but this is by no means balanced by the gross and unwarranted abuse of the compound for nutritional purposes." Dr. Magnus Pyke, of the Ministry of Food, records interesting facts about the problems of British war-time food rationing. The review of selected papers on nutrition which follows the main articles provides a valuable compendium of the most important literature.

This issue of the *British Medical Bulletin* could advantageously be read together with reports (*Brit. Med. J.*, 127, Jan. 27, 1945; *The Lancet*, 829, Dec. 30, 1944) of the Nutrition Society's meeting on the nutritional role of the microflora of the intestines, to some aspects of which the work of the Unit of Animal Physiology working at Cambridge has made valuable contributions (see R. A. McAnnally and R. T. Phillipson, *Biol. Rev.*, **19**, 41; 1944). The facts given at this meeting of the Nutrition Society about the biosynthesis of certain vitamins in the bowel will have their influence upon medical practice. *The Lancet* (*loc. cit.*) reviews, for example, the evidence for the view that the use of sulphonamides may sterilize away the beneficent bacteria which synthesize essential vitamins. The conclusion that we shall have to regard the intestinal flora as part of the individual's constitution is yet another of many recent instances of that consideration of the whole organism plus its environment, which is a fundamental concept of modern biology. If, moreover, it is true that certain vitamins may be synthesized in the intestine, it may be necessary, as the *British Medical Journal* (191, Feb. 10, 1945) warns us, to reconsider work done on these vitamins with man as the experimental animal. Certainly the work here discussed by this journal suggests that further investigation is required of the view that diets very deficient in vitamin B may quickly cause physical and mental deterioration.

G. LAPAGE.

APPOINTMENTS VACANT

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

JUNIOR ENGINEERING ASSISTANT—The Waterworks Engineer and Manager, Civic Centre, Southampton (August 3).

ASSISTANT POWER STATION CHEMIST—The Borough Electrical Engineer, 40–41 Lune Street, Preston, endorsed 'Assistant Chemist' (August 4).

ASSISTANT AGRICULTURAL ORGANIZER—The Principal, Agricultural Institute and Experimental Station, Kirton, Boston, Lincs. (August 4).

HEAD OF THE MATHEMATICS AND PHYSICS DEPARTMENT of the South-East Essex Technical College and School of Art, Longbridge Road, Dagenham—The Chief Education Officer, County Offices, Chelmsford (August 4).

ASSISTANT LECTURER IN PHYSICS, and a LECTURER in METALLURGY, in the Bradford Technical College—The Director of Education, Town Hall, Bradford (August 4).

LECTURERS (2) IN CHEMISTRY—The Secretary, The University, Birmingham, 3 (August 8).

DISTRICT MECHANICAL ENGINEERS by the Iraqi State Railways—The Ministry of Labour and National Service, Appointments Department A.9, Room 670, York House, Kingsway, London, W.C.2, quoting Ref. No. C.2378.A (August 10).

ENGINEER AND GENERAL MANAGER—The Town Clerk, Town Hall, Upper Street, Islington, London, N.1, endorsed 'Engineer and General Manager' (August 11).

CORPORATION CHEMIST AND CITY ANALYST to the Corporation of Glasgow—The Town Clerk, City Chambers, Glasgow, endorsed 'Corporation Chemist and City Analyst' (August 11).

ASSISTANT LECTURER IN MATHEMATICS at the Bradford Technical College—The Director of Education, Town Hall, Bradford (August 11).

AGRICULTURAL ASSISTANT, and an ASSISTANT DAIRYING INSTRUCTRESS, at the Somerset Farm Institute, Cannington—The Chief Education Officer, County Hall, Taunton (August 11).

ASSISTANT (man or woman) IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (August 13).

LECTURERS IN CHEMISTRY, and a LECTURER IN PHYSICS AND MATHEMATICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3 (August 15).

SECRETARY—The Director, School of Oriental and African Studies, University of London, London, W.C.1 (August 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, and an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Hull (August 18).

ASSISTANT REGISTRAR—The Registrar, University College, Hull (August 18).

PROFESSOR OF CHEMISTRY—The Secretary, Royal Technical College, Glasgow (August 31).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (August 31).

LECTURER IN APPLIED MATHEMATICS, and an ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Acting Registrar, The University, Leeds, 2 (September 1).

PRINCIPAL—The Secretary to the Board of Governors, College of Aeronautics, 14 Belgrave Square, London, S.W.1 (September 8).

LECTURER IN GEOGRAPHY—The Secretary and Registrar, The University, Bristol (September 10).

SENIOR ASSISTANT TO THE LIBRARIAN—The Secretary and Treasurer, University College, Dundee (September 30).

CHAIR OF PSYCHIATRY tenable at the Maudsley Hospital—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (October 1).

PRINCIPAL—The Secretary, King's College of Household and Social Science, c/o University College, Leicester.

HONOURS GRADUATES interested in problems of AGRICULTURAL AND BIOLOGICAL RESEARCH—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

PRACTICAL ENGINEER to break down Machining Operations from Drawings—The Ministry of Labour and National Service, Appointments Office, 153 Barras Bridge, Newcastle-upon-Tyne, 2 (quoting Ref. No. 211.M).

TEACHER OF MATHEMATICS and/or DRAWING in the Engineering Department of the Burton-upon-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent (endorsed 'T').

LECTURER (temporary full-time) IN PHYSIOLOGY AND GENERAL SCIENCE at the Chelsea College of Physical Education (temporarily evacuated to Borth, Aberystwyth)—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3.

LECTURER (full-time, Graduate) IN ELECTRICAL ENGINEERING for Electrical Engineering subjects to Higher National Certificate standard, a LECTURER (full-time, Graduate) IN MECHANICAL ENGINEERING for Mechanical Engineering subjects to Higher National Certificate standard, and part-time LECTURERS for Evening Classes in ELECTRICAL, MECHANICAL and PRODUCTION ENGINEERING, WELDING, INDUSTRIAL ADMINISTRATION, FOREMANSHIP, TIME AND MOTION STUDY, PRODUCTION CONTROL and INDUSTRIAL PSYCHOLOGY, in the Engineering Department ; and a part-time LECTURER IN PHYSICS up to General Degree standard, in the Science Department—The Principal, Kingston Technical College, Kingston, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 3 : Contributions Towards an Understanding of the Calcicole and Calcifuge Habit in some Irish Plants. By Dr. D. A. Webb and Anne V. Hart. Pp. 19–28. (Dublin : Hodges, Figgis and Co., Ltd. ; London : Williams and Norgate, Ltd., 1945). 1*s*. [206

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December, 1944. Pp. 10. (Cambridge : Fitzwilliam Museum, 1945.) [206

Friends of the Fitzwilliam Museum. Thirty-sixth Annual Report for the Year 1944. Pp. 4. (Cambridge : Fitzwilliam Museum, 1945.) [206

Association of Special Libraries and Information Bureaux. Report of Proceedings of the Nineteenth Conference, 1944. Pp. 91. (London : Association of Special Libraries and Information Bureaux, 1945.) 6*s*. [216

Lister Institute of Preventive Medicine. Report of the Governing Body, 1945. Pp. 14. (London : Lister Institute, 1945.) [216

Food Conditions in Occupied Poland : Analysis of the German Food-Rationing System in Poland. By Dr. Leon Dmochowski. Pp. iv+92. (London : Polish Ministry of Labour and Social Welfare, 1944.) [37

Association of University Teachers. Report on University Developments, Part 2, comprising the Place of Research in the Life of a University, the Relations of Academic and Industrial Science, the University as a Regional Focus. Pp. 18. (Bristol : J. W. Arrowsmith, Ltd., 1945.) 1*s*. [37

Other Countries

Exploration du Parc National Albert. Mission H. Damas (1935–1936). Fascicule 9 : Nématodes libres d'Eau Douce. Par J. H. Schuurmans Stekhoven, Jr. Pp. 31. Fascicule 10 : Nématodes parasites. Par J. H. Schuurmans Stekhoven, Jr. Pp. 13. Fascicule 11 : Trichoptera. Par G. Marlier. Pp. 34. Fascicule 12 : Ostracoda. Par W. Klie. Pp. 64. Fascicule 13 : Collemboles. Par G. Marlier. Pp. 14. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1944.) [156

Exploration du Parc National Albert. Mission P. Schumacher (1933–1936). Fascicule 1 : Die Kivu-Pygmaen und ihre soziale Umwelt im Albert-Nationalpark. Par P. Schumacher. Pp. 151+24 plates. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1943.) [156

Exploration du Parc National Albert. Mission J. Lebrun (1937–1938). Fascicule 6 : Mousses. Par F. Demaret and V. Leroy. Pp. 68. Fascicule 8 : Desmidiées. Par P. van Oye. Pp. 42+4 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1943.) [156

Exploration du Parc National Albert. Mission S. Frechkop (1937–1938). Fascicule 1 : Mammifères. Par S. Frechkop. Pp. 186+30 plates. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1943.) [156

Exploration du Parc National Albert et du Parc National de la Kagera. Mission L. van den Berghe (1936). Fascicule 1 : Enquête parasitologique, 1. Parasites du sang des vertébrés. Par L. van den Berghe. Pp. 15+2 plates. Fascicule 2 : Enquête parasitologique, 2. Helminthes parasites. Par L. van den Berghe. Pp. 30+12 plates. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1942–1943.) [156

Exploration du Parc National de la Kagera. Mission S. Frechkop (1938). Fascicule 1 : Mammifères. Par S. Frechkop. Pp. 58+3 plates. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1944.) [156

Fondation pour favoriser l'étude scientifique des Parcs Nationaux du Congo Belge. Premier Rapport (1935–1940). Pp. 42+1 plate. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, n.d.) [156

Aspects de Végétation des Parcs Nationaux du Congo Belge. Serie 1 : Parc National Albert. Vol. 1, Fascicules 3, 4 and 5 : La Végétation du Nyiragongo. Par J. Lebrun. Pp. 84+18 plates. Premier Rapport Quinquennial (1935–1939). Pp. 76+7 plates. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1942.) [156

Animaux protégés au Congo Belge et dans le Territoire sous mandat du Ruanda-Urundi. Par S. Frechkop, G. F. de Witte, J.-P. Harroy et E. Hubert. Pp. xxi+469. (Bruxelles : Institut des Parcs Nationaux du Congo Belge, 1941.) [156

Afrique qui Meurt. La dégradation des Sols Africains sous l'influence de la Colonisation. Par Jean-Paul Harroy. Pp. 558+1 plate. (Bruxelles : Académie Royale de Belgique, 1944.) [156

Polymer Bulletin. Bimonthly. Published with the co-operation of the Bureau of High Polymer Research, Polytechnic Institute of Brooklyn. Vol. 1, No. 1. Pp. 26. (New York : Interscience Publishers, Inc., 1945.) 2.90 dollars a year. [166

Proceedings of the American Philosophical Society. Vol. 89, No. 1 : Reports on Scientific Results of the United States Antarctic Service Expedition 1939–1941. Pp. 398. (Philadelphia : American Philosophical Society, 1945.) [166

Board of Scientific and Industrial Research. Oil of Patchouli. By M. H. Subba Rao and M. Nagesa Rao. Pp. 12. (Bangalore : Government Press, 1945.) [166

Commonwealth of Australia : Council for Scientific and Industrial Research. Bulletin No. 183 : Experimental Determination of the Influence of the Red-legged Earth Mite (*Halotydeus destructor*) on a Subterranean Clover Pasture in Western Australia. By K. R. Morris. Pp. 36. (Melbourne : Government Printer, 1944.) [166

Proceedings of the United States National Museum. Vol. 96, No. 3191 : A New Guano and two new Species of Percoid Fishes from New Guinea, Family Centropamidae. By Leonard P. Schultz. Pp. 115–122. (Washington, D.C. : Government Printing Office, 1945.) [166

Transactions of the New York Academy of Sciences. Series 2, Vol. 7, No. 5 : Geology of Ceramic Materials in New York State. By Dr. John G. Broughton. Pp. 27. (New York : Academy of Sciences, 1945.) [166

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

MEMORIAL SERVICE

A Memorial Service for the late Major Charles E. S. Phillips, O.B.E., of Castle House, Shooters Hill, S.E., one of the Founder Fellows of the Institute of Physics and until recently Hon. Secretary of the Royal Institution, will be held in London at as early a date as can be arranged in the Autumn, of which notice will be given in due course.

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.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Vacancies exist at the Building Research Station, Garston, Watford, Herts, for research and other technical work on building.

ENGINEERS (mainly Civil Engineers), CHEMISTS, PHYSICISTS and ARCHITECTS are required. Appointments will normally be in one of the following temporary grades, the basic salary ranges (for men) being indicated in brackets: SENIOR SCIENTIFIC OFFICER (£680–£800), SCIENTIFIC OFFICER (£400–650), JUNIOR SCIENTIFIC OFFICER (£275–345) and ASSISTANT I (£400–£500), ASSISTANT II (£315–£375) and ASSISTANT III (£130–£300). Civil Service war bonus, at present £60 per annum for adults (men), is payable in addition. The salary ranges and bonus are somewhat lower for women.

For the Scientific Officer grades, the minimum qualification required is a good honours degree (or its professional equivalent) in the appropriate branch of science or profession with (except in the Junior Scientific Officer grade) considerable experience of research or of practical work. In the Assistant grades, the qualification required is at least that of the Intermediate Science of London University or its equivalent (including Intermediate standard in architecture). For some posts graduates are required. Appropriate technical experience is necessary for the Assistant II and Assistant I grades.

Special requirements include:

CHEMISTS. Mainly PHYSICAL chemists (but also one METALLURGICAL chemist) for investigation of properties of building materials, including fundamental work. For one senior post special importance will be attached to good academic research experience.

One MINERALOGIST is required for petrographic work in building materials.

ENGINEERS, PHYSICISTS and APPLIED MATHEMATICIANS for research on constructional problems, study of performance and testing of structures, examination and development of designs, problems of heating, ventilation, sound and heat insulation, lighting, etc. In some cases experience of scientific investigation of engineering problems and first class mathematical ability are the more desirable qualifications; in others, practical experience, including familiarity with building construction, experience of modern factory production methods and investigations on them and (in one case) of mechanical engineering problems relating to buildings and their construction.

ARCHITECTS with good professional qualifications and practical experience and preferably with a good training in elementary science.

Certain of the posts in the ASSISTANT grades are for abstracting etc. of technical literature and call for scientific training and good knowledge of foreign languages.

Write, quoting D.S.I.R., to Ministry of Labour and National Service, Appointments Department, A.9, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by August 11, 1945.

UNIVERSITY OF BIRMINGHAM

Applications are invited for two vacant Lectureships in Chemistry. One of the Lecturers will be appointed in Grade IIc (£450–500) and the other in Grade IIa (£650–750) or IIb (£500–650) according to qualifications and experience. Further particulars can be obtained from the undersigned, to whom applications should be submitted before August 8.

C. C. BURTON,
Secretary.

The University,
Birmingham, 3.

BRITISH PLASTICS FEDERATION BOWEN PRIZE FUND

The Council of the British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund, offer three prizes, to the value of £50 each, for award in June 1946.

The prizes will be awarded for original scientific contributions in Chemistry, Physics, Engineering or Chemical Engineering of post-graduate standard and having a bearing on the plastics industry.

Two of the prizes will be open for competition only for employees, of not less than twelve months service, of member firms of the British Plastics Federation.

One prize will be open to anyone domiciled in Great Britain.

The Council reserves to itself the right to restrict the number of prizes awarded if contributions should not be deemed to be of sufficiently high standard.

Contributions, which *must not bear* the name of the author, should be enclosed in a sealed envelope and forwarded with a covering letter giving the following information:

Name and address of author.

Name of his employers and length of time he has been employed by them, with a letter from a responsible official representing his employers giving permission for the author to submit the contribution.

Authors of contributions for the open prize, if not employed by an industrial undertaking, should state their occupation. If authors of contributions for the open prize are employed by member firms of the Federation they should also submit a letter from their employers giving them permission to submit the contribution.

Contributions should be sent to the General Manager, British Plastics Federation, 47–48 Piccadilly, London, W.1, so as to reach him not later than first post on Saturday, March 30, 1946.

It is the desire of the Council of the Federation that all suitable contributions submitted for these prizes shall be published but it reserves the right to determine, in conjunction with competitors, the method and place of publication.

UNIVERSITY OF BOMBAY

DEPARTMENT OF CHEMICAL TECHNOLOGY

Applications are invited for the posts of (1) Sir Homi Mehta Reader in Plastics, Paints and Varnishes in the scale of Rs. 400–25–700, and (2) Singhanee Lecturer in Chemical Engineering in the scale of Rs. 200–20–400/25–500.

Six typewritten copies of the application together with six copies of testimonials should be forwarded so as to reach the Registrar, University of Bombay, before September 15, 1945.

The Reader will be appointed in the first instance until July 7, 1946, but the vacancy is likely to be permanent. Both the posts are on probation for two years and are non-pensionable, but the Reader and Lecturer will be required to subscribe to the University Provident Fund.

The Reader should possess a degree of a recognized University in Chemical Technology and the Lecturer in Chemical Engineering. Both should have adequate experience in research, teaching and works practice. The Reader will be in charge of the Plastics section under the Director of the Department, and the Lecturer will work in the Chemical Engineering section under the Reader in Chemical Engineering and the Director of the Department. Both will be required to conduct research in their respective subjects.

The applicants should give full details regarding their age, education and training, teaching, research and practical experience and a list of publications.

By order,
S. R. DONGERKERY,
University Registrar.

Bombay.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for TWO Grade III Assistant Lectureships in APPLIED MATHEMATICS, at initial salaries of from £350–£400 according to qualifications. The appointments will be made for one year in the first instance, but each will be renewable for further periods of one year, until, after a total not exceeding three years, consideration may be given to the question of promotion to Grade II.

Applications giving full particulars of age, teaching experience, research or service qualifications, together with not more than three testimonials or the names of not more than three referees, should be forwarded to the undersigned, from whom further particulars may be obtained, not later than October 1, 1945.

It is hoped that the successful candidates will be able to commence duty at the University in January, 1946, but leave of absence may be given to a successful candidate who on the date mentioned is still engaged in National Service.

STANLEY DUMBELL,
Registrar.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as ASSISTANT LECTURER IN PHYSICS in the College.

Salary at present according to the old Burnham Scale, which is from £186 to £480 per annum. Commencing salary according to qualifications and experience. A war bonus of £52 per annum is also paid. The salary scale is at present under review.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College not later than August 4, 1945.

THOS. BOYCE,
Director of Education.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as LECTURER IN METALLURGY in the College. Applicants should preferably possess industrial and research experience in metallurgical work.

Salary at present according to the old Burnham Scale, which is from £186 to £480 per annum. Commencing salary according to qualifications and experience. A war bonus of £52 per annum is also paid. The salary scale is at present under review.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College not later than August 4, 1945.

THOS. BOYCE,
Director of Education.

KING'S COLLEGE NEWCASTLE-UPON-TYNE

IN THE UNIVERSITY OF DURHAM

Applications are invited for the following posts in the Department of Chemistry:

(a) Lecturer in Organic Chemistry. Salary £500 per annum. Duties to commence October 1, 1945.

(b) Lecturer in either Analytical Chemistry or Physical Chemistry. Salary between £350 and £400 per annum according to qualifications and experience. Duties to commence October 1, 1945.

Further particulars may be obtained from the undersigned, to whom ten copies of application, together with the names of not more than three referees, should be sent not later than Saturday, August 11, 1945.

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

NATIONAL FARMERS' UNION AND CHAMBER OF AGRICULTURE OF SCOTLAND

ECONOMICS OFFICER (MALE)

Applications are invited for the post of Economics Officer to the above Organization. Applicants should be experienced agricultural economists. The successful applicant will be required to interpret statistical information, initiate costings investigations and act as Accountant to the Union and Chamber. Remuneration according to qualifications and experience. Applications giving full particulars and stating salary expected, together with the names of three Referees, and any recent testimonials, should reach the General Secretary, 6 Ainslie Place, Edinburgh, 3, on or before August 15, 1945.

ROTHAMSTED EXPERIMENTAL STATION

The Statistical Department will shortly have one or more vacancies for honours graduates interested in problems of agricultural and biological research. Applications are invited from mathematicians, with or without previous experience of statistical methods, and from biologists, agriculturists, or other science graduates with some knowledge of statistics. Salary will depend upon qualifications and age, probably within scale of Scientific Officer (£400–680, plus bonus) or Probationer (£275–£347, plus bonus). Applications should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts, giving full particulars of education, qualifications, previous experience if any.

UNIVERSITY OF BRISTOL

The University invites applications for a LECTURER IN GEOGRAPHY. Salary £500–£600 per annum, according to qualifications and experience. Applications should reach the undersigned, from whom further particulars may be obtained, not later than August 31, 1945. The appointment will date from October 1, 1945, or as soon after as possible.

WINIFRED SHAPLAND,
Secretary and Registrar.

UNIVERSITY OF OTAGO

DUNEDIN, NEW ZEALAND

DIRECTOR OF SCHOOL OF DENTISTRY

Applications are invited for the position of Professor of Dentistry and Director of the Dental School in the University of Otago.

Salary £1,500 rising to £1,700 per annum (N.Z. currency).

Full particulars may be obtained on application by September 15 to the High Commissioner for New Zealand, 415 Strand, London, W.C.2.

HUDDERSFIELD TECHNICAL COLLEGE

Principal: DR. J. W. WHITAKER

RESEARCH SCHOLARSHIPS

Applications are invited from graduates or candidates with equivalent qualifications for Research Scholarships tenable for two or more years. The Scholarships vary in value from £100 to £150 per annum and are tenable in the Department of Coal Tar Colour Chemistry and/or other Departments of the College. The Scholarships are open to candidates of either sex.

Further particulars may be obtained from the Principal.

H. KAY,
Director of Education.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

Campden Hill Road, London, W.8

The College Council invites applications for the appointment of PRINCIPAL, to take office in October 1946.

Further particulars may be obtained from the Secretary, King's College of Household and Social Science, c/o University College, Leicester.

THE SIR JOHN CASS TECHNICAL INSTITUTE

JEWRY STREET, LONDON, E.C.3

The Governors invite immediate applications from University Graduates for the following posts, which in the first instance will be temporary and subject to review at the end of each session:

LECTURERS IN CHEMISTRY

LECTURER IN PHYSICS AND MATHEMATICS.

Salary in accordance with the Burnham (Technical) Scale for London. Conditions of appointment and form of application obtainable from the Principal and returnable by August 15, 1945.

Wanted: Grade B Laboratory Technician to assist in work involving the chemical estimation of vitamins. Experience in chemical and physical technique desirable. Application with full particulars to the Secretary, N.I.R.D., Shinfield, Reading.

NEW ZEALAND GOVERNMENT

Applications are invited for the position of CHIEF NUTRITION OFFICER, Ruakura Animal Research Station, Hamilton, New Zealand. Salary up to £790 per annum (N.Z. currency), according to qualifications and experience. Applicants should possess a degree in Agricultural Science or in Veterinary Science and should have done post-graduate work in animal nutrition.

Full details can be obtained by August 10, 1945, from the High Commissioner for New Zealand, 415 Strand, London, W.C.2.

UNIVERSITY OF OXFORD

WYKEHAM PROFESSORSHIP OF PHYSICS (THEORETICAL)

Applications are invited for the above Professorship, and should reach the Registrar of the University by September 29, 1945. Stipend, £1,200 per annum (plus children's allowances), but Professorship will be included in revision of stipends now under consideration. Residence required during six months in each academic year. Retiring age, 65. The selected candidate will not necessarily be required to take up duties at once. Further particulars may be obtained on application to the Registrar, University Registry, Oxford.

UNIVERSITY OF OXFORD

DONALD POLLOCK READERSHIP IN ENGINEERING SCIENCE

Applications are invited for the above Readership and should reach the Registrar of the University by August 20, 1945. Tenable for seven years. Stipend £750 per annum, plus children's allowances, but general revision of stipends is now under consideration. Retiring age 65. Preference given to candidates distinguished in Electrical Engineering Science, or in Thermodynamics, including heat engines. Further particulars may be obtained on application to the Registrar, University Registry, Oxford.

THE MUSEUMS ASSOCIATION

Applications are invited for the post of Secretary-Editor of the Museums Association. Candidates (male or female) should have had administrative and editorial experience. Salary £350 rising by increments to £400 per annum.

Further particulars can be obtained from Mrs. L. M. Bond, Acting Secretary, The Museums Association, Chaucer House, Malet Place, London, W.C.1, to whom applications, with copies of two recent testimonials, should be sent to reach her by August 10.

Laboratory Technician (Biochemical Analysis) preferably with experience in Micro methods. Salary £260 rising by yearly increases of £13 to £312, according to age and experience. Apply, giving names of not more than three referees, to The Hon. Secretaries, The Royal Hospital for Sick Children, Edinburgh.

THE UNIVERSITY OF SHEFFIELD

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for appointment as Lecturer in the Department of Electrical Engineering. Preference will be given to candidates with qualifications in light-current engineering, particularly in electronics. Salary £570 per annum with war-time marriage and children allowance, and superannuation provision under the Federated Superannuation Scheme for Universities. Further particulars may be obtained from the undersigned with whom applications should be lodged by August 31.

A. W. CHAPMAN,
Registrar.

MIDLAND AGRICULTURAL COLLEGE

SUTTON BONINGTON, LOUGHBOROUGH

Applications are invited for the post of ASSISTANT ANALYTICAL CHEMIST in the Department of Advisory Chemistry. Candidate should possess an Honours Degree in Chemistry and have had some experience in analytical work. Commencing salary £300 per annum plus War Bonus, at present £60 per annum.

Applications should be sent to the Principal of the College not later than August 4, 1945.

Government of Sierra Leone. Vacancy for Agricultural Chemist (woman) in the Department of Agriculture—salary £450 for two years then £455 × 25 to £600. The appointment will be an agreement for one tour of service of up to 24 months in the first instance, free passages and free furnished quarters or an allowance in lieu and free medical attention. Qualifications required are, B.Sc. with 1st or 2nd Class honours in Chemistry or its equivalent and some experience in agricultural chemistry. Write quoting F.4342.A, to Ministry of Labour and National Service, Appointments Department, A9, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by August 25, 1945.

Physical Chemist, wide experience spectrographic methods, applied particularly to organic chemistry, desires post-war position with good prospects. Box P.123, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Optical Instrument Designer required. Experience in Continental industries of advantage. Good salary and prospects. Box 382, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

For Sale. D.Sc. (London) robes. Mellor's Chemistry Vols. 1 to 8. Science Abstracts A 1929 to 1944. Apply Box P.124, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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