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LOOKING FORWARD

THE announcement of the official cessation of hostilities with Germany overshadows all other considerations. As we have been frequently reminded, we are by no means at the end of our perilous journey; but we can at least rejoice soberly in the accomplishment of one stage of it, and that a stage which has been fraught with the direst danger. When we look back over the past six years, no one can but be amazed at the achievements of peace-loving peoples against an enemy who over a period of years devoted himself to preparations for war.

Much of our success has been due to the efforts of scientific and other professional workers, who were swift to respond to the call for their services. Throwing aside their normal occupations—in industry, the universities and elsewhere—even before the outbreak of war they put themselves individually at the disposal of the country. Through the Central Register, a most valuable body of information on the scientific and engineering man-power resources of Britain was voluntarily compiled, which has made possible the staffing of the large number of war-time factories necessitated by the scale and diversity of needs of modern war. Moreover, the general public has not been unaware of, or ungrateful for, the contributions made by science to the task of defeating the enemy; indeed, there have been times when it has been necessary to check public enthusiasm and to remind people at large that science alone could not achieve a decision. In the Press and in addresses in the Houses of Parliament and elsewhere, there have been many sincere tributes to the effectiveness of the application of scientific knowledge and methods in the most unexpected fields. The reason for this outburst of enthusiasm for science is clear enough, but it is a reflexion upon the general scope of education in Britain—and also upon scientific workers for their lack of missionary zeal—that such achievement should apparently come as a surprise to a majority of the people.

It may not be out of place even here to indicate very briefly some of the noteworthy advances in knowledge which have been brought to public notice during the War. Radiolocation and other developments in radio communication immediately come to mind, in spite of the fact that it has not been possible to publish much definite information on the subject. Happily much of the work in this field of electronics has obvious applications for the days of peace. The development of aeronautics, both as regards power-driven machines and gliders, has been equally striking. Aeroplanes of a size which would have been regarded before the War as possible but highly unlikely within several decades are now almost commonplace, and great fleets of a thousand or more operating as a unit are being used. But beyond great increase in size and speed of the individual machine and of the operational unit, there is a host of ancillary services, each of which can make a contribution to post-war progress. Air navigation, by night and by day, has become as precise as sea navigation, and both will benefit from the increasing sureness of radio communication. The significance of the enhanced power and reliability of internal combustion engines requires no emphasis ; and the development of a new prime mover, the jet propulsion engine, though particularly associated in the minds of most people with the 'flying bomb', will have its place in the aerial transportation of the future. Meteorology has been amassing data the importance of which can only be surmised ; it is sufficient to note that trans-Atlantic flights in both directions have become matters of routine.

In the medical field there have been equally noteworthy achievements. Turning again to problems connected with the aeroplane, it is noteworthy that much progress has been made in connexion with high-altitude flights. As regards more strictly medical matters, mention must be made of the extended use of the sulpha drugs, and also of the applications of penicillin ; between them, there is little doubt that the sulpha drugs and penicillin have been the means of reducing substantially the number of fatalities from war wounds. Great progress has been made, as is usual in such times, in the surgery of war wounds, and also in the treatment of burns. Blood transfusion has been carried out on a scale never previously contemplated, and has led to much important new work on the constitution of the blood, the factors it carries and their significance in inheritance. Considerable importance is also attached to the discovery of new insecticides, of which D.D.T. is probably best known.

Food technology has also received a great stimulus. The drying of milk and eggs was carried out on a commercial scale before the War, but the cutting off of supplies of fresh eggs from the Continent, and the great curtailment of shipping space, have increased the traffic in the powdered products by an extraordinary amount, until they have become part of our regular rations. Valuable knowledge has also been acquired in the preparation of concentrated foods.

Perhaps more important still is the opportunity which enforced rationing has given of seeing that the nation, as a whole, has had available a diet which medical statistics have shown to be very satisfactory from the point of view of physical health. In this connexion it is interesting to note that, probably for the first time, certain imports have been deliberately regulated as to kind and quantity in accordance with scientific data derived from nutritional studies.

More purely social studies also come into the picture. The paucity of knowledge on population movements and their effects became evident on the outbreak of war, with the ill-conceived but well-executed evacuation of the children of London and other big cities. As a piece of organization the operations were successful, but too little attention was given to the human element, with the result that a steady drift back to the cities quickly set in. The transfer of industries to safer areas was more successful, perhaps of necessity, but brought in its train many difficulties which ought at least have been eased by deeper knowledge of social trends. The data thus painfully acquired will be of considerable value to future studies of population movements and mass psychology. War-time study of munition workers and others has also provided useful material in the field of health in industry, and has amply justified the investigations of the Industrial Health Research Board, which originated from similar investigations undertaken during the War of 1914–18.

Enough has probably been said to remind readers that many scientific developments of first-rate importance have taken place during the War. But it must not be imagined that we have any desire to extol war, or even to credit it with additions to knowledge. The developments referred to above were inherent in the progress of science ; the War has provided almost unlimited financial support, increased opportunities and the stimulus of public interest born of the nation's peril.

Turning now to the immediate future, and even confining ourselves to strictly utilitarian considerations, there is still a multitude of tasks ahead for scientific workers, from the highest levels to the lowest. In these columns it is not so necessary to stress their part in promoting the well-being of the community, and in industry and commerce, though this is of high importance. We have in mind rather the problem of the control of Germany in the post-war world ; and we stress the point because even men of science themselves may not realize the extent to which a just but effective control will depend on scientific knowledge and method. That the multitude of problems should be approached in a scientific manner by assembling the data and determining action on the impartial consideration of the whole need not be emphasized. Even in the political field, there are problems of mass psychology on which scientific men should be able to provide valuable guidance. In the control of industry, the influence of the man of science and the engineer is more obvious. Indeed, it is not too much to say that without scientific knowledge it is impossible to devise adequate controls, and policy-making in this field must be largely in the hands of scientific men. Some of the possibilities were indicated in an article in *Nature* of April 24, 1943, p. 455, referring to the control of 'key' chemicals, and reference was made to the difficulty, for example, of effectively separating the fertilizer from the explosives industries.

Then again, adequate control of the manufacture of fine chemicals in Germany will be necessary. Some may go so far as to say that it must be suppressed ; but it would be better to ensure that the undoubted abilities of German chemists in this field should be used, not for flooding other nationals' markets to the exclusion of local products and creating world-wide monopolies of strategic and commercial importance, but for the good of mankind. The problem is a difficult one, and should not be dismissed without careful consideration.

Even in the munitions industries it is only the final stages of the products that are specifically connected with war. In their engineering, metallurgical and chemical aspects, they are inextricably mingled with agricultural and other industries. Thorough appreciation of the scientific basis of these industries is necessary in order to formulate measures of control, and more than a superficial acquaintance with physics and chemistry will be required to supervise the controls imposed. Chemical industry should not be entirely suppressed, for that would not only lead to additional unemployment, directly and indirectly, but also to the increased dependence of Germany on imports ; and that at a time when the utmost strain is being imposed on the United Nations to supply their own needs in the agricultural and industrial fields. Again the problem is an intricate one, which will require careful discussion in the light of all the known facts.

The fact that the Government has been asking for civilian recruits with various grades of scientific and engineering knowledge for service in Germany after the War in Europe ends indicates that there is appreciation in Government circles of the part that scientific men can play. There can be no question that their services, provided they are not unduly constrained by the administrative and military machines, will be of vital importance in the control of Germany.

Enough has probably been said to show that scientific workers have played a full part in the prosecution of the War, and that they must be intimately concerned in the years to come in dealing with numerous problems arising directly out of it. In addition to such *ad hoc* activities, it is generally conceded that science must take an ever-increasing share in the promotion of peace-time industry, and that ample provision must be made for that form of research which is perhaps best described as the pursuit of knowledge for its own sake.

The broad outlines of the strategy and tactics of research in Great Britain during the years to come were outlined in a series of six articles on "Scientific and Industrial Research" published in *Nature* last autumn, and the main points are worth repeating. Strategy is the premier consideration, for it must determine the general programme, and it will obviously involve decisions on policy at the highest levels. The whole educational system of the country is involved, in that it will decide the quality of the personnel who will carry out research, while the nation must be able to appreciate the significance of the work scientific men do and the way in which they approach their tasks. No rigid dividing line should, or indeed can, be set between so-called pure and applied research ; and increased facilities should be made available for the interchange of personnel between the universities, industry and Government service. The recent foundation of senior fellowships in science in the universities, where those appointed will combine research with a certain amount of teaching, is probably a most valuable step in the right direction. This leads inevitably to the consideration of the position of the universities in the post-war world. Expansion there must be, but radical innovations would not appear to be needed ; the universities must continue to be, fundamentally, communities of teachers and students, where knowledge is sought for its own sake, as well as for its value as a preparation for a particular task or mode of livelihood. In particular, they will be expected to provide opportunities for the development of the qualities required for leadership.

It is, of course, premature to attempt to foresee the optimum number of research workers in advance of the actual programme of research. But some consideration of subjects is not out of place. Thus it is already realized that both biology and geology will require many more trained workers than are at present available, and the universities will have to make corresponding preparations. Social biology is a relatively new and actively growing subject which will demand consideration. Re-allocation of research effort between the various sciences may become an urgent necessity ; this will clearly involve machinery for the co-ordination of research in the universities and elsewhere. The British tradition favours evolution, and it is to be expected that existing institutions and methods, where they have proved successful, will be developed and extended. New institutions will obviously be necessary ; but flexibility is of prime importance. The increase of State assistance to the universities must not be allowed to encroach on their independence. As regards research in Government institutions, there is at present insufficient correlation of effort between the various bodies, and there should be provision for associating it with advances in the fields of social science and economic science. Research carried out by industrial firms is more difficult to organize, but the suggestion from industry itself of a central co-ordinating office is worth careful consideration.

In any discussion of the future of scientific and industrial research, prominent consideration must be given to the improvement of conditions of service. By this is meant not salary alone, but also questions of status, publication of the results of research, superannuation, interchange of staff between university, Government and industrial institutions, and so on. Here the professional institutions can play a leading part ; for they have among their members the varied knowledge and experience which will be invaluable in formulating codes of professional conduct and related matters (see also *Nature*, December 2, 1944, p. 693).

This cursory survey of the present achievement and future significance of science has ended, as it began, with the human element. This has been thought necessary, because it is on the personality, integrity and devotion of the man of science that so much will depend. Never has science stood so high in public esteem ; never have the efforts of scientific men been so widely appreciated and acclaimed. Science has been accorded—and willingly accepted—a foremost place in the highest councils of the nations ; it must continue in that place, and by its influence justify the faith the peoples have grown to have in it. The key to the present and the future is unremitting vigilance and purposeful activity. There must be no slackening of effort, no relaxation of standards. Rather must the present thanksgiving be a spur to additional exertion, in the sure knowledge that we are building on a tried and stable foundation a new and progressive world order.

MENTAL HEALTH IN WAR-TIME

The War and Mental Health in England

By Prof. James M. Mackintosh. Pp. v+91. (New York: Commonwealth Fund; London: Oxford University Press, 1944.) 5*s*. 6*d*. net.

THIS book does not pretend to be either a scientific or a medical treatise on the subject of mental health in England during the War. It is a collection of essays written in non-technical language describing the successive phases of the first four years of the second World War and giving an account of the author's impressions of the effect of war conditions upon the population.

It discusses the industrial worker, the new soldier, the housewife, food-rationing, the evacuation scheme and the child in war-time.

There is a general impression that war conditions are unfavourable to mental health and that this is indicated by an increased amount of recognizable mental illness in war-time. The prevalence of neurosis in the War of 1914–18, popularly termed 'shell-shock', and the argument that modern warfare, bristling with new dangers and, in any case, imposing privations of a greater or lesser degree of severity, will exert unaccustomed strain and cause mental breakdowns, are chiefly responsible for this impression.

Examination of the subject shows that the issue is more complex. In the first place, in 1922 the Army Council Committee reported that the name 'shell-shock' should be eliminated, that the War of 1914–18 produced no new nervous disorders but that they were the result of genuine concussion in a small proportion of cases, or the result of emotional shock (usually in constitutionally predisposed persons) in 80 per cent of cases, or the result of nervous and mental exhaustion; and that no psychoneurosis should be classified as a battle casualty any more than sickness or disease is so recorded. Most of the neuroses arising out of the War of 1914–18 were either anxiety states or hysteria. The findings of the Army Committee were fully confirmed at a conference which was held at the Ministry of Pensions in July 1939[1].

In the second place, 'neurotic incapacity', like other forms of disease, is greatly influenced by environment. It is well known that a man infected by tuberculosis—a disease sometimes associated with mental symptoms—may often lead an active and useful life, provided he lives under sheltered conditions and does work adapted to his physical capacity. Put such a man into competition with healthy labour or enlist him into the Fighting Services and he breaks down with his quiescent pulmonary lesion flaring up into activity. In the same way, many a soldier may be diagnosed as mentally ill or be discharged from the Army, who in peace-time would never have come under medical observation for mental aberration, although he may not have been in perfect mental health. As Dr. Aubrey Lewis[2] has observed in discussing this subject:

"So there is in part a spurious rise, due to more systematic medical examination of the population, to more careful diagnosis, and to a change in the demands of the environment, converting a harmless anomaly into an incapacitating disorder. This applies, of course, with especial force to mental deficiency: so-called higher grades—i.e., 'dull and backward', 'feeble-minded'—will be detected and returned in the statistics of a Service population, whereas they would have escaped attention under pre-war conditions."

It is undoubtedly true, on the other hand, that war brings out qualities of resilience and endurance which make for the preservation of mental health under the most adverse conditions. Before the War, certain persons in authority were highly apprehensive of panic and nerve-storms in the congested areas of London when exposed to air-raids. No such disorders occurred. In colloquial language, "the people could take it". The War has inspired a feeling of corporate unity and service to the common weal which helps to lessen the incidence of mental illness, and good morale has been shown under the strain of repeated and incessant aerial bombardment.

Another factor for consideration is that in the present War certain reforms have been instituted which are advantageous to mental health. To quote Dr. Aubrey Lewis[2] again:

"If, for example, production committees, welfare managers, and factory medical officers have improved the mental as well as the physical health of workers, they partly counteract the adverse factors in war-time industry, which need no recapitulation. Having been instituted under the pressure of war needs, they may be laid to the credit of war even though there is no essential link."

Lastly, a most important factor is the general improvement in national health which had been secured to a considerable extent, at all events, through the national health services, by 1939. They prevented not only physical but much mental disorder.

Dr. Aubrey Lewis[3] reports that air-raids have not been responsible for any striking increase in neurotic illness; indeed, crude figures from hospitals and outpatient clinics suggest a considerable drop. The incidence of such illness in fire-fighters and other workers in civil defence has been low. Mental disorders in England and Wales have diminished.

In the total number of persons suffering from notified mental disorder there was a decrease of 4,048 during 1941 and a decrease of 3,516 during 1942. The average annual decrease for the five years ended December 31, 1942, was 1,952, which contrasts with an average annual increase of 1,691 in 1934–38 (Twenty-ninth Annual Report of the Board of Control).

Suicides in Great Britain during the war years show a steady drop as contrasted with Germany, where, according to the *Reichgesundheitsblatt* of October 1942, there has been a rise in the suicide-rate in large towns.

The incidence of mental disease and ill-health in the Services has not been large, but there has been a great development of psychological and psychiatric work in these Services, and every endeavour has been made to eliminate misfits and to keep the fighting population both mentally and physically healthy.

Statistical and clinical evidence, on the whole, indicates that war conditions have lessened rather than increased mental illness. It is important to remember that the final chapters of the story have still to be told. "The amount of mental ill-health manifest during the war is not a safe index of what is really happening to the mental health of the community" (Lewis). The figures of the British Ministry of Pensions and those published in the

United States of America[4] for mental disorders after the War of 1914–18 indicate that a high proportion of men and women affected eventually succumbed to mental illness as a result of prolonged war-strain.

Prof. Mackintosh advocates greater attention to psychiatry in the medical curriculum and enhanced encouragement by the State of the psychiatric social worker. The difficulty here is that psychiatry embraces many schools of thought; it is by no means an exact science, and sometimes the patient treated by a fervent disciple of Freud has his mental illness aggravated rather than ameliorated. As Lewis[2] observes: "I do not think we shall need cohorts of psychiatrists". But we do need general practitioners trained on sound lines in the social and psychiatric problems of their work and familiar with the mental aspects of organic disease.

Much mental illness has a physical basis and the converse statement is also true. In this connexion reference may be made to an interesting paper by Morris and Titmuss[5], which discusses the rising mortality from peptic ulcer. The authors claim that the effects of heavy air attacks during 1940–41 resulted in, first, a sharp rise in mortality from duodenal ulcer which was closely followed by a similar movement in mortality from gastric ulcer. The circumstances were, at all events, associated. There is a constant interplay between physical and mental ill-health.

Work of this kind opens out fresh avenues of research into the nature of the relation between mental and physical disease, which is a much more hopeful line of investigation than speculative theories concerning repressions, obsessions and complexes.

Prof. Mackintosh's book calls for little criticism. He makes too sweeping a statement on p. 7 when he observes that "prewar Government policy did little to improve physique and nothing to uplift the mind". The work done by the Education and Health Ministries of Great Britain in physical training, in the provision of milk and meals in schools, in preventive medicine and in hygiene over a number of years preceding the War, had greatly improved the physique and nutrition of the school-child in comparison with the past. Nor had the question of the physique of the adolescent been ignored. The Board of Control was pursuing an enlightened policy towards mental disease, and considerable attention was devoted to the neuroses and the treatment of mental defectives. Indeed, Prof. Mackintosh's own work both as a medical officer of health and as chief medical officer of the Department of Health for Scotland would alone indicate that pre-war Government was not unmindful of its responsibilities for physical and mental health.

These essays give a vivid historical picture painted in words with considerable literary ability. They emphasize the grit, self-control and determination of the English people when fighting for their national existence and they show how the nation, as a whole, acclaimed and responded to the inspiration of Mr. Churchill's leadership. ARTHUR S. MACNALTY.

[1] Ministry of Pensions. Neuroses in War-Time. Memorandum for the Information of the Medical Profession. Pp. 7. (London: H.M. Stationery Office, 1940.)

[2] Lewis, A., "Mental Health in War-Time", *Public Health*, 57, No. 3, 27 (1943).

[3] Lewis, A., "Neurosis in England under War Conditions", *Lancet*, ii, 175 (1942).

[4] Dayton, N., "New Facts on Mental Disorders" (Baltimore, 1940).

[5] Morris, J. N., and Titmuss, R. N., "Epidemiology of Peptic Ulcer. Vital Statistics", *Lancet*, ii, 841 (1944).

POST-WAR NUTRITIONAL RELIEF IN EUROPE

Nutrition and Relief Work

A Handbook for the Guidance of Relief Workers. (Published by the Council of British Societies for Relief Abroad.) Pp. 111. (London, New York and Toronto: Oxford University Press, 1945.) 5*s*. net.

THE appearance of this little text-book is indeed opportune. Soon there will be at work in many European countries a large army of relief workers, both foreign and native, of whom very few can have had any previous experience of the job they have undertaken. As usual, a good proportion of these workers will be English-speaking, and for these this book in English, with all the relevant information and sound advice contained in its hundred pages, should prove a real companion and guide. The list of experts invited by the Council of British Societies for Relief Abroad to form a committee responsible for this guide book itself gives promise of a worthy production. The result is no disappointment.

The earlier chapters contain a simple but scientific account of the physiology of human nutrition, of the energy or calorie value, and the separate nutritive elements—proteins, fats, carbohydrates, minerals and vitamins—which must be included in an adequate diet, and further of the quantitative requirements for each of these dietary essentials. This is followed by a description in non-technical language of the signs which may indicate a state of partial starvation due to a lack of food in general, as well as of the symptoms which may suggest a specific deficiency of one or other of the essential nutrients, and of the variability of these symptoms as they may appear among different classes of the population—infants, children, and adult men and women. Tables are given which show the calorie value and composition of the chief foods, including their content of minerals and vitamins.

The remainder of the book, devoted chiefly to the technical aspects of nutritional relief, reveals the wide experience possessed by those who have compiled it. Sections are devoted to methods of dietary surveys, to storage and handling of foods, to camp equipment and emergency methods of cooking and serving meals.

A particularly interesting chapter deals with the food habits peculiar to the inhabitants of different European countries, situated, respectively, in the north and west, and south and east; and a useful table is given which shows the consumption of principal foods in these districts in periods both before and during the War. Here perhaps a little criticism of minor points and a few additions might be useful. In Italy, although consumption of other dairy produce may be low, it is the usual custom to take grated cheese with the almost daily meal of macaroni or spaghetti; the widespread use of garlic in cooked foods might also be mentioned. In Austria and some parts of southern Germany, the meat, usually eaten at the midday meal in all but the poorest households, most frequently takes the form of *Rindfleisch*—beef of poor quality which is stewed in the soup which precedes it and is rendered palatable by a variety of sauces, changed from day to day. The glossary of food and cooking terms in French and German might be enlarged with advantage and some alternative expressions given. For example, in South Germany and Austria milk curd is usually known as *Topfen* and cream as *Obers*; in France, *blé* may signify wheat as well as other cereals, and corn or maize might be translated as *maïs* or *blé de Turquie*. If the present translations of 'hunk of bread' were used, there would certainly be disappointment in a recipient led to believe he would receive a *tartine* or a *Butterbrod*.

If it must be admitted that the perfect relief worker, like the poet, is born and not made, it may also be admitted that less perfect specimens might be brought appreciably nearer in quality to the ideal, after a careful study of the information and advice contained in this unpretentious but valuable little book. H. C.

THE HUB OF THE FUTURE WORLD

The Geography of World Air Transport

By J. Parker Van Zandt. (America Faces the Air Age, Vol. 1.) Pp. viii+67. (Washington, D.C.: Brookings Institution; London: Faber and Faber, Ltd., 1944.) 5*s*. net.

THE Brookings Institution was established in 1927 with the twin objects of "aiding constructively in the development of sound national policies and . . . to offer training of a super-graduate character to students of the social sciences". In pursuance of these objects, it initiated in 1943 a programme of economic research in aviation under the direction of Dr. J. Parker Van Zandt. The director has now prepared the introductory volume to a promised series, and he limits himself to outlining the basic setting of the world air transport problem.

The author points out the many erroneous ideas of the space relationships of the countries of the world which have arisen from the still all too common use of Mercator's projection for wall maps and atlas maps of the world. Curiously enough, much that he has to say may be novel to the American public, but is actually what has been taught in British schools for the past four decades. Americans may be shocked to find that Chicago is nearer to Istanbul than to Buenos Aires, and that Los Angeles is nearer Moscow than to Rio. "Most of the world that matters lies in one hemisphere . . . 94 per cent of all the people and 98 per cent of the world's industry", and the centre of that hemisphere is in western Europe. Actually London is used as the centre of what is called the "Principal Hemisphere". Of the eight major "trade areas", four dominate the world—Greater Europe, North America, U.S.S.R., and Asia —and the conclusion is reached that the future will confirm rather than reverse this position. It is thus regarded as a basic fact with respect purely to world air transport operations that the favoured position is at the hub of the hemisphere. While the disadvantages of America's peripheral position are partly offset by her gigantic industrial development and purchasing power, it is argued that more efficient operation and lower costs through greater volume will be needed to counter the handicap of longer average distance to world markets.

Attention is directed to the immensely strong position which could be held if only the countries of Greater Europe acted in unison. Despite the focal position of the British Isles, and the importance, above all others, of the difficult North Atlantic route, the suggestion is made that the limited land areas available in Britain will be a handicap. Despite the war-time use of Goose Bay in Labrador, the author holds that the importance of trans-polar and high-latitude routes has been much exaggerated.

That the main result of this frank American survey should be to affirm that "geography is still a controlling factor" and that Britain automatically becomes the centre of the future air-age world should give us in Britain food for serious thought. Forty years have passed since Sir Halford Mackinder wrote "Britain and the British Seas", yet technical progress and inventions have but underlined his concept of the importance of Britain's world position.

L. DUDLEY STAMP.

BIOLOGY OF FLIGHT

The Biology of Flight

By Prof. Frederick L. Fitzpatrick and Karl A. Stiles. Pp. vi+162. (London: George Allen and Unwin, Ltd., 1944.) 8*s*. 6*d*. net.

THIS book attempts to cover a very wide field indeed, ranging from the flight of insects and birds, to aviation medicine, and the control of disease that may be spread by air travel. It gives a very lucid if somewhat superficial description of these matters in a form which assumes no previous knowledge of the subject.

However, there is no need for simple treatment of a scientific subject to be inaccurate; unfortunately, a number of inaccuracies suggest that the authors have little practical knowledge of, or very close contact with, some of the matters which they describe. For example, "from the practical standpoint it is considered unsafe for the average person to fly much above 20,000 ft. because of the limits of present oxygen equipment". This is done almost every day by many thousands of pilots and air-crews. Discussing Donati's altitude record of 47,358 ft. (corrected), it is clear that the authors have overlooked the difference between corrected altitude and pressure altitude. Again, "a descent of 10,000 to 15,000ft. without ventilation of the middle ears will usually cause rupture of the ear drums". The factor causing rupture of the ear drums is the differential pressure to which they are subjected. This cannot be expressed in thousands of feet unless the absolute height is stated. Descent from 45,000 ft. to 30,000 ft. will not cause rupture.

The use of the word 'probably' in connexion with statements giving numerical data is out of place. The figures should be checked.

Some of the photographs are official British pictures from the Ministry of Information. The line illustrations are clear, but some do not seem to present any fact of interest; for example, Fig. 33. Fig. 17, purporting to show the burning of a candle at various altitudes, bears little relation to the truth. It would have been better if the accurate photographic plate in Ruff and Strughold's "Atlas der Luftfahrtmedizin" could have been copied. Had the authors tried this simple experiment themselves with a candle, ventilated bell jar, and filter pump, they would have found a candle still burns dimly at the pressure corresponding to 40,000 ft.

There is a paucity of collected work on the biology of flight and a very definite place for an accurate simple treatise on the subject. It is a pity that the present book is marred by loose writing and misstatement. B. H. C. MATTHEWS.

CLIMATE AND HUMAN COMFORT*

By Prof. DAVID BRUNT, F.R.S.

Imperial College of Science and Technology, London

Bodily Reactions to Heat and Cold

THE temperature of the deep tissues of the human body is said to be 98·4° F. in normal conditions, any large deviation from this value being uncomfortable, and in extreme cases fatal. It is generally stated that a rise of body temperature to 107° F. is likely to be fatal, but there is no equally definite range of fall of temperature which can be regarded as fatal. Heat is continually being generated within the body, even during sleep, as the result of the chemical processes associated with breathing, digestion and physical effort, all these processes being grouped under the term metabolism. This heat is conducted to the skin, partly by the normal conducting power of the body tissues, partly by the blood-stream, and is dissipated from the skin to the environment. Heat cannot be conducted to the skin unless the temperature of the skin is lower than that of the deeper tissues of the body. Observations show that the skin temperature varies over different parts of the body, being lowest of all over the feet, and next lowest over the hands. From this we may appreciate that special care is needed in the design of boots and gloves for men exposed to conditions of extreme cold.

When the body is exposed to cold, the following reactions occur: (*a*) the skin temperature falls; (*b*) there is an onset of shivering, an involuntary effort to increase the internal production of heat by muscular action; and (*c*) the adrenal and thyroid glands discharge fluids which accelerate the metabolic generation of heat.

When the body is exposed to heat, the sweat glands discharge sweat on to the surface of the skin, where it evaporates, and in so doing takes heat from the body. Heat is dissipated from the skin in three ways: (*a*) by radiation exchange between the outer surface, partly clothing, partly uncovered skin which the body presents to the environment; (*b*) by convection of heat, which can be simply described as the carrying of heat from or to the surface of the body by the air coming into contact with it; and (*c*) by the evaporation of sweat.

There is in addition a small loss of heat in the respiratory passages and lungs; but in the discussion of the heat balance of the body we may neglect this item, though it may well be an important factor in determining comfort.

Indoors, the three items mentioned must balance the metabolic rate of generation of heat. Out of doors, in bright sunshine, the gain of heat from the sunshine is effectively an addition to the metabolic rate. The convective loss or gain is proportional to the square root of the air speed, and the evaporation from unit wetted area of the skin, in given conditions of air temperature and humidity, must also depend on air speed in the same manner.

In low and moderate air temperatures, the evaporative loss of heat from the skin is practically independent of air temperature, and the only controllable modes of dissipation of body heat are those due to radiation and convection. These two factors are proportional to the difference between the temperatures of the surface of the body and of the air, while the convective loss is also proportional to the square root of the air speed. Further, an increase in the amount of clothing worn has the same effect as putting an additional resistance into an electric circuit. It decreases the outward flow of heat and raises the skin temperature. The rate of loss of heat from the body can thus be decreased by wearing more clothing, by increasing the air temperature, or by decreasing the air movement; and it can be increased by reversing one or all of these possibilities.

In high temperatures, or during great physical exertion, the secretion of sweat and its evaporation is the main factor in the dissipation of heat from the skin. An examination of the measured rates of loss of heat by convection and evaporation shows the curious result that, even when the body appears to be completely wetted with sweat, the area of skin from which evaporation occurs is only about one third of the area from which heat is lost by convection. The rate of evaporation from unit wetted area is the greater the higher the wind speed, and the lower the humidity of the air. If, while the temperature is kept constant at such a high level that active sweating occurs, either the humidity is increased, or the air speed decreased, or both changes are made, the body responds by an increase of the wetted area of skin. The reverse of this statement is also true. No instrument can produce a parallel to this response, and so it is not to be expected that any instrument will enable us to measure in a simple manner the reaction of the human body to given atmospheric conditions.

We find that the human body can so react to a wide range of external conditions as to preserve the internal temperature at 98·4° F. or near it. The skin tries to produce its own climate. This effort is most successful when one is just comfortably warm in bed, the temperature under the bedclothes being then 85°–86° F.

Limits of Heat-stroke Conditions

A long series of measurements of the various factors involved in the heat balance of the body in controlled conditions of temperature, humidity and ventilation, made in the John B. Pierce Laboratory of Hygiene, Newhaven, Conn., by the Director (Dr. C. E.-A. Winslow) and Drs. Herrington and Gagge, enable us to write down expressions for the magnitude of the heat losses from the body in any given conditions. The equation of heat balance of the body can be written in such a form as to give the highest relative humidity in which body temperature can remain constant, in given conditions of air temperature and ventilation. To allow for the possibility of very light ventilation, this is taken to be 17 ft. per minute, and in what follows this rate of ventilation must be regarded as assumed, unless some other rate is specifically mentioned. It is also assumed that the temperature of the radiating solid surfaces in the environment is equal to the air temperature.

The details of the computation have been given elsewhere, and will not be repeated here. Fig. 1 shows the results of five such computations. For men resting indoors, or in the shade, Curve *AA* gives the limit of tolerable conditions for a nude man, and Curve *BB* for a lightly clothed man. In conditions represented by a point to the left of the appropriate curve for nude or clothed men, the body temperature will not rise, while in conditions represented by any point to the right of the curve the body temperature will rise, and will continue to rise so long as exposure

* Discourse delivered at the Royal Institution on March 9.

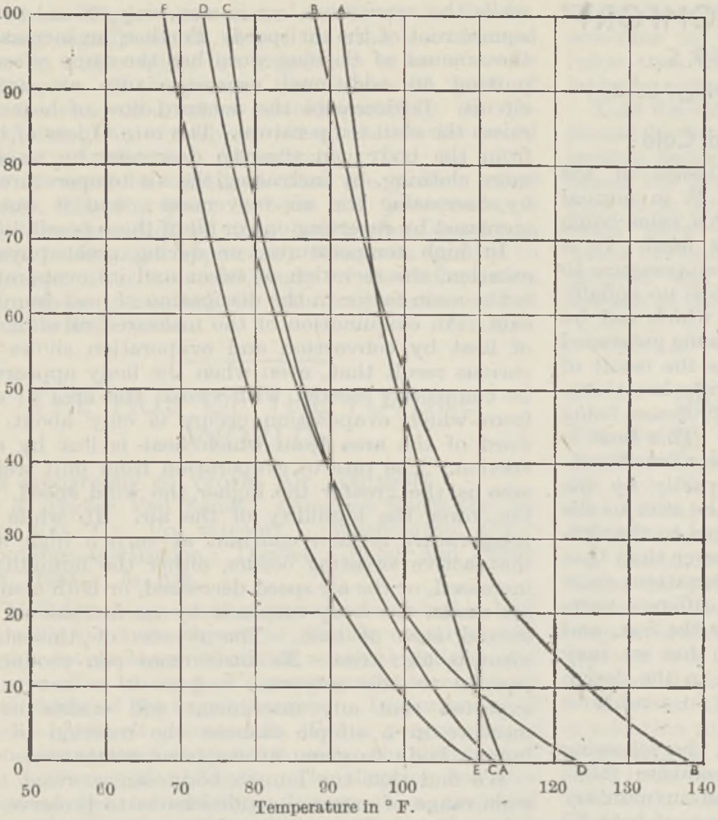

Fig. 1*. CURVES SHOWING THE LIMITS OF THE RANGE OF TOLERABLE CONDITIONS FOR VARYING DEGREES OF ACTIVITY ; *AA* FOR NUDE SUBJECTS RESTING INDOORS ; *BB* FOR CLOTHED SUBJECTS RESTING INDOORS ; *CC* FOR CLOTHED SUBJECTS RESTING IN SUNSHINE ; *DD* FOR CLOTHED SUBJECTS WALKING AT 4 M.P.H. (NO SUNSHINE); *EE* FOR CLOTHED SUBJECTS WALKING AT 4 M.P.H. IN BRIGHT SUNSHINE.

* Figs. 1, 2 and 3 are from Prof. Brunt's paper in *Endeavour* of July 1944.

to these conditions is continued. With continued rise of body temperature, the blood-pressure falls, the pulse-rate increases, strong palpitation occurs, followed by a condition of stupor, ending in death by heat-stroke. It is seen in Fig. 1 that the wearing of clothing affords considerable protection against heat, since, in completely dry air, the upper limit of tolerable temperature is about 138° F. for a clothed man, and 113° F. for a nude man.

Nothing that has been written above should be regarded as excluding the possibility of remaining for short periods in air at temperatures far beyond the limits prescribed by Curves *AA* and *BB* of Fig. 1. In the *Philosophical Transactions of the Royal Society* of 1775 will be found several papers by Dr. Charles Blagden, later secretary of the Royal Society, in which are described experiments in rooms kept at very high temperatures. Blagden stayed in a room, in which the air temperature was maintained at 240°–260° F., for a period of eight minutes ; during the first seven minutes he experienced no discomfort, but the subsequent rapid increase of distress in breathing and of a feeling of anxiety caused him to leave the room after a total stay of eight minutes.

In Fig. 1 Curve *CC* represents limiting conditions for a lightly clothed man, sitting in bright sunshine, Curve *EE* the limits for a clothed man walking at 4 m.p.h. in bright sunshine, and Curve *DD* the limits for a clothed man walking at 4 m.p.h. on a cloudy day.

A ready check on the limits set by Curve *BB* in saturated air is fortunately available. It has been pointed out by the late Dr. J. S. Haldane that in saturated air in coal mines, a temperature of 88° F. is about the highest temperature which can be tolerated, even by men not doing any work. This close agreement affords some confirmation of the reliability of the computations on which Fig. 1 is based. Exposure to conditions in which body temperature rises by 1–1½° F. per hour produces no permanent injury, provided the exposure is not continuous over a long period. Thus, with periodic withdrawal to cooler conditions, miners can work in conditions in which long-continued exposure would end in heat-stroke.

Acclimatization

It is generally acknowledged that, within limits, it is possible for a man to accustom himself to living and working in temperatures above or below the normally accepted limits. Acclimatization to hot conditions consists largely in training the sweat glands to function efficiently, and perhaps in part in learning to avoid strenuous exertion. In temperate climates some degree of acclimatization is necessary at the beginning of each summer, since the sweat glands are inactive during the winter. When a very hot day comes at the beginning of summer, it is far more distressing than an equally hot day later in the summer.

Men who work in the very hot deep mines of South Africa are subjected to a regular process of acclimatization, first doing very light work in hot stopes, and increasing slowly their rate of work. But even after acclimatization, when working in the hotter mines, coloured workers show a definite rise of internal temperature, sometimes amounting to 2° F. or more when working in air, say, of temperature 85° F., relative humidity 98 per cent (wet bulb temperature 84·6° F.), and ventilation 20 ft. per minute. In saturated air there can be no loss of heat from the skin, either by convection or by evaporation of sweat, unless the skin temperature is higher than the air temperature. Further, if heat is to be transported to the skin from the deeper tissues, the internal temperature must be higher than the skin temperature. So, when a man works in saturated air at 95° F., his skin temperature must be higher than 95° F., and his internal temperature must be several degrees above the normal value, probably 101°–102° F. at lowest.

Effect of Increased Ventilation

It is easy to compute limits of tolerable conditions with any selected rate of air motion, for nude subjects. The extension of the preceding work for clothed subjects is not at the moment possible. The conductivity of the clothing with air speed 17 ft./min. has been evaluated from experimental data, but there is not available any series of observations from which the conductivity of clothing can be related to the air speed.

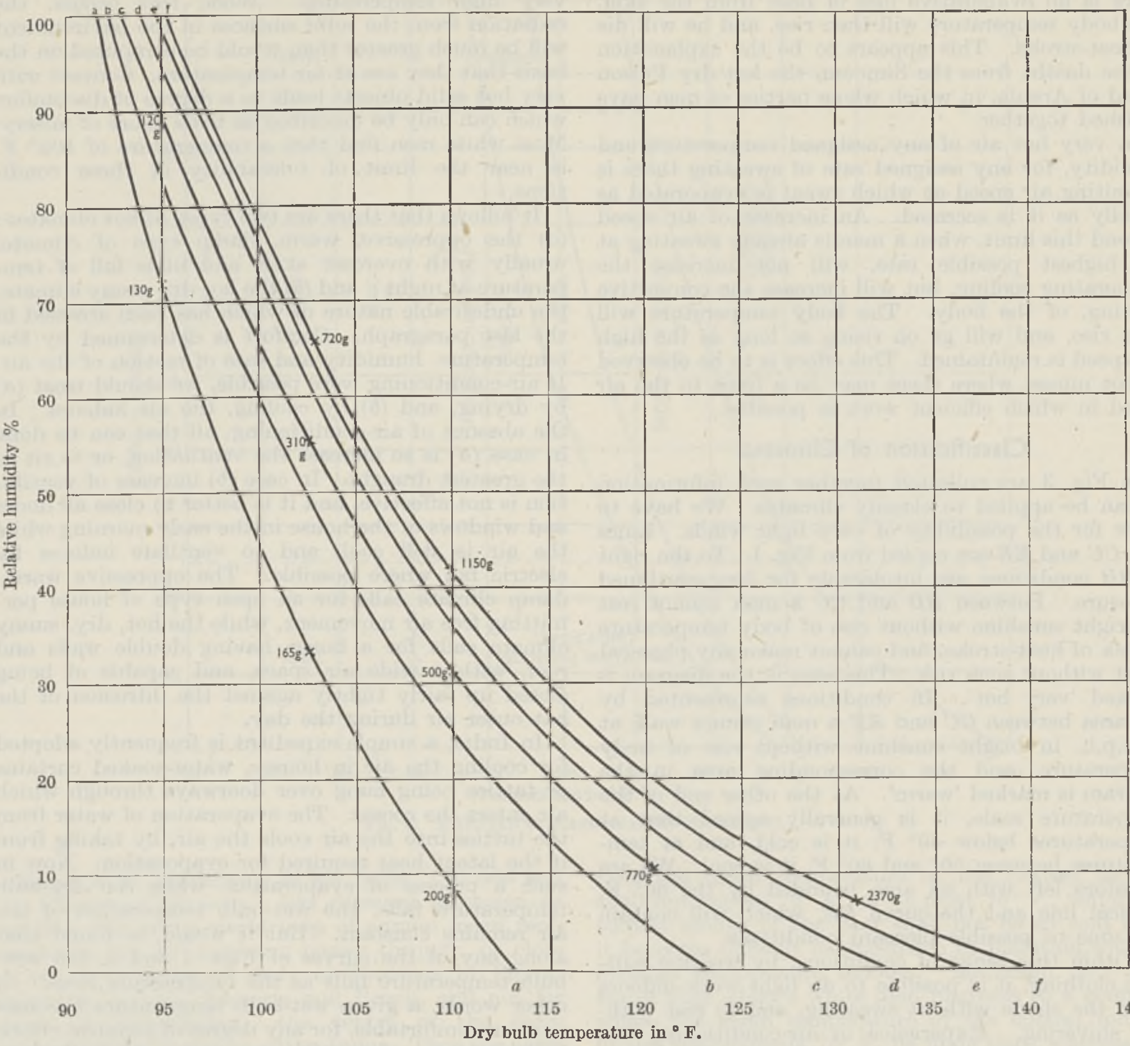

Fig. 2. THE EFFECT OF VENTILATION ON HEAT-STROKE CONDITIONS FOR NUDE SUBJECTS. THE CURVES GIVE LIMITING TOLERABLE CONDITIONS, *aa* FOR AIR MOVEMENT 0·085 METRE PER SECOND (17 FT. PER MINUTE); *bb* FOR 0·25 METRE PER SECOND (50 FT. PER MINUTE); *cc* FOR 0·5 METRE PER SECOND (100 FT. PER MINUTE); *dd* FOR 1 METRE PER SECOND (200 FT. PER MINUTE); *ee* FOR 2 METRES PER SECOND (400 FT. PER MINUTE); *ff* FOR 5 METRES PER SECOND (1,000 FT. PER MINUTE). FIGURES SUCH AS 200g. MARKED ON THE CURVES INDICATE THE RATE OF LOSS OF WATER PER HOUR BY EVAPORATION FROM THE WHOLE BODY, SKIN AREA BEING ASSUMED TO BE 1·8 SQUARE METRES.

Fig. 2 reproduces a series of curves for six values of the air speed. It is seen that in a wind of a little more than 2 m.p.h. the limits are given by *dd*, and with relative humidity 60 per cent, the tolerable temperature is about 6° F. higher than with air speed 17 ft./min., while in completely dry air the corresponding rise in tolerable temperature is nearly 20° F. The numbers shown on the curves indicate the rate of loss of water from the skin by evaporation of sweat, from the whole body of a man of average size. (Skin area 1·8 sq. metres, or 19·4 sq. ft.) For example, the 130 g. indicated on Curve *aa* at 95° F., relative humidity 72 per cent, indicates that a man resting indoors in such conditions would lose water from the body by sweat at least at the rate of one pint in a little more than four hours. The 1,150 g. shown at temperature 110° F., relative humidity 42 per cent, indicates that a man resting in the shade in these conditions with a wind of 1,000 ft./min. (11·1 m.p.h.) would lose water by sweating at the rate of at least two pints per hour, while the figure of 2,370 g. lower on the Curve *ff* indicates a loss of more than half a gallon per hour.

There are two aspects of these high rates of sweating which deserve further consideration. In the first place, sweat is not pure water, but contains, in addition to various organic compounds, common salt, and the salt lost by sweating must be replaced, or serious consequences to health will follow. Of these consequences miner's cramp is frequently cited as a typical example. In the second place, it should be noted that it is possible for dehydration of the body to cause sweating to stop. The consequences may be fatal. If, for example, a man is exposed to a wind of just over 11 m.p.h., at a temperature of 110° F. and relative humidity 42 per cent, his body temperature can remain normal so long as he sweats at the rate of about two pints per hour. If he stops sweating, he will thus be exposed to conditions in which radiation and convection heat the body, while there is no evaporative loss of heat from the skin. His body temperature will then rise, and he will die of heat-stroke. This appears to be the explanation of the deaths from the Simoom, the hot dry Poison Wind of Arabia, in which whole parties of men have perished together.

In very hot air of any assigned temperature and humidity, for any assigned rate of sweating there is a limiting air speed at which sweat is evaporated as rapidly as it is secreted. An increase of air speed beyond this limit, when a man is already sweating at his highest possible rate, will not increase the evaporating cooling, but will increase the convective heating, of the body. The body temperature will then rise, and will go on rising so long as the high air speed is maintained. This effect is to be observed in hot mines, where there may be a limit to the air speed in which efficient work is possible.

Classification of Climates

In Fig. 3 are collected together such information as can be applied to classify climates. We have to allow for the possibility of very light winds. Lines *BB*, *CC* and *EE* are copied from Fig. 1. To the right of *BB* conditions are intolerable for long-continued exposure. Between *BB* and *CC* a man cannot rest in bright sunshine without rise of body temperature or risk of heat-stroke, and cannot make any physical effort without such risk. This area in the diagram is marked 'very hot'. In conditions represented by the area between *CC* and *EE* a man cannot walk at 4 m.p.h. in bright sunshine without rise of body temperature, and the corresponding area in the diagram is marked 'warm'. At the other end of the temperature scale, it is generally agreed that at temperatures below 50° F. it is cold, and at temperatures between 50° and 60° F. it is cool. We are therefore left with an area bounded by the 60° F. vertical line and the curve *EE*, which will contain the zone of possible pleasant conditions.

Within this range of conditions, by wearing suitable clothing, it is possible to do light work indoors or in the shade without sweating, and to rest without shivering. Experience in air-conditioning has confirmed this, and has shown that, with medium relative humidity, men can do light work indoors with the maximum degree of comfort in temperatures between 60° and 76° F. The optimum temperatures prescribed by heating and ventilating engineers are, in the United States, 76° F. in summer, 72° in winter; in England, 66° in summer, 62°–64° in winter.

Very high relative humidity is oppressive at high and moderate temperatures, and raw at low temperatures. Very dry air is keen at low temperatures, while at moderate and high temperatures it is at first stimulating, but ends by producing irritation, headaches, and a marked tendency to becoming quarrelsome. The Föhn wind, a warm dry wind which blows down the sides of many mountain ranges, has long been notorious for producing these effects of irritability and quarrelsomeness, and dwellers in some desert regions manifest an undesirable permanence of irritability.

Fig. 3 is based on an assumption which was stated earlier, but requires emphasizing, that the temperature of solid surfaces is the same as the air temperature. There are conditions in which this assumption is not justified, particularly in hot sunny climates, in which the walls and roofs of houses and any solid objects exposed to the sunshine attain a very high temperature. When this occurs, the radiation from the solid surfaces in the environment will be much greater than would be computed on the basis that they are at air temperature. Contact with very hot solid objects leads to a degree of discomfort which can only be described as little short of misery. Most white men find that a temperature of 105° F. is near the limit of tolerability in these conditions.

It follows that there are two types of hot climates: (*a*) the oppressive, warm, damp type of climate, usually with overcast skies and little fall of temperature at night; and (*b*) the hot dry sunny climate, the undesirable nature of which has been stressed in the last paragraph. Comfort is determined by the temperature, humidity and rate of motion of the air. If air-conditioning were possible, we should treat (*a*) by drying, and (*b*) by cooling, the air indoors. In the absence of air-conditioning, all that can be done in case (*a*) is to increase the ventilation, or to sit in the greatest draught. In case (*b*) increase of ventilation is not effective, and it is better to close all doors and windows of the house in the early morning while the air is still cool, and to ventilate indoors by electric fan where possible. The oppressive warm, damp climate calls for an open type of house permitting free air movement, while the hot, dry, sunny climate calls for a house having double walls and roof, with a wide air space, and capable of being closed up fairly tightly against the intrusion of the hot outer air during the day.

In India, a simple expedient is frequently adopted for cooling the air in houses, water-soaked curtains or tatties being hung over doorways through which air enters the rooms. The evaporation of water from the tatties into the air cools the air, by taking from it the latent heat required for evaporation. Now in such a process of evaporation, while the dry-bulb temperature falls, the wet-bulb temperature of the air remains constant. But it would be found that along any of the curves of Figs. 1 and 3, the wet-bulb temperature falls as the temperature rises. In other words, a given wet-bulb temperature becomes more uncomfortable, for any degree of physical effort, in any degree of ventilation, as the dry-bulb temperature increases.

The Ideal Climate

Can we now determine the ideal climate? To this question a definite answer can be given provided we have a clear statement of the *idea* underlying the search for the *ideal*; and we must avoid the common error of regarding the climate in which it is pleasant to spend a summer holiday as the ideal climate in which to live permanently, and to do one's work. Before we can determine the ideal climate we must, in fact, know for what degree of activity the climate must be ideal. Clearly the ideal will not be found either in the very cold polar regions or the very hot tropical regions. In a paper published some two years ago, I endeavoured to solve the first stage of the problem by postulating that it should be possible for a lightly clothed man to walk at four miles per hour in the sunshine without sweating, and to sit in the sunshine, or stand or sit in the shade or indoors doing light work, without shivering. With relative humidity of about 60 per cent, the temperature to fit this prescription will be between 66° and 68° F., and the optimum is thus 67° F. For the nude man the optimum temperature will be about 4° higher, say 70°–71° F.

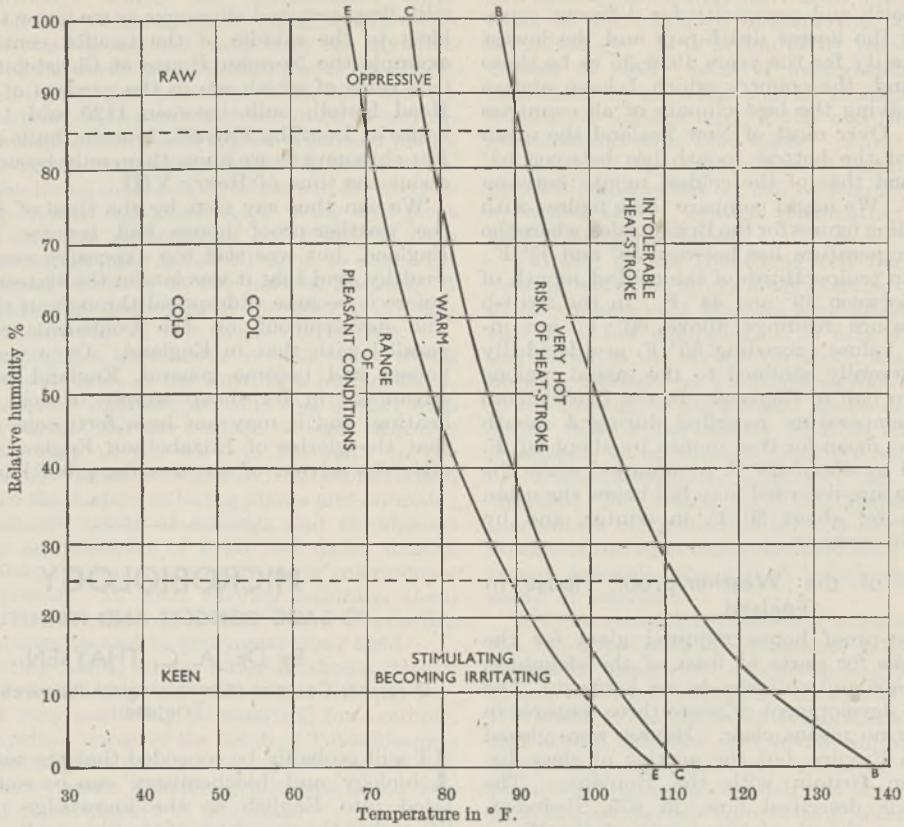

Fig. 3. A TENTATIVE CLASSIFICATION OF CLIMATES.

Major S. F. Markham, in his book "Climate and the Energy of Nations", has directed attention to the fact that, on a world map of annual mean temperatures, the 70° isotherm passes through, or close to, all the centres of early civilizations in Egypt, Palestine, Assyria, Sumeria and Persia, and not far north of Mohenjodaro, the centre of the early civilization in the valley of the Indus. Thus the early civilizations arose in regions where the mean temperature of the year is now, and probably was then, 70° F. or very near it; and as they were founded by men who wore so little clothing that we may regard them as nude, we may take this as a confirmation of the estimate given above of the ideal temperature for the nude man.

An annual mean temperature of 70° F. would mean a summer temperature well above the limit, and a winter temperature well below it, so that the summer afternoons would be too hot, and the winter nights too cool, for comfort. With the development of methods of indoor heating in winter, the optimum conditions would shift to climates where the summer heat was less extreme; but the winter cold not such as to make indoor heating impossible, as exemplified in ancient Greece, and still more notably in the Roman Empire. With the fall of the Roman Empire, indoor heating became far less common, and almost died out, and the next major civilization, the Muslim, was again in the region of the 70° F. isotherm. Later on, in western Europe, as indoor heating developed, and houses once again became weather-proof, civilization began to make rapid strides.

We can now go a stage further, and state that for a healthy and active life the climate must be such that the mean temperature of the hottest month shall not exceed 70° F., or at most 75° F., while the coldest month of the year shall not be so cold that it becomes difficult or expensive to maintain a comfortable temperature indoors. Markham (*loc. cit.*) states that when a white man migrates to a country where the mean temperature of the hottest month of the year exceeds 75° F. he finds that, whereas he and his children may be able to tolerate the changed conditions, his grandchildren will show a marked loss of energy and of mental and physical efficiency. Markham suggests that the 'poor white' problem which has arisen in many hot countries is a result of migration to unsuitable climatic conditions. It is unlikely that any simple hard-and-fast rule can afford a solution of the problem of desirable climates. Some allowance must be made for the effects of low relative humidity and of high wind speed, in modifying the disabilities of hot climates.

An examination of world maps of mean temperatures for each month of the year shows that only a very small fraction of the land areas satisfies the condition that the hottest month of the year has a mean temperature not above 75° F., while the coldest month of the year has a mean temperature not below freezing point. The largest single area satisfying these conditions is that part of western Europe which includes the British Isles, France, northern Spain, Switzerland, Germany, the Netherlands, Denmark, and a strip along the south-western shores of Scandinavia. Within this area, there is a higher level of health and prosperity than in the neighbouring regions.

Markham quotes a considerable volume of statistics relating to health and prosperity for different countries, showing the lowest death-rate and the lowest infantile mortality for the years 1926–35 to be those of New Zealand, the country which I have always regarded as having the best climate of all countries in the world. Over most of New Zealand the mean temperature of the hottest month lies between 62° and 70° F., and that of the coldest month between 45° and 52° F. We might compare these figures with the corresponding figures for the British Isles, where the July mean temperature lies between 58° and 62° F., while the mean temperatures of the coldest month of the year lie between 39° and 44° F. In the British Isles, temperature readings above 90° F. are infrequent, and values exceeding 95° F. are decidedly rare, being generally confined to the inland regions of the southern half of England. In the British Isles the highest temperature recorded during a month may exceed the mean for that month by about 20° F. in winter, and by about 30° F. in summer, while the lowest temperature recorded may fall below the mean of the month by about 30° F. in winter, and by about 20° F. in summer.

Development of the Weather-proof House in England

The weather-proof house required glass for the windows, bricks for parts at least of the structure, and the fireplace and chimney as we know it. The history of the development of these three features in England is by no means clear. Houses were glazed in the Roman Empire, but the making of glass disappeared from Britain with the Romans. The Venerable Bede described how, in 675, Benedict, when building a church at the mouth of the Wear, had to go to France to find and bring back glass workers to glaze the windows of his church. Bede further states that these glaziers not only glazed the church windows, but also taught the English how to make glass. The knowledge they imparted was not lasting, for in 758 we find the Abbot of Jarrow appealing to the Bishop of Mainz to send him a craftsman in glass. The earliest evidence we find of glass-making in England refers to 1230, in which year a deed granted certain lands at Chiddingfold in Surrey to one Lawrence, "vitrarius". Chiddingfold was apparently the earliest centre of glass-making, but English glass was poor in quality until the sixteenth century. Even then glass windows were so rare and valuable that they were often bequeathed, like jewels, apart from the house. The decision by the Court of Common Pleas in 1599, that glass windows should not be removed from a house, reveals the prevailing state of things with regard to windows.

Aubrey, an antiquarian writer of the seventeenth century, said that glass windows were rare except in churches and gentlemen's houses until the time of Henry VIII, and added that to his own remembrance, copyholders and poor people in Herefordshire, Monmouthshire and Shropshire had none before the Civil War. Aubrey also wrote that before the Reformation, ordinary men's houses "had no chimneys, but flues like louvre holes. Some of 'em were in being when I was a boy".

So far as definite records are available, bricks were first made in England (at Hull) in 1303, and only became reasonably good and cheap a century later. One of the earliest examples of brickbuilding in England, with English bricks, is the north and east part of Queens' College, Cambridge, built in 1448.

There are still to be seen in England a few houses with fireplaces and chimneys as we know them dating back to the middle of the twelfth century, as for example the Norman House at Christchurch, Hants (the ruins of which are in the gardens of the King's Head Hotel), built between 1125 and 1150, and a house at Boothby Pagnell, Lincoln, built about 1150. But chimneys as we know them only became common about the time of Henry VIII.

We can thus say that by the time of Henry VIII the weather-proof house had become possible in England, but was still too expensive except for the wealthy, and that it was late in the sixteenth century before it became widespread throughout the country. The development on the Continent was roughly parallel with that in England. Once weather-proof houses had become general, England had a great advantage in its cheap supply of coal for indoor heating, and it may not be a fortuitous coincidence that the glories of Elizabethan England came soon after the advent of the weather-proof house.

MICROBIOLOGY

ITS BASIC CONCEPT AND ITS FUTURE

By DR. A. C. THAYSEN

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IT will probably be conceded that the terms 'microbiology' and 'biochemistry' can be roughly translated into English as the knowledge of invisible life and as the chemistry of the living cell respectively. As such, these definitions aptly circumscribe the fields of study embraced by the two branches of science. Yet, all too often, the term microbiology is referred to as synonymous with that of biochemistry, as if these two branches of science dealt with identically the same problems, required the same training, and would use the same approach to the solution of their problems. This, however, is not necessarily the case and has no foundation in the basic concept of microbiology.

If one searches for this basic concept, one must eventually be led back to the living cell itself as it exists in its natural habitats. For only by a study of the changes which the cell performs under such conditions does it appear possible to obtain a correct insight into its functions ; and only by an evaluation of these functions under controlled growth conditions can a measure be obtained of the future possibilities of the science of microbiology. This is undoubtedly the lesson to be learned from the polemic between Pasteur and Liebig in their writings on the function of yeast in fermentations, and it is the axiom insisted upon by Koch, when he demanded that, before a disease can be ascribed to the action of an organism, it is essential to grow the suspected type under artificial conditions free from all others and to produce with the cultured specimen the identical symptoms in healthy animals which had been observed to occur in diseased forms under natural conditions.

A primary function of microbiology then appears to be the study of micro-organisms in their natural habitats and to endeavour to isolate them from these for cultivation under artificial conditions with the view of reproducing natural changes or any other changes of which they may be found capable.

The knowledge which has accumulated since Leeuwenhoek first observed micro-organisms in droplets of water has shown, not only that the invisible population of the earth is as abundant as is its macroscopic counterpart, but also that it is met with in places and under conditions which would be utterly inadequate to sustain the life of higher organized plants or animals. This presupposes a flexibility in the make-up of the free-living microscopic cell which far exceeds that of any higher organized living being and gives an insight into the diversity of the problems with which microbiology may be called upon to deal. On the other hand, a study of the natural habitats of micro-organisms should make it possible to circumscribe the limitations of this branch of science.

For example, the microscope reveals that, where water is present, even in the form of a humid atmosphere, free-living microscopic cells can be met with almost anywhere. On the surface of inert objects; in the arctic ice; in the sea; in the soil; in the hot springs of volcanic localities; in subterranean oil wells; on the surface of living plants and animals; in the intestinal tracts of animals and throughout the interior and exterior of dead and dying animal and vegetable tissues, actively growing microscopic cells are present. In such varying habitats, then, must they find conditions which make it possible for them to survive and to propagate their kind.

On the other hand, where water is absent it may safely be predicted that no microscopic life can persist, and it may positively be asserted, for example, that the so-called 'curse' of the tomb of Tutankhamen could not possibly be ascribed to microbiological life, as was done in some quarters when this tomb was opened and found devoid of moisture.

There are, of course, other limitations, such as temperature and reaction, but the range here is often extraordinarily wide, much wider than would be feasible among higher cell organizations.

A particularly interesting form of limitation of types rather than of numbers is met with in the soil and among the microflora and microfauna of the intestinal tract of most animals, where a few types have established themselves irrespectively of the feeding habits of the animal. Though a much wider range of types must originally enter the intestine they appear unable to survive in competition with the established forms.

The mechanism by which such specialization is brought about can only be ascertained by a study of the habits of the living cell itself. It is conceivable that the rate of growth of the established types may be faster than that of the accidentally entering cells, either because the conditions prevailing favour the former, or that the normal types during their growth produce substances which are harmful to all but the established types. Whatever the explanation, the example given illustrates the influence which the natural habitat may exercise on the organisms living in it and indicates the importance which must be attached to its study.

An extensive exploration of some of these habitats began during the second half of the nineteenth century. Because of the utilitarian aspect of this study it resulted not only in added knowledge and in a widening of the field of microbiology, but unfortunately also in a subdivision of the science into at least four different and more or less water-tight compartments: medical, or pathological bacteriology; dairy bacteriology; soil bacteriology; and the mycology of the fermentation industries. Though this specialization may have been unavoidable at the time, it did much to obscure the potentialities of microbiology. It is undoubtedly responsible for the neglect of many fields of exploration, such as the microflora of oil wells and oil storage tanks, of the rotting of textiles and of the corrosion of metallic structures in soils and water. How important an extension of the exploration of natural habitats of micro-organisms can be, can be seen from the modern developments in sewage purification and in the retting of textile fibres.

Turning to the free-living cell itself and to the bearing which its study must exercise on the progress of microbiology, it appears appropriate to illustrate this by a few examples. The first which comes to one's mind is the revolution which was caused in the brewing industry by the introduction of pure cultures in the brewing of lager beer. There are many others which carry equal weight, such as the prophylactic treatment of infectious diseases with pure cultures of certain pathogenic organisms, the preparation of 'starters' for cream used in butter-making, the inoculation of deficient soils with cultures of specific strains of nitrogen-fixing bacteria and, to take a more recent example, the use of micro-organisms in the assay of vitamins.

If it be conceded, then, that a knowledge of both the living cell and of its habitat is essential for the successful expansion of microbiology, it is relevant to ask how such knowledge should be circumscribed. Obviously it should be as comprehensive as possible and should embrace all relevant information on the morphology, the biology, including cytology and physiology, and the chemistry of the cells, the latter both as regards their composition and their functions. An exclusive study of one or two of these aspects would fail to give a balanced picture of an organism and would in many cases lead to an erroneous estimate of its potentialities. For example, in the case of the preparation of gluconic acid by certain fungi the conversion of the sugar used is governed by the biochemical properties of the organism. But it is influenced also by its morphology, for it has been shown that the action of the fungus used on the sugar which it converts to gluconic acid can be greatly increased by a change in the morphology from matted hyphæ to smaller cell aggregates which can be more uniformly aerated than the mats of hyphæ.

Again, in the production of baker's yeast, an industry which is based on the ability of certain yeasts to build up their cell substance from carbohydrates and inorganic nitrogen, the rate of growth of the cells is markedly influenced by the number of cells present in their habitat at any given time. Here a study of the growth-rate of the individual cell will indicate the conditions required to secure full advantage of the biochemical process of the organism.

Finally, a case may be cited in which the exploration of the biochemical activities of an organism supplied the clue to the connexion between its growth and the spoilage of fish living in the proximity of its natural habitat. It had been observed that trout and salmon entering certain rivers became useless as a food because their flesh became contaminated with a pungent earthy taint. The origin of this taint remained obscure until an examination of the river beds revealed extensive areas covered with the growth of a micro-organism which produced a volatile organic nitrogenous substance. This substance, when dissolved in high dilution in water in which fish were living, imparted to their flesh the same earthy taint with which the spoiled fish had been tainted.

Reverting to the significance of biology in microbiological research, it is relevant to point out that without its aid it would be impossible to describe an organism and to compare or identify it with known types for eventual classification and conservation. Neglect in this respect has been responsible in the past for much confusion, and many types already studied have been lost in the course of time with little hope of recovery, because their original description was wholely inadequate for them to be re-identified. Within the last two decades a serious effort has been made to remedy this state of affairs by the acceptance of a standard code of identification and by opening in various countries specialized collections of type cultures in which recognized types of micro-organisms are maintained and into which new types can be incorporated as they become known, each provided with a comprehensive description, covering its general biological characters, its relationship to other types, as well as any special pathogenic, chemical or other properties which it may possess.

Turning to the place of chemistry in microbiology, it is probably correct to claim that its functions should be twofold. It should explore the relevant changes in a habitat which result from the metabolism of micro-organisms, and it should investigate the chemical composition of the organism itself so that information may be obtained on its food requirements. Further, the intermediary products which result from its activity should be explored so that the steps can be ascertained by which the final metabolic products are arrived at.

In the course of time chemistry, as applied to micro-organisms, has branched off into a third direction which cannot be regarded as strictly relevant to its main function. This side-line originated in the observation that the metabolic processes of micro-organisms are fundamentally similar to those of higher organized forms of life. The free-living microscopic cell, therefore, with its much contracted life-cycle, is often chosen for the study of metabolic changes, which might not be as conveniently explored on tissues removed from higher animals or plants.

Within its more legitimate sphere, the chemistry of micro-organisms covers a wide field of unexplored ground, in spite of the not inconsiderable amount of information which has been acquired already. Such knowledge makes it possible, for example, to predict with some measure of assurance the nature of some of the chemical compounds which can be produced by micro-organisms and the stages through which the substances utilized by the free-living microscopic cell are broken down into final metabolic products. This is particularly so in the case of the carbohydrate metabolism of micro-organisms. Much less is known about the changes through which nitrogen passes under their influence, and still less of those in which sulphur, phosphorus, silicon and other elements may be involved.

As for the carbohydrates, it may be said that, whether they be polysaccharides or monoses, hexoses or pentoses their breakdown by micro-organisms gives rise to the same ultimate products: carbon dioxide and water. Some organisms fail to utilize carbohydrates to this extent and more complex end-products will result, notably organic acids, alcohols, ketones and esters. But even in such cases, and in spite of the seemingly endless possibilities, the number and the nature of the end-products will be restricted to comparatively few groups. This is due to the standardized type of enzyme reaction employed by micro-organisms in metabolizing carbohydrates, even where the organisms belong to the most varied biological groupings.

It is for this reason that the application of micro-organisms in the preparation of organic compounds from carbohydrates must remain a limited field of application, a field which in the course of time, and for economic reasons, may become even further restricted than it is to-day. Where fermentation processes have already been introduced, for example, in alcohol manufacture and in the production of citric, lactic and acetic acids, they have in most cases maintained their economic predominance. That they will do so in future is already problematic, at any rate in the case of lactic and acetic acids, other than vinegar. For these acids can now be produced more cheaply by chemical methods than by fermentation. That vinegar is still made commercially with the aid of micro-organisms illustrates the advantage possessed by fermentative processes in such industries as brewing and wine production, which are based on the conversion of carbohydrates into products in which subtle and often undefinable metabolic substances constitute an essential part of the final product.

It has already been mentioned that the biochemical aspect of the nitrogen metabolism of micro-organisms is far less explored than that of carbon. Nevertheless, micro-organisms have been, and are being, used on the largest scale in processes which are based on the nitrogen metabolisms of such organisms. The fixation of atmospheric nitrogen in the soil by addition of pure cultures of certain bacteria is a case in point; removal of undesirable tissues from hides in leather manufacture; sewage disposal; casein digestion in cheese-making; and protein synthesis from inorganic nitrogen compounds are others.

A very special interest is attached to the chemical exploration of bacteriostatic and bacteriolytic substances produced by micro-organisms, substances into the composition of which nitrogen enters. A purely biological approach to this subject, though an essential preliminary, would not suffice for full advantage to be gained from the existence of these substances. Their production by micro-organisms at any given time may often be totally inadequate for large requirements, and they will, moreover, often be difficult to isolate from the substrates in which they have been produced biologically. The final goal here would appear to be their chemical identification and synthesis by the organic chemist.

Recent work on the sulphur metabolism of micro-organisms has brought to light several interesting observations which indicate that this field also may be of interest not only to the biologist but also to the chemist, the farmer and the engineer. For it has by now been established that certain micro-organisms, through their sulphur metabolism, play a significant part in the corrosion of metallic structures which are exposed in soils or water. Others influence soil fertility through their sulphur metabolism.

The fields of the phosphorus and silicon metabolism of micro-organisms remain almost unexplored. If experience gained in other fields may be taken as a guide, an exploration here could most profitably be approached by a study of those micro-organisms which occur in places where phosphorus or silicon undergo 'spontaneous' changes.

This brings the discussion back from a contemplation of the functions of chemistry in microgeology to the question of the significance of the free-living cell in its natural habitat, a question which has already been referred to as fundamental. It seems appropriate at this juncture to substantiate this contention by a further example.

Where micro-organisms develop in their natural habitats they do so at the expense of substances which can serve their energy requirements. Such substances may range from highly complex organic compounds to simple elements. The result of the action of micro-organisms on them will inevitably be a change in their chemical composition, a change which, if undesirable from a human point of view, will be characterized as destructive.

The destructive activities of micro-organisms are too manifold to enumerate, ranging as they do from the taking of human life to the elimination of dead vegetation; from the spoilage of milk and all other foods to the mildewing of fabrics; from the contamination of gas stored in gasometers to the destruction of natural rubber, or the breakdown of liquid fuels, or the corrosion of metallic structures. A study of all such destructive activities and a clarification of their significance must always constitute a major function of microbiological research, worthy of a degree of attention at least equal to that devoted to the adoption of micro-organisms as catalysts in the production of organic substances.

What bearing, it may finally be asked, has all this on the planning of future microbiological research? It implies that the biological aspect should be safeguarded in greater measure than has been done in the past, and that a more general approach to the subject should be encouraged, not, be it understood, at the expense of specialized investigations, but in addition to and in amplification of them.

There will be needed in future a more comprehensive survey of the natural habitats of the microscopic world than has hitherto been undertaken. There is need to-day for a much more thorough exploration of the destructive activities of micro-organisms than has so far been conducted. There is need for a better understanding of the symbiotic and antagonistic activities of micro-organisms, and of the adaptive properties of the microscopic world in its natural habitats. There is need for more work connected with the classification and preservation of type cultures, and for a fresh approach to an understanding of the biological and biochemical principles underlying established microbiological processes. Improvements in such processes could not fail to result from such work. Finally, there is need for the training of workers in general microbiological principles.

Planning of microbiological research on the above lines is unlikely to be effectively undertaken in laboratories designed for specialized purposes such as pathology, dairying, soil investigations or biochemistry.

A homestead for general microbiological research is needed suitable for carrying out also the training of workers on more general lines than has been customary in the past. By whom such an establishment should be conducted, by universities or under Government auspices, may be a matter for discussion. Of its usefulness there can be but one opinion.

OILFIELDS IN GREAT BRITAIN*

By Dr. G. M. LEES
Anglo-Iranian Oil Co., Ltd.

In *Nature* of March 31, 1934, an article on "Petroleum in Great Britain" gave the following conclusion on the prospects:

"Oil pools of commercial magnitude (*pace* natural gas, shale oil and allied indications and potentialities) cannot reasonably be anticipated in any known area in Great Britain. Many years of official geological survey—a centenary in 1935 in point of fact—together with much independent work, leave few spots unknown, if not in detail, at least in sufficient outline to preclude even faint hope".

On December 6, 1944, G. M. Lees and A. H. Taitt read a paper to the Geological Society of London on "The Geological Results of the Search for Oilfields in Great Britain" and the president of the Society, Prof. W. G. Fearnsides, on opening the discussion, said that "Never before had so much exact and new information about the underground geology of Britain been presented to the Society. . . . The D'Arcy Exploration Company's [the exploration subsidiary of the Anglo-Iranian Oil Co.] delivery of some 300,000 tons of native oil had been a notable contribution to the war effort, but the by-product of knowledge gained of Carboniferous rocks, under and about the edges of the coalfields, was not less vital in the interests of the nation".

The pessimistic, though confident, opinion of 1934 was presumably written without a full appreciation of the capacity of the modern technique of geophysics and of rapid exploration drilling to probe the structural and stratigraphical secrets below the unconformable cover of Permian and Mesozoic strata. This blanket completely obscures the older rocks throughout extensive areas in the Eastern Midlands, East Anglia and south-central England, and such borings as had penetrated below the unconformity were too few and too scattered to allow any satisfying deductions to be drawn from their results. These areas were, therefore, virtually *terra incognita* at depths below a few thousand feet, or less, from surface.

The exploration programme of the D'Arcy Exploration Company has extended over a number of separate and unrelated geological prospects—the Mesozoic in southern England, the Carboniferous in the western and eastern Midlands, the Permian in North Yorkshire and the Calciferous Sandstone Series in Scotland. During the course of the past ten years, intensive geological and geophysical work and the drilling of fifty-two deep and forty-three shallow exploration borings by the Company have yielded an immense amount of new information. They have proved five oilfields and two areas of natural gas, and these fields are now producing from 243 wells. The total production up to the end of 1944 was 337,000 tons. The crude oil is of good quality, with good light and lubricating oil fractions. The specific gravity ranges from 0·83 to 0·89.

The oilfields are situated about eight miles north-west of Newark at Eakring, Duke's Wood, Caunton and Kelham Hills, and there is one isolated small field at Formby, between Liverpool and Southport. The Nottinghamshire oilfields produce from depths of 1,900–2,500 ft. from sandstones in the Millstone Grit Series and, to a lesser extent, from sandstones

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in the basal part of the Coal Measures. The oil is concentrated in the crestal parts of minor anticlines forming part of a major anticlinal area which extends from the Trent at Rolleston to the vicinity of Ollerton. The Formby oilfield is a small accumulation in Keuper Waterstones sealed upwards by Glacial clay, and in this case the oil is produced from a depth of 100–120 ft. The structure is a faulted monocline, but it is thought probable that the oil has migrated upwards from a lower source, perhaps in the Carboniferous. Two deep borings have been made to explore the lower possibilities, but so far without result.

The gas-fields are at Aislaby in Eskdale, North Yorkshire, and at Cousland near Dalkeith, Scotland. In the former case the reservoir rock is a Permian limestone, and in the latter it is the sandstones of the Oil Shale Group of the Calciferous Sandstone Series. Short tests have indicated that the gas may be present in sufficient quantity to justify commercial exploitation.

The discovery of the Nottinghamshire oilfields resulted from geophysical work carried out, for the most part, by the staff of the Anglo-Iranian Oil Company. Seismic refraction arc surveys have proved to be the most successful method, whereas the reflexion method has given disappointing results. Gravity and magnetometer methods have also been used. These geophysical surveys have revealed the presence of a number of structural highs in extensive areas in eastern Nottinghamshire and in Lincolnshire, and a number of these have already been tested by drilling; although the ratio of success to failure has been low, the search continues.

An immense amount of new geological information on the stratigraphy and structure of the Carboniferous rocks below the Permian unconformity has been revealed by these borings. Coal seams of significant thickness have been penetrated by borings at Spital, Dunston and Stixwould, north, south and south-east respectively of Lincoln City. The coal seams lie at about 4,000 ft. depth, and although for this reason they are not likely to be mined in the near future, they represent a substantial addition to the known British reserves of coal. It is possible that coal seams at shallower depth may be present underground in the surroundings of the Wash or even in north Norfolk; the former possibility was already envisaged by Prof. Kendall many years ago. On the debit side of the coal account, the area north of Newark, both east and west of the River Trent, has been proved to lack coal seams of important thickness, while to the south of Newark there is a considerable area in which there is an exceptional development of volcanic rocks within the Coal Measures, at the expense of workable seams. Farther south, however, there is an improvement, as a boring at Widmerpool, eight miles south-east of Nottingham, has proved two good seams.

Another important by-product of the search for oil has been the discovery of potash salts of Permian age in Eskdale, North Yorkshire. Both sylvite and polyhalite are present, and this result shows that the potash deposits of the Zechstein Sea, which have such economic importance in north-west Germany, extend also into north-eastern England. The potash beds in Eskdale are at a depth of 3,650–4,775 ft. and, while this may exceed easy mining depth, there is a possibility that the deposits may extend farther north towards the Tees valley and rise to a lesser depth.

Inevitably, after several decades of rural spoliation by uncontrolled industry, a certain apprehension has been felt lest the development of oilfields might be at the expense of the amenities of the countryside of Britain, but it need not and has not been so. Every care has been taken to cause as little disturbance as possible; after a well has been drilled, the derrick is removed and only a small pumping jack marks the position of the boring. Electric power is used for pumping, and the motors are both small and silent. Buried pipelines carry the oil from the fields to a railway siding whence it is transported in tank cars to a refinery.

OBITUARIES

Engineer Vice-Admiral Sir George Goodwin, K.C.B.

ENGINEER VICE-ADMIRAL SIR GEORGE GOODWIN GOODWIN, who died at Havant on April 2, was the sixth to hold the important position of engineer-in-chief of the Fleet—an office created in 1847. The first two holders, Thomas Lloyd and Sir James Wright, were civilians, but after the latter retired in 1887, the holders have all been naval engineer officers: Richard Sennett, an inspector of machinery, following Wright and he in turn being succeeded by Engineer Vice-Admirals Sir John Durston, Sir Henry Oram, F.R.S., and Sir George Goodwin. These four distinguished officers were all products of the admirable system of training inaugurated by the Admiralty in the dockyards and at the Royal Naval College, Greenwich.

Goodwin, who was born in 1862, became an engineer student at Portsmouth and received part of his education in the Dockyard School. While still a boy, he attained the highest position in the Cambridge Local Examinations and thereby became available for a scholarship at the University of Cambridge. He chose to continue his naval career, however, passed through Greenwich with distinction and, except for about four years afloat, was afterwards employed either at Chatham Dockyard or at the Admiralty. He rose through the old ranks of assistant engineer, engineer and chief engineer, to the new ranks of engineer commander, engineer captain and engineer rear-admiral before, in 1917, on his succeeding Oram, reaching the highest rank at present open to a naval engineer officer.

In Goodwin's early days, there were many ships with low-pressure boilers and simple-expansion engines. He saw these types of machinery give way to compound- and triple-expansion engines, steam turbines, water-tube boilers and other important innovations. Known to a large number of officers afloat and ashore, he helped to bridge the gulf which existed between the engineering staff at the Admiralty and engineer officers in the Fleet, and on his retirement was entertained at dinner in the Grand Hotel, London—a unique occasion.

Among Goodwin's honours was that of the honorary degree of LL.D. conferred upon him when he attended the James Watt centenary celebrations at Birmingham in 1919, as the Admiralty representative. He was the first naval engineer to be so recognized by any university in Britain.

After his retirement from the naval service, Sir George Goodwin threw himself heart and soul into the work of various technical institutions, and in 1925 joined the old-established shipbuilding and engineering firm of J. Samuel White and Co., Ltd., of East Cowes, of which he became chairman.

Dr. G. L. Taylor

THE untimely death of George Lees Taylor at the age of forty-eight has robbed medicine and genetics of an able and industrious worker who had made notable contributions in this field. Born in 1897 at Ashton-under-Lyne, the son of Albert Taylor, he graduated in medicine at the University of Manchester in 1920 after a distinguished undergraduate career. After two years of resident hospital appointments, Taylor spent seven years in general practice, but in 1929, when the chance occurred to become John Lucas Walker Student with Prof. H. R. Dean at Cambridge, Taylor decided to abandon practice and to devote himself to teaching and research. During the next six years Taylor's work was chiefly serological, and he published a series of ten papers on precipitin reactions which established his reputation for painstaking and consistently sound work. During this time he was awarded the M.D. with commendation (Manchester) and the Ph.D. (Cambridge).

When, in 1935, the Rockefeller Foundation enabled the Galton Laboratory, University College, London, to establish a special department for the study of blood groups in relation to human genetics, Taylor was ripe to take charge of this work, and he threw himself into it with characteristic zeal and determination. Detailed study of the blood groups and their genetics had received but little attention in Great Britain, and Taylor had first to establish reliable methods and criteria for the *A*, *B*, *O* groups, the *M* and *N* factors and such other blood group factors as had been described elsewhere. To widen his experience he studied for a time in Denmark with Friedenreich, and during 1935–39 he busied himself with the distribution of blood groups in Great Britain and with investigations upon rare human anomalies such as Huntington's chorea and acholuric jaundice.

At the outbreak of war Taylor at once took charge of the Galton Serum Unit established in the Department of Pathology, Cambridge, to provide adequate supplies of reliable grouping serum for war purposes, and it is scarcely too much to say that the swift development of reliable Blood Transfusion Services throughout Great Britain would scarcely have been possible without the help so freely and willingly given to all by Taylor and his staff. As a result of his carefully standardized testing sera, reliable blood grouping results were placed within the reach of all services and hospitals; the volume of serum thus dispensed involved Taylor in a constant struggle to maintain adequate supplies of standard reagents—a work ungrudgingly pursued, the difficulties of which are often inadequately recognized. In spite of so much daily routine, Taylor continued his scientific work and was able to publish a further series of papers on the distribution of blood groups and subgroups in Great Britain based on a very much larger number of tests performed in the Transfusion Services. Taylor was quick to appreciate the scientific importance of the *Rh* factor, and his appeal with Mollison for samples of blood from the mothers of babies with erythroblastosis met with an excellent response which enabled him to pursue this subject so vigorously that within less than two years he and his collaborators had described seven allelomorphs of the *Rh* factor and four different types of anti-*Rh* serum. These results were obtained quite independently of simultaneous studies in America by Wiener, Levine and others, but the work of Taylor and his associates provided a welcome clarification of the confused state of American terminology, and Taylor's name will always be associated with the classification of the allelomorphs of the rhesus factor.

G. L. Taylor was a quiet, unassuming man, always ready to give his time to smoothing away the difficulties of others in what was an abstruse and difficult field. His friendly, helpful personality endeared him to a wide circle of friends, by whom he will be greatly missed. Our sympathy goes out to Mrs. Taylor and her young daughter.

D. F. CAPPELL.

NEWS and VIEWS

Colonial Microbiological Research Institute

THE Colonial Office announces that it has been decided to establish in Trinidad a Colonial Microbiological Research Institute, for the general study of microbiological problems in tropical conditions. The Institute will be under the general supervision of the Colonial Products Research Council, and will be financed from funds provided under the Colonial Development and Welfare Act, 1940. The first director of the Institute will be Dr. A. C. Thaysen, of the Chemical Research Laboratory, Department of Scientific and Industrial Research. He has been responsible there for the fundamental work on which the food yeast factory, now in course of erection in Jamaica, has been planned. Dr. Thaysen is leaving at once from Trinidad to discuss the siting and construction of the Institute's laboratories and connected matters. It is hoped that, when the Institute is under way, it will be possible to afford facilities for postgraduate work by visiting men of science in addition to the work of the staff of the Institute itself (see also p. 564 of this issue).

Scientific Activities in Paris

DURING the past few months, a few men of science in France have been able to visit Great Britain and to take up again the threads of scientific intercourse. Now we are able to welcome the re-appearance of *La Nature*, the well-known popular journal of science and its applications, after three years of suppression. The first issue, dated January 1, 1945, consists of only sixteen pages, and it is shorn of its attractive cover, but it contains well-illustrated articles on penicillin and its manufacture and on the solar corona, and a useful map of French broadcasting stations with data of their wave-lengths, powers, etc. The Editor announces that the journal will be devoted, as before the War, to the popularization of science, its applications, its methods and its significance for human progress. Later issues are equally attractive, the articles being well illustrated and maintaining a nice balance between pure science and its applications. *La Nature* is being published twice a month at 10 francs a copy. Another sign of increasing scientific activity in Paris is a comprehensive programme of public meetings arranged by the French Association of Scientific Workers under the auspices of the Centre National de la Recherche Scientifique, which have been going on since early spring. The meetings have been divided into lectures on laboratory technique, public lectures on current scientific topics and visits to laboratories. The programme, which contains more than a hundred entries, reveals an enthusiasm that augurs well for the resurgence of science in Paris.

Physical Society: Presentation of Duddell Medal

AT a meeting of the Physical Society to be held at the Royal Institution at 4 p.m. on May 23 the Duddell Medal for 1944 will be presented to Dr. F. W. Aston in recognition of his invention and subsequent development of his mass spectrograph. This instrument, first designed and constructed in 1919, made use of a new and ingenious method of electromagnetic focusing and enabled Aston to establish that many elements consist of mixtures of isotopes, as foreshadowed by J. J. Thomson's work on neon. With later modifications of the instrument, Aston investigated most of the known elements and showed that all the stable isotopes, of which he discovered hundreds, had nearly integral masses, taking O as 16. Aston's later work is concerned mainly with the small deviations from this whole-number rule, representing the binding energies of the isotopes in the nucleus. Using a much improved mass spectrograph, he measured masses with a precision of 1 in 20,000 and determined the binding energies in isotopes of the lighter elements with great accuracy. Finally, from the masses and the photometrically determined relative abundances of the isotopes, Aston calculated "chemical atomic weights" for comparison with, and as a check upon, the results of other methods. At the same meeting, Prof. E. N. da C. Andrade will deliver his presidential address, taking as his subject "The History and Future of the Physical Society".

Belgian Delegation in Britain

A SECOND group of Belgian professors, representing the Belgian Fondation Universitaire, is visiting Britain for a fortnight at the invitation of the British Council. For five of them it is their first visit to this country. The delegates are: Prof. Jean Brachet, Faculty of Science, Brussels; Prof. Marcel Homes, Faculty of Science, Brussels; Prof. Henri Koch, Faculty of Comparative Physiological Science, Louvain; M. Marius Lecompte, keeper of the Belgian Royal Museum of Natural History; Prof. Jean Louis, State Agricultural Institute, Gembloux; Prof. Victor Van Straelen, Faculty of Science, Ghent, and Brussels; Dr. Pierre Wigny (law and legal science); Prof. Jean Haesaert, Faculty of Law, Philosophy and Letters, Ghent; Prof. Paul Rousseau, Faculty of Law, Louvain; Prof. Paul de Visscher, Faculty of Law, Louvain. Among the places the delegation will visit are the British Museum, the Imperial College, Kew Gardens and the Bureau of Micrology, University College, London, the London School of Hygiene and Tropical Medicine, the Society for Visiting Scientists, Rothamsted Experimental Station, Oxford and Cambridge.

Advisory Committee on Building Research

The Minister of Works has appointed a scientific advisory committee to advise on and to suggest lines of scientific research; to suggest where this research could best be carried out and to keep it under review; and to advise on the practical possibilities and further development of the results of current research. The committee consists of Prof. J. D. Bernal (physics), Birkbeck College, London (chairman); Dr. E. F. Armstrong, member of Building Research Board; Prof. J. F. Baker (mechanical sciences), University of Cambridge; Prof. P. M. S. Blackett (physics), University of Manchester; Prof. W. E. Curtis (physics), University of Durham; Dr. C. C. Douglas, University of Oxford, chairman, Joint Committee on Heating and Ventilation (Building Research Board and Industrial Health Research Board); Prof. C. D. Ellis (physics), King's College, London; Prof. I. M. Heilbron (organic chemistry), Imperial College of Science and Technology, London, scientific adviser, Ministry of Production; Prof. J. M. Mackintosh (public health), University of London; Mrs. J. V. Robinson, lecturer in economics, University of Cambridge; Sir Ernest Simon, chairman, Advisory Council, Ministry of Fuel and Power; Mr. F. E. Smith, chief superintendent, Armament Design Dept.; Prof. W. N. Thomas (engineering), University College, Cardiff; and Prof. S. Zuckerman (anatomy), Universities of Oxford and Birmingham. Mr. I. G. Evans, director of building research; Lord Amulree, medical officer, Ministry of Health; and Dr. R. S. F. Schilling, secretary, Industrial Health Research Board, are assessors. Sir Reginald Stradling is executive officer.

Release of Requisitioned Land and Premises

THE second report from the Select Committee on National Expenditure for the Session 1944–45 deals with the release of requisitioned land and buildings. It emphasizes the weaknesses in existing land legislation which were stressed during the debate in the House of Commons on the Requisitioned Land and War Works Bill, and shows the need for incorporating in the Bill provisions to amplify the assurances which Sir John Anderson gave to the House of Commons in that debate. An instance cited in the report of an airfield constructed on 600 acres of farm land and 260 acres of common land in the 'green belt', into which the Select Committee inquired, shows that existing legislation fails to protect common land or to provide for its reinstatement. The menace to the countryside which still persists is shown by two further examples: the Admiralty's claim to Bodmin Moor, rich in archæological interest and potentialities for research, and also an important catchment area, for use as a bombing range—since dropped—and the War Office inability to say whether the tract between the Frome River and Studland and Swanage Bays, cleared for training purposes, is to be restored to public use.

On the question of premises, the Select Committee's report indicates that the fundamental need is the same, and its principal recommendation is that a supervisory authority should be entrusted with the task of pressing for the release of requisitioned premises, bearing in mind urgent civilian needs; and a central and independent review of the use of premises and of storage requirements should be instituted and pressed forward with all practicable speed. But while a valuable system of co-ordinating the release of requisitioned land and premises has been devised, the little use that has so far been made of it is not to be attributed entirely to departmental reserve or inaction: it is due at least in part to the absence of decisions at the centre. The report recommends that the Government should not only come to an early decision whether it is more

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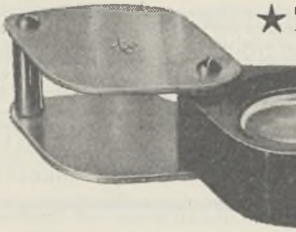

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WINIFRED SHAPLAND,
Secretary and Registrar,
The University, Bristol, 8.

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Secretary.

13 George Square, Edinburgh.

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University of London. The Senate invite applications for the Readership in Anthropology tenable at the London School of Economics and Political Science (salary not less than £750).—Applications must be received not later than first post on July 9, 1945, by the Academic Registrar, University of London, Richmond College, Richmond, Surrey, from whom further particulars should be obtained.

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to the national disadvantage to sterilize space by housing surplus stores or to scrap the stores, but also provide the departments, with the least possible delay, with the directions as to the strength and organization of the defence forces required after the War, which will enable them to determine which properties they will need to acquire and which of those now held they will eventually be able to release. Besides, the Select Committee recommends an independent review by the Government of the practice of departments in the retention of stores, and in this connexion the advice of Government scientific and research organizations should be sought in classifying stores according to their probable future use, having regard to scientific progress. The procedure for declaring stores obsolete also requires speeding up, and surplus stores and scrap arising overseas should, wherever possible, be disposed of without being brought back to Great Britain. Subject to political and strategic considerations, the fullest use should be made of storage facilities overseas for stores required for the war against Japan.

Museums as Contemporary Educational Centres

A memorandum received from Mrs. M. Harrison, acting curator of the Geffrye Museum, London, E.2, deals with the present-day problems of the creative use of leisure in an industrialized society—the education of children of a non-academic turn of mind, and the bridging of the gap that still tends to lie between school and the actualities of life. It is suggested that the solution lies in the establishment of centres specially equipped to show the individual, on a scale within his grasp, his place, meaning and purpose within the contemporary world. These centres could present in an appropriate manner a variety of visual material culled from industrial, commercial and public sources. They could also provide for courses of instruction in art and craft work and in contemporary social studies, educational film shows, facilities for study, and a scheme for loans to schools, with the view of encouraging further the individual's practical interest in, and investigation of, his or her surroundings in relation to the world at large.

Most of the plan is very feasible—indeed, several of the methods advocated have for some time been in successful operation in the 'village colleges' of Cambridgeshire; but it is difficult to accept the suggestion that it would be possible "to show the contemporary world . . . the direction in which the whole world is moving", either for reasons of exhibition space, or of opinion. There is much within it, however, which might well claim the attention of 'centres' already in existence, such as the larger provincial museums. For example, some of these in presenting the geology of their various areas are already 'illustrating' the fundamentals (not mentioned in the plan) inseparable from some industries. Upon such foundations the institutions concerned might profitably build along the lines suggested, and thereby help to refute the accusation (recently made at a meeting of the British Association) that the majority of museums in Great Britain are out of touch with modern life.

Burrell Art Collection for Glasgow

The Corporation of the City of Glasgow reports this important acquisition in its Art Gallery and Museums Report for the year 1943–44. Sir William Burrell's collection, which consists of pictures, tapestries, stained glass, furniture, carpets, porcelain, ivories, enamels and silver, has long been associated with his name. It is probably most widely known for its tapestries, which include many of international importance. While presenting this valuable material for the cultural benefit of Glasgow, the donor has at the same time made provision for the purchase of additional works of art (more especially for those of the Gothic period), and for a special building to house it. This building will eventually be erected in the country not less than sixteen miles from the city.

Cancer Control in Peru

The August issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an interesting article on this subject by Dr. Julio Bedoya Paredes, of the National Institute of Radiology of Peru, who states that since this Institute was founded two years ago a record has been kept of cases according to the site of the cancer, classification, treatment and results. The Institute includes a reception service, specialized clinics, such as gynæcology, surgery and internal medicine, X-ray, basal metabolism, laboratory and histopathology sections, statistical, health education and preventive sections. It is intended to create a biopsy service through which specimens may be sent by air to the Institute for diagnosis.

Announcements

Dr. J. F. J. Dipping, head of the Chemistry Department at the Mining and Technical College, Wigan, has been appointed head of the Science Department at the South-East Essex Technical College, Dagenham.

To encourage the reading of papers by student members of the Institute of Fuel, also those taking courses at universities and technical colleges, the Council has decided to make an annual award of a medal together with a prize consisting of books and instruments to the value of £5. Particulars can be obtained from the Secretary, Institute of Fuel, 30 Bramham Gardens, London, S.W.5.

At the anniversary meeting of the Royal Institution held on May 1, the following officers were elected: *President*, Lord Rayleigh; *Treasurer*, Sir Robert Robertson; *Secretary*, Dr. A. O. Rankine; *Managers*, Prof. E. N. da C. Andrade, Dr. F. H. Carr, Sir Charles Darwin, Prof. Herbert Dingle, Dr. P. Dunsheath, Viscount Falmouth, Prof. G. I. Finch, Prof. C. L. Fortescue, Captain H. L. Hitchins, Mr. James Kewley, Mr. Arthur Marshall, Prof. H. R. Robinson, Dr. G. Shearer, Mr. H. S. Souttar, Sir George Thomson; *Visitors*, Brigadier R. A. Bagnold, Mr. J. G. Bennett, Mr. M. G. Bennett, Major W. H. Cadman, Dr. W. H. J. Childs, Mr. F. P. Dunn, Mr. Kenneth Gray, Dr. Wilfred Hall, Mr. James Henshilwood, Dr. W. Jevons, Mr. L. B. W. Jolley, Mr. G. S. W. Marlow, Prof. L. C. Martin, Mr. E. Kelly Maxwell, Prof. H. J. Plenderleith.

A course of six lectures on "The Problem of Freedom in a Planned Society" to be delivered on Wednesdays, beginning May 16, at 7.30 p.m., at Victory House Hall (N.S.P.C.C.), Leicester Square, London, W.C.2, has been arranged by the Progressive League. The speakers include Prof. H. Levy, Major Adrian Stephen, Prof. M. Polanyi, Prof. F. A. Hayek, Dr. C. A. Smith, and Prof. D. Mitrany. Tickets, 6*s*. for the course, 1*s*. 6*d*. for single lectures, can be obtained from the secretary of the Progressive League, 20 Buckingham Street, London, W.C.2, or at the door.

LETTERS TO THE EDITORS

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

Extra X-Ray Reflexions from Diamonds

Dr. R. S. Krishnan and Mr. G. N. Ramachandran have stated[1] that they are not able to confirm my observations on type II diamonds, and they conclude that "The objections which Mrs. Lonsdale has raised against the interpretation of the X-ray reflexions observed with diamond given by the Bangalore workers are thus believed to be without experimental foundation".

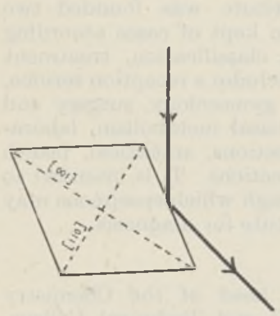

(a) (b)

Fig. 1.

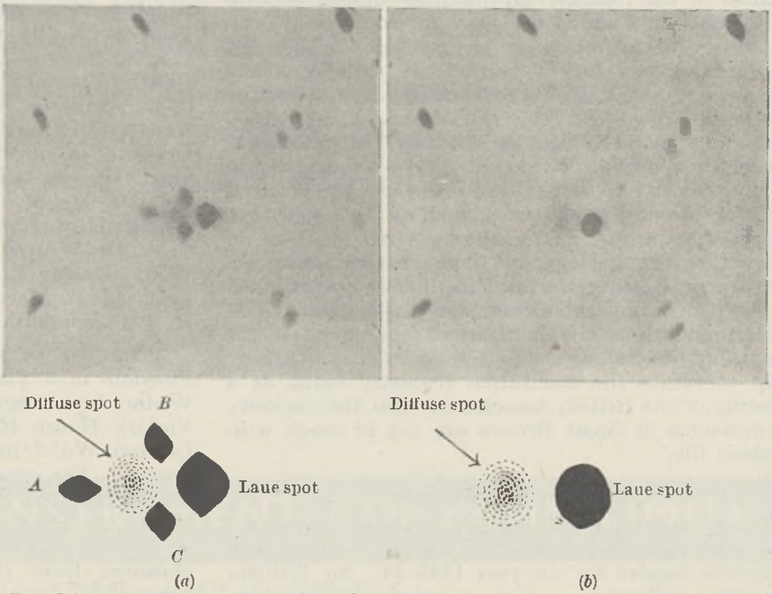
Two years ago, however, Sir C. V. Raman, after stating his theory, continued: "The appearance of the quantum X-reflections with one kind of diamond and their non-appearance in the other kind then follows as an immediate consequence. In other words, this difference in X-ray behaviour of the two kinds of diamond is actually a proof . . ."[2]. I am afraid that the Bangalore workers cannot have it both ways. If the difference in the two types of diamond is an immediate consequence of Raman's theory, then Krishnan and Ramachandran's denial that any such difference really exists does not support the theory, but contradicts it.

I am not concerned, however, with proving or refuting a theory; at this stage, facts are more important. As I understand their letter, Krishnan and Ramachandran have found a group of three extra spots for type I diamonds, whereas for type II diamonds they have found only one extra spot. This spot is rather diffuse; but coincides in position with the strongest of the three type I spots. They conclude that it is, in fact, the same spot. These data show that the diamond orientation used in their experiments was as shown in Fig. 1(*a*), the $[1\bar{1}0]$ axis being vertical (normal to the plane of the diagram) and the angle of incidence near the Bragg angle. I fully agree that in this orientation, the positions of the sharp spot found only for type I and of the diffuse spot found for all diamonds are nearly identical (see p. 317, paragraph (6) and Plates 35*f*, 38*d*,*e*, 39*d* of my paper[3]). In type I diamonds the diffuse spot forms a background to the sharp spot; in type II diamonds it exists alone; but without the evidence of the accompanying streaks or streaky spots, it is certainly difficult to distinguish the two effects.

If the diamond is turned through 180° about the normal to the (111) reflecting plane, however, so that its orientation is as shown in Fig. 1(*b*), no such possibility of confusion arises. The X-ray effects found in this orientation are as shown in the photographs and explanatory diagrams (Figs. 2 *a* and 2 *b*).

In this orientation the diffuse spot found for type II diamonds is clearly *not* equivalent to any of the three extra type I diamond spots *A*, *B* or *C*. It differs from them in intensity, shape, diffuseness, behaviour with change of temperature and of crystal mis-setting from the exact Bragg angle. It becomes larger and much more diffuse as the mis-setting increases, whereas the three type I spots *A*, *B*, *C* become slightly smaller and remain sharp. It is also temperature-sensitive, and they are much less so. This diffuse spot found for type II diamonds corresponds in all respects with the diffuse spot found at the centre of the *A*, *B*, *C* group for type I diamonds in orientation (*b*), except that it is more intense, because type II diamonds are inherently better reflectors. I have taken more than six hundred Laue photographs of various diamonds and have confirmed these observations again and again. The similarity between the diffuse (thermal) spots in the two types of diamond and the entire absence in type II of the sharp extra spots characteristic of type I photographs has been proved not only for the {111} reflexions but also for {220} {113} reflexions in various orientations.

Krishnan and Ramachandran say that their type II diamond diffuse spot was very little temperature-sensitive. I offer the following explanation. Type II diamonds are not only mosaic, but also they often show definite distortion, such as slight spiralling of



(*a*) Type I diamond: orientation as in Fig. 1 *b*. (*b*) Type II diamond: orientation as in Fig. 1*b*.

Fig. 2.

the crystallites[4]. The result of this distortion is that although the real diffuse spot does vary with temperature, it is sometimes partially overlaid by a sharper and more intense distortion spot which does *not* vary with temperature. Using a large crystal and big X-ray beam, as Krishnan and Ramachandran appear to have done, it is easy (in orientation Fig. 1 *a*) to confuse this sharp distortion spot with the sharp spot found for the near-perfect type I diamonds. They occur in the same place. In orientation (*b*) this confusion is quite impossible, especially if a really fine X-ray beam is used, so as to obtain maximum resolution. I suggest that Dr. Krishnan and Mr. Ramachandran should turn their diamonds through 180° about the normal to the reflecting (111) plane and test orientation (*b*) using a ½-mm. diameter cylindrical collimator, and that they should look for the {220} and {113} effects in the two types of diamond and compare these also. I think that this controversy about a question of experimental fact would then cease.

Kathleen Lonsdale.

Royal Institution,
Albemarle Street,
London, W.1.
March 9.

[1] Krishnan, R. S., and Ramachandran, G. N. *Nature*, 155, 234 (1945).
[2] Raman, C. V., *Curr. Sci.*, 12, 40 (1943).
[3] *Proc. Roy. Soc.*, A, 179 (1942).
[4] Lonsdale, K., *Mineral. Mag.* (in preparation).

Frictional Properties of Wool Fibres

The friction apparatus devised by Bowden and Leben[1] to examine the friction of metals has been used to study the frictional properties of wool fibres. Some accessories were made to adapt the apparatus to the application of loads of 0·05–1 gm. and the measurement of small frictional forces, but in essentials it remains the same as described by the above authors. The modifications enabled a single fibre mounted in a bow to be carried forward with a speed of 0·01 cm. sec.$^{-1}$ while pressed against a cylindrical piece of ram's horn with the required load. The horn was mounted on a strip of clock spring, the deflexion of which, recorded photographically by a moving-film camera, was a measure of the frictional force.

'Stick-slip' phenomena similar to those previously obtained[1] were recorded. The with-scale and anti-scale directions along the fibre were readily distinguished by the magnitude of the frictional force and the character of the stick-slips (see graphs *a* and *b*). The effect of wetting the fibre could be studied easily. Particular attention was paid to the variation in the two coefficients of friction (μ_1 and μ_2) with the *p*H of the wetting fluid, and to the effect of treating the fibre with shrinkage-reduction processes.

Typical values for the coefficients (horn-wool) obtained under several conditions are given in the accompanying table.

Speakman and Stott[2] have used the quantity $\frac{\mu_2 - \mu_1}{\mu_1}$ to give a measure of the tendency of individual fibres to undergo unidirectional migration which is recognized as the cause of wool felting and garment shrinkage. In view of the considerable difference between μ_2 and μ_1, a directional coefficient defined by $\frac{\mu_2 - \mu_1}{\mu_2 + \mu_1}$ is preferred here. The directional

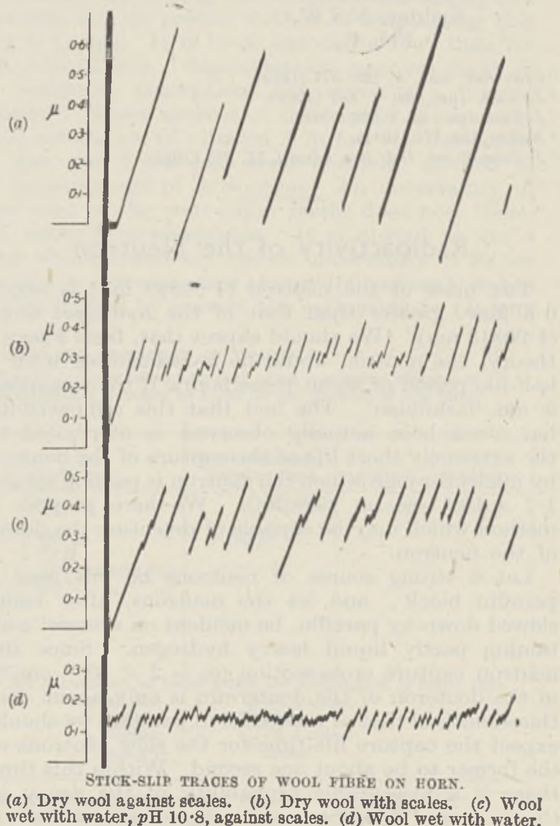
Typical values for coefficient of friction (wool on horn). Load, 0·20 gm. μ_1 with-scale coefficient; μ_2 anti-scale coefficient.

No.	Sample	Conditions	μ_2	μ_1	Directional coefficient
1	Normal coarse merino	air dry	0·5	0·3	0·2
		wet *p*H 4	0·6	0·3	$0{\cdot}3_5$
		,, *p*H 10·8	0·6	0·2	$0{\cdot}4_5$
		,, *p*H 1·3	0·7	0·3	0·4
2	*Chlorine treated wool	wet *p*H 4	0·1	0·1	0·0
		,, *p*H 10·8	$0{\cdot}0_2$	$0{\cdot}0_2$	0·0
		,, *p*H 1·3	0·1	0·1	0·0
3	*Bromine treated wool	wet *p*H 4	$0{\cdot}2_5$	0·2	0·1
		,, *p*H 10·8	$0{\cdot}0_5$	$0{\cdot}0_5$	0·0
		,, *p*H 1·3	$0{\cdot}1_5$	$0{\cdot}1_5$	0·0
4	*Alcoholic caustic potash treated wool	wet *p*H 4	0·6	0·4	$0{\cdot}1_5$
		,, *p*H 10·8	0·5	$0{\cdot}3_5$	$0{\cdot}1_5$
5	*Sulphuryl chloride treated wool	wet *p*H 4	0·7	$0{\cdot}6_5$	$0{\cdot}0_5$
		,, *p*H 10·8	$0{\cdot}4_5$	0·4	$0{\cdot}0_5$
		,, *p*H 1·3	0·9	0·8	$0{\cdot}0_5$

* Treatments commonly used to reduce the shrinkage of woollen goods.

coefficient is increased by wetting the fibre, and the increase is greater in acid and alkaline than in neutral media (see Table, No. 1). The rate of felting is also greater both in acid and alkaline solutions than in neutral. Speakman, Stott and Chang[3] have attributed this to the increased extensibility of the fibres in such solutions, but it is probable from these results that the increased directional friction also contributes.

As can be seen from the table, Nos. 2–5, shrinkage-reduction processes reduce the directional friction in alkaline solutions. This would cause a reduced rate of felting and would account for their effect in



Stick-slip traces of wool fibre on horn.
(*a*) Dry wool against scales. (*b*) Dry wool with scales. (*c*) Wool wet with water, *p*H 10·8, against scales. (*d*) Wool wet with water, *p*H 10·8, with scales.

reducing the shrinkage of woollen goods. 'Wet' chlorine and bromine treatments reduce the directional friction in alkaline media by decreasing both μ_1 and μ_2 to low values. Sulphuryl chloride treatment makes μ_2 approach μ_1 without greatly reducing the average friction. Alcoholic potash treatment increases both μ_1 and μ_2 in alkaline solution to approximately the same value.

In these preliminary experiments, horn was chosen as the second rubbing surface because it is chemically similar to wool and is more convenient to handle. A few experiments with wool fibre against wool fibre gave essentially the same results. Further work on this problem is continuing.

The above was written before I had an opportunity of seeing the recent communication by Whewell, Rigelhaupt and Selim[4]. These authors, using an 'angle of slip' method of measuring friction, have demonstrated changes in directional friction or scaliness. Our conclusions are in agreement, except that they find a decreased directional friction in alkaline solutions. This may be due to the fact that their determination was made at pH 9·24. I have previously reported that under some conditions a minimum rate of felting occurs at this pH with an increased rate at higher pH's[5].

My thanks are due to Drs. F. P. Bowden and D. Tabor for permission to use the facilities of the Lubricants and Bearings Section of the Council for Scientific and Industrial Research, and to Dr. Tabor for help in discussion.

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Radioactivity of the Neutron

THE mass of the neutron (1·00893 mμ) is about 0·8 Mev. greater than that of the hydrogen atom (1·00813 mμ). We should expect that, from Fermi's theory, the neutron would be β^--radioactive with a half-life period of about three hours, if the transition is not 'forbidden'. The fact that this radioactivity has never been actually observed is attributed to the extremely short life of the capture of the neutron by nuclei through which the neutron is passing (about $1 \cdot 7 \times 10^{-4}$ sec. in paraffin). We here propose a method which may be capable of detecting the decay of the neutron.

Let a strong source of neutrons be put near a paraffin block; and let the neutrons, after being slowed down by paraffin, be incident on a vessel containing partly liquid heavy hydrogen. Since the neutron capture cross-section ($\sigma_c = 2 \times 10^{-28}$ cm.^{2})[1] in the deuteron of the deuterium is only about one-thousandth of that of the nuclei in paraffin, we should expect the capture life-time for the slow neutrons of the former to be about one second. Within this time there is a measurable probability of the decay of the neutron. Thus the vessel containing liquid heavy hydrogen, being exposed to slow neutrons for a certain time, must also contain hydrogen as the decay product of neutrons. The presence of these hydrogen atoms may be detected spectroscopically.

It may also be mentioned that the use of liquid helium instead of liquid heavy hydrogen would probably give better results, because the value of σ_c for neutrons in helium is probably smaller than in deuteron, although there is no experimental evidence for this up to the present.

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A Simple Calculation of the Perihelion of Mercury from the Principle of Equivalence

IT is known that first-order phenomena described in the general theory of relativity can be deduced from the principle of equivalence. The present note serves as an illustration.

The principle of equivalence demands that the length along the field direction be deviated, to the first order of approximation, in the ratio: dr : $(1 + \lambda/r)dr$, where λ is GM/C^2; and that the time, dt, be modified into the expression $(1 + \lambda/r)^{-1}dt$. But the length normal to the field direction undergoes no change.

Hence the kinetic energy is expressible in the form $\frac{1}{2}(\beta^4\dot{r}^2 + \beta^2\dot{\theta}^2r^2)$ and the Lagrangian is accordingly $\frac{1}{2}(\beta^4\dot{r}^2 + \beta^2\dot{\theta}^2r^2) - V(r)$; where $V(r) = - GM/r$, $\beta = (1 + \lambda/r)$.

Now the equation of motion of a test body is

$$\frac{d}{dt}(\beta^4\dot{r}) - \beta^2 r\dot{\theta}^2 - 2\dot{r}^2\frac{\partial\beta}{\partial r} - r^2\dot{\theta}^2\frac{\partial\beta}{\partial r} + \frac{\partial V}{\partial r} = 0, \quad . \quad . \quad (1)$$

$$\beta^2 r^2\dot{\theta} = h \ (= \text{const.}), \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where β denotes $(1 + \lambda/r)$.
Retaining only the first order of λ, we have from (1) and (2):

$$-\frac{h^2}{r^2\beta^2}\frac{d}{d\theta}\beta^2\frac{d\mu}{d\theta} - \frac{h^2}{\beta^2 r^2}\mu = -GM\mu^2 - h^2\mu^4\lambda + 2\dot{r}\frac{\partial\beta}{\partial r},$$

$$\text{or } \frac{d}{d\theta}\beta^2\frac{d\mu}{d\theta} + \mu = \frac{GM}{h^2}\beta^2 + \lambda\mu^2 - 2\frac{r^2\dot{r}^2}{h^2}\frac{\partial\beta}{\partial r}.$$

$$\text{But } \frac{d}{d\theta}\beta^2\frac{d\mu}{d\theta} = \beta^2\frac{d^2\mu}{d\theta^2} - 2\frac{r^2\dot{r}^2}{h^2}\frac{d\beta}{dr};$$

$$\text{hence } \frac{d^2\mu}{d\theta^2} + \beta^{-2}\mu = \frac{GM}{h^2} + \lambda\mu^2,$$

$$\text{or} \qquad \frac{d^2\mu}{d\theta^2} + \mu = \frac{GM}{h^2} + 3\lambda\mu^2.$$

This is the same equation as that obtained from Schwarzschild's solution and the geodesic equation of a test body.

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Spectrophotometric Determination of Vitamin A in Fish Oils

THE purpose of this note is to show that when the vitamin A content of a fish oil has been determined spectroscopically, the result should be expressed in mgm. vitamin A per gm. of oil. $E^{1\text{ per cent}}_{1\text{ cm.}}$ 328 mμ should also be stated. In this laboratory we have had experience of the confusion that is rife in commercial transactions and investigational surveys when the results of the spectroscopic estimation of vitamin A in fish oils are expressed in I.U./gm., and we seek the co-operation of chemists in the removal of this source of confusion. $E^{1\text{ per cent}}_{1\text{ cm.}}$ 328 mμ (hereinafter referred to for short as the extinction E) is a physical property of an oil which can be measured to an accuracy of 2 per cent on a suitable ultra-violet spectrophotometer. For the estimation of vitamin A the extinction is taken as proportional to the concentration of vitamin A. The use of the extinction to express vitamin A content has the advantage of an unequivocal meaning for the chemist, but does not convey to dealers or consumers a clear indication of the concentration of vitamin A in the oil.

A 'conversion factor' by which the extinction is multiplied to give the vitamin A content in I.U./gm. has been used in an attempt to overcome this difficulty. The attempt has failed because research workers and industrial laboratories in different countries use widely different 'conversion factors' lying within the range of 1400 to 3000. Thus the British Pharmacopœia uses the factor 1600; Morton[1] states "In the U.S.A. the 'conversion factor' of 2150 is commonly used". Baxter and Robeson[2] find values between 2350 and 3160 depending on the conditions; and a recent determination by the Advisory Committee to the British Pharmacopœia reported by Hume[3] gives the value 1740 as the best value for the 'conversion factor'. The reasons for this unfortunate situation are discussed by Morton[1] and Hume[3]. The result is that the vitamin A content of oils from different sources cannot be deduced from the potency in I.U. gm. stated on the labels of the containers—a situation which causes mistakes and admits of misrepresentation in commercial dealings.

A solution to the problem of clearly stating the vitamin A content is obtained if the extinction is multiplied by a factor to give the result in mgm. vitamin A per gm. of oil. Such a factor is known to an accuracy of ± 3 per cent, which is within the error normally expected in the spectroscopic assay of fish oils. The factor required to convert E oil to mgm. vitamin A per gm. oil is $\frac{1000}{E_{\text{pure vit. A}}}$.

Measurements of $E_{\text{pure vit. A}}$ which have been recorded in the literature since 1933 are noted in Table 1.

TABLE 1. EXTINCTION (AT THE MAX. NEAR 328 Mμ) OF VITAMIN A ALCOHOL IN ETHYL ALCOHOL.

Date	$E^{1\text{ cm.}}_{1\text{ per cent}}$	Notes on sample	Ref.
1933	1600	Non-crystalline concentrate prepared by molecular distillation	4
1933	1700	Non-crystalline concentrate prepared by molecular distillation	5
1934	1600	Non-crystalline concentrate prepared by molecular distillation	6
1937	2100 falling to 1800 on standing	Crystalline, containing methyl alcohol of crystallization	7
1939	1800	Crystalline	8 9
1942	1750 ± 21	Nine samples of crystals	2
	1780	One sample, checked photoelectrically by Zscheile, F.P. (3 determinations)	2

Recent values for E of pure vitamin A alcohol in ethyl alcohol are covered by the figure 1780 ± 50. This figure should be used for the estimation of non-saponifiable extracts. In fish oils, vitamin A is present as an ester. From Table 2, which lists the effect of esterification and solvent, a reduction to 1750 ± 50 is indicated. This figure should be used when the estimation is performed without prior saponification of the oil.

The chief error in the spectroscopic assay is the presence of irrelevant absorption at 328 mμ. Some estimate of the extent of irrelevant absorption may be obtained by noting the shape of the absorption spectrum, but no precise method of eliminating this error is known. It is more serious for low- than for high-potency oils. Saponification removes most of the irrelevant absorption, but involves a loss of vitamin[11]. These sources of error make the spectroscopic estimation of vitamin A in fish oils less accurate than the 2 per cent error normally allowed in the measurement of extinction. An uncertainty of 3 per cent in the conversion factor does not, therefore, make it unacceptable. It is absurd to use a factor which commonly has an uncertainty of 30 per cent and in extreme cases almost 100 per cent, as has the factor used to convert the extinction to I.U./gm.

TABLE 2. EFFECT OF SOLVENT AND ESTERIFICATION OF THE EXTINCTION OF VITAMIN A.

In the following table is given the ratio of the extinction of the ester in a given solvent to that of an equivalent amount of vitamin A alcohol in ethyl alcohol. The extinction of vitamin A alcohol in alcohol is taken as 1,780 for the purpose of this table. Irrelevant absorption has been subtracted where necessary.

Solvent	Vit. A alcohol	Non-sap. content	Palmitate	Fish oils	β-naphthoate	Anthraquinone 2-carboxylate	Acetate	Succinate
Alcohol	1·00	1·00 *S*	0·97 *B*	0·97	0·92 *B*		0·97 *B*	0·80 *B*
*Iso*propyl alcohol	0·98 *Z*				0·995 *M*	0·995 *M*		
Cyclohexane	0·93 *Z*	0·97 *S*		0·98 *S*	1·00 *H*			
	0·88 *B*	0·89 *A*			1·09 *H* (+ 10% arachis oil)			
					0·95 *H* (+ 100% „ „)			
Hexane	0·98 *Z*	0·97 *S*	0·94 *Z*(?)*					
Iso-octane	0·96 *Z*		0·98 *Z*(?)*					
Ether	1·03 *Z*	1·07 *S*	1·00 *Z*(?)*	1·09 *S*				
Chloroform	0·83 *G*	0·86 *S*		0·90 *S*				
		0·71 *B*						
Methyl alcohol		1·03 *Z*						
Ethyl formate		0·96 *Z*						
Benzene		0·83 *G*						
Petrol ether		0·91 *G*						
		0·99 *B*						

* For the calculation of these ratios the assumption is made that

$$\frac{E^{\text{Palmitate}}_{\text{Ether}}}{E^{\text{Palmitate}}_{\text{Alcohol}}} = \frac{E^{\text{Vit. A alcohol}}_{\text{Ether}}}{E^{\text{Vit. A alcohol}}_{\text{Alcohol}}}$$

These ratios are deduced from the following authors: *A*, Adamson and Evers[10]; *B*, Baxter and Robeson[2]; *G*, Gillam and El Ridi[11]; *H*, Hume[3]; *M*, Mead, Underhill and Coward[8]; *S*, Smith[12]; *Z*, Zscheile and Henry[13].

We, therefore, urge that this practice be discontinued, and that results of the spectroscopic estimation of vitamin A in fish oils be expressed in mgm. vitamin A per gm. of oil. For the convenience of analysts, and as an indication of the basis of the estimation, $E_{1\,\text{cm.}}^{1\,\text{per cent}}$ 328 mμ should also be stated.

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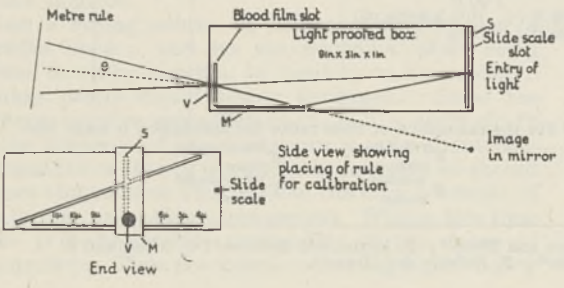
Apparatus for Measuring Mean Cell-Diameters in Blood Film

A VARIANT on the halometer for the measurement of mean cell-diameters in blood films was constructed recently in a laboratory in the Middle East. As it is easy to construct, very portable and independent of darkened room and electric battery, it may be of some interest.

The feature which makes the adjustment simple and sturdy but precise is a sliding scale which carries a diagonal slit across a slit cut in the end of a light-proofed box. Thus light can only enter the box where the two slits intersect, and as the slide-scale is moved across the slit in the end of the box, this point of entry is seen to move along the end of the box at a speed governed by the angle of the diagonal slit in the slide-scale. At a suitable angle the adjustment can be made as fine as is desired. The use of a mirror inside the box provides a companion to this point of light in the box, moving in the opposite direction. The pair gives the two required diffraction patterns the proper juxtaposition of which gives the measurement reading on the scale.

The apparatus consists of a light-proofed box (9 in. × 3 in. × 1 in., a common size of tin here was found to be very convenient); a microscope slide (when blackened on one side to obviate double reflexion this makes an excellent mirror); a rectangular sliding piece as wide as the box (made to fit in or on the lid of the box when not in use; its sides should not wear too easily).



A slit *S* is made along most of the length of one end of the box. In the top and bottom just behind this end, slots were cut to fit the slide-scale piece, so that when this is in position it completely prevents light from entering the box through the slit. A smooth microscope slide *M* was painted black on one side and fitted to the narrow side of the box, reaching to within ¼ in. of the other end. In this end near the mirror a round viewing-hole *V* 6 mm. across with the nearest edge 2 mm. above the plane of the mirror was cut. Slots suitable to take the blood films were made in the top and bottom just behind the viewing-hole. The slot in the slide-piece was cut at a small angle to the length of the rectangle, but sufficient to give a range of movement to the point of entry of the light from 2 cm. to 7 cm. above the plane of the mirror. It is convenient to make the length of this piece such as to fit in or on to the lid of the instrument. A curved spring strip to steady the slide in its slots may be considered necessary to eliminate variations in the readings. These measurements gave a range of reading from 5 to 11 microns. The inside of the box was blackened to exclude stray reflexions with their extra haloes.

Calibration can be done in many ways. The principle of the halometer relates the angle 2θ of separation of the two diffraction patterns to the predominant cell-diameter *M* according to the relation

$$\sin\theta = Nl/M, \qquad (1)$$

where l is wave-length of ring used (usually 0·655 microns, in the middle of the red), N is order of ring from centre of system (usually 2).

It is required to mark the positions of the slide-scale where the measurement of this angle corresponds to various suitable values of *M*. It is convenient to make the marks where the scale enters the box, on the viewing-hole side of it. In this manner it is possible to observe the diffraction patterns with one eye while watching the reading with the other.

A suitable method of measuring the required angles accurately is to place the instrument on a table in a dark room with the slide-scale projected over the end of the table and the slit illuminated with a bright diffuse light, for example, a 'pearl' bulb. The instrument should always be used with a diffuse source of light such as a lighted wall, daylight or 'pearl' bulb, as the light entering the box has to illuminate the viewing-hole directly and via the mirror simultaneously. With the instrument in the above position, a pin is placed vertically in the slot intended for the blood films centrally to the viewing-hole. Two shadows of the pin are now outlined in the viewing-hole, and can be received on a screen, or better still a metre rule, which should be placed at right angles to the line from the pin to the mid-point between the two shadows. As the angle between the rays striking the pin is the same as the angle between the shadows thrown by them, this angle of separation between the two lights at the pin can be measured. In fact, the ratio between half the distance between the shadows on the rule and the distance from the rule to the pin is the tangent of the angle θ the sine of which is given in equation (1). Putting in the usual figures, we may then write:

$$\text{Half distance between shadows} = \text{distance of rule from pin} \times \tan \sin^{-1} 1{\cdot}31/M.$$

A table according to these figures is appended. The first column gives the reading for the predominant cell-diameter and the second gives the proper separation of the shadows on a rule at 100 cm. from the pin.

Cell-diameter (microns)	Distance between shadows at 100 cm.	Cell-diameter (microns)	Distance between shadows at 100 cm.
4	69·4 cm.	8½	31·0 cm.
4½	62·5 „	9	29·3 „
5	54·3 „	9½	27·9 „
5½	49·0 „	10	26·4 „
6	44·7 „	10½	25·2 „
6½	40·9 „	11	24·0 „
7	38·1 „	11½	22·9 „
7½	34·9 „	12	22·0 „
8	33·2 „		

The technique is insert a suitable blood film and, pointing the instrument at a diffuse source of light, to adjust the separation of the coloured rings until the second red rings in each system touch, and then to read off on the scale. It is important that the film be well covered to give a bright spectrum, but there should not be much overlap as the reading represents the predominant diameter of object on the slide (not the arithmetic mean). Two or three films should be examined as a check, approaching the end point from each side in each case. The degree of anisocytosis is represented by the spread of the component spectra, that is, of the spread between the outer red of the smaller cells and the inner violet of the larger cells. In rare cases of anæmia with high degree of anisocytosis the method is completely vitiated by blurring.

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Sorption of Fumigants

Work recently published by Lubatti[1] and by Winteringham[2] and experiments still in progress in the Imperial College seem to give some insight into the mechanism of the sorption of organic vapours, used as fumigants, on wheat.

Fumigants are sorbed by wheat very slowly. Three main factors are involved, (*a*) permeability of the seed coats, (*b*) diffusion and sorption in the endosperm, (*c*) chemical reactions which may take place in the tissues of the grains. The seed coats form a continuous envelope relatively impervious to gases, and they appear to be the main factor controlling sorption. In wheat which has been deprived by abrasion of the seed coats, sorption appears to be of the same order as that in ground wheat.

The investigations of Barrer and Rideal[3] and those of Wicke[4] have established that in certain sorbents the rate of sorption is governed by the laws of diffusion. This is true in wheat with vapours which do not undergo a chemical decomposition or are only slightly reactive. Examples of such vapours are those of ethylene dichloride and hydrogen cyanide. Equilibrium with these is substantially reached in 15–20 days, and the experimental curves follow closely those calculated from Fick's law.

The forces which retain ethylene dichloride and hydrogen cyanide in wheat are predominantly physical (van der Waals). Accordingly, sorption decreases with increase in temperature. It has also been found that the amount of fumigant sorbed is approximately the same at any time-concentration product, whether the concentration is kept constant or allowed to fall, provided that the average concentrations are the same.

Other vapours, such as those of ethylene oxide, react with the constituents of the wheat grains. The reaction does not usually take place with one specific chemical compound. Many constituents of the tissues take part in the process, in which enzymic action may also assist. The rate of decomposition of the fumigant in the course of these reactions is apparently unimolecular. This may be due to the slowest process being diffusion through the tissues of the grain. The analogy between diffusion through polymers and unimolecular reactions has been pointed out by Barrer[5]. When sorption of the vapour is accompanied by chemical reaction, equilibrium is not approached even after several days. The curve representing the rate of sorption results from the superposition of two or more curves. With ethylene oxide there is a definite curvature towards the time axis during the first twenty-four hours, while physical forces are predominant; but later the curves straighten out and rise rapidly with time as the chemical action proceeds. It is during this period that the rate of diffusion through the tissues is probably the limiting factor. It would appear that these complex changes cannot be represented by mathematical expressions which would apply to more than one system.

With chemically active vapours, sorption increases with an increase in temperature. The time-sorption curve, calculated from experiments carried out with falling concentration, gives lower values than those obtained in experiments performed at an equivalent even concentration. Benton's work[6] has shown that the velocity of chemical reactions at constant volume is not the same as that occurring in flow systems.

The sorption isotherms at a steady concentration, within the range of concentrations examined, appear to be rectilinear. As equilibrium is not rapidly reached, the so-called isotherms must be represented by a family of rectilinear curves arranged fanwise, the slope of the curves increasing with time. There appears to be a striking analogy between sorption by wheat and permeation through membranes. The work of Daynes[7], Barrer[5] and others has shown that the rate of activated diffusion of gases through membranes of organic polymers is linearly related to the difference of pressure established between the surfaces of the membrane.

An increase of the moisture contents of wheat brings about an increase of sorption with all the fumigants studied. This also may be connected with changes of permeability and structural rearrangements in the tissues of the wheat grain. Moisture content is a factor as important as time, concentration of vapour or temperature. A clearer view of the sorption of vapours by wheat is obtained when the 'isohygrotherms' are represented by tridimensional graphs showing the amount of vapour taken up against the changes of concentration and time.

A fuller account of the experiments referred to in this letter and the conclusions which can be drawn from them will be published elsewhere.

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Effects of Sodium Thiocyanate on the Development of Amphibia

IN previous work it has been shown that the notochord of embryos of *Rana esculenta* L., which from the late blastula stage onwards have been kept in solutions of 0·5–1 per cent sodium thiocyanate for 12–48 hr., appear hyperdeveloped in comparison with the controls[1]. The same effect can be observed in embryos of the axolotl of *Amblystoma tigrinum* Green (= *A. mexicanum* Cope) and likewise in lampreys (*Petromyzon* [= *Lampetra*] *planeri* Bl.). A similar effect occurs under the influence of sodium iodide, vital dyes (pyocyanin, methylene-blue) and paranitrophenol[2]. Some details of the alterations in development produced by sodium thiocyanate are given below.

The hyperdevelopment of the notochord characteristic of the influence of sodium thiocyanate becomes evident through enlargement of the area of cross-section of the notochord. Often, especially when the experimental larvæ are shorter than the controls, the notochord folds up. In these larvæ the notochord is longer than the body. From a comparative estimate of the volume of the notochord one finds, for example, in a larva of *Rana esculenta* (Fig. 2) originating from a blastula kept in 0·5 per cent solution of $NaSCN.2H_2O$ for 48 hr., a volume of $86 \times 10^6 \mu^3$ as against $48 \cdot 5 \times 10^6 \mu^3$ in the control (Fig. 1). This increase in volume is due to an increase in the number of cells already present in the rudiment of the notochord. In fact, as soon as the notochord is well defined, we have counted 1,561 cell-nuclei in the notochord of an embryo kept for 24 hr. in 0·5 per cent solution of sodium thiocyanate as against 1,090 in the control. When treated after neurulation, but before the tail-bud stage, one obtains larvæ with a notochord which is enlarged in the tail, but normal in the trunk.

Parallel to the increase in the dimensions of the notochord are phenomena of hyperevocation. In several embryos a large mass of cells is formed which occupies the roof of the encephalic vesicles from the posterior part of the middle-brain to the hind-brain. This mass in some cases reaches the spinal cord. The cells of this mass in part degenerate; the rest form a ganglion lying in the median line in the roof of the fourth ventricle. The cross-section of the mylencephalon of these embryos is larger, and the lumen of the fourth ventricle may be obliterated by the growth of this ganglion.

All these alterations seem to be the reverse of those produced by the action of lithium chloride, which causes an inhibition of the development of the notochord and of the prechordal plate and thus a hypo-evocation, namely, cyclopia[3]. Experiments were made in order to determine what kind of substances are capable of producing cyclopia in embryos of the frog and axolotl. These were found to be substances which precipitate proteins. The stronger they are in Hofmeister's series, the more readily do they produce cyclopia[4]. Sodium thiocyanate and sodium iodide, which produce monsters with hyperdeveloped notochords and hyperevocation, inhibit protein precipitation. Sodium thiocyanate, which has the greater effect, is the more inhibitory according to Hofmeister's series. The vital dyes and paranitrophenol, which cause an increase in respiration, have the same action as the inhibitory substances. This shows itself in various phenomena of embryonic development. One can obtain 'animalization' of the

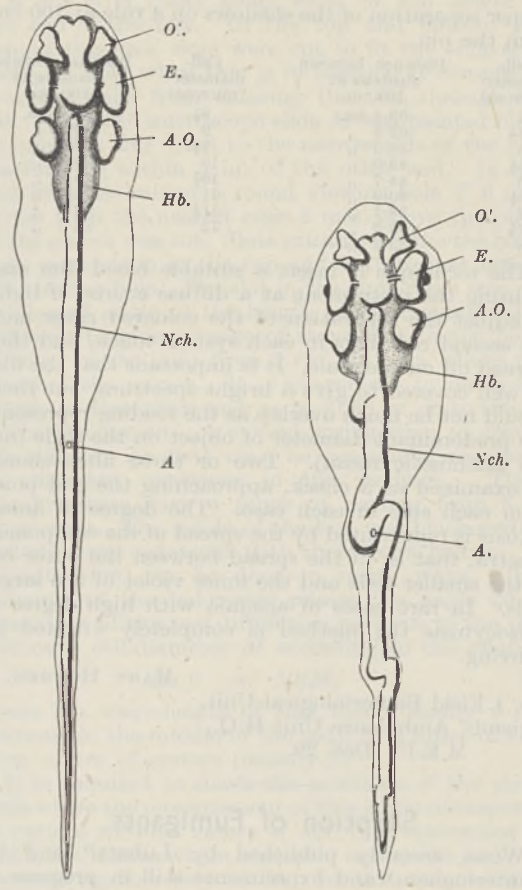

Fig. 1. Fig. 2.

Figs. 1 and 2. RECONSTRUCTIONS OF THE NOTOCHORD AND OF THE NERVOUS SYSTEM AS SEEN FROM THE VENTRAL SIDE: (1) OF THE CONTROL LARVA; (2) OF A LARVA WHICH AS A LATE BLASTULA WAS KEPT FOR 48 HR. IN 0·5 PER CENT SOLUTION OF $NaSCN.2H_2O$; *A.*, LEVEL OF THE ANUS; *A.O.*, OTOCYST; *E.*, EYE-CUP; *Hb.*, HIND-BRAIN; *Nch.*, NOTOCHORD; *Ol.*, OLFACTORY ORGAN. (× 17.)

embryos of echinoderms both with sodium thiocyanate and sodium iodide[5] and also, though to a lesser extent, with the vital dyes or paranitrophenol[6]. Ventral explantations of young gastrulæ of Amphibia show neural evocation, whether cultured in Holtfreter's liquid containing sodium thiocyanate[7] or vital dye[8]. In these experiments sodium thiocyanate is more active than methylene-blue[7].

The similarity of action of the vital dyes and sodium thiocyanate in these experiments is not yet clear.

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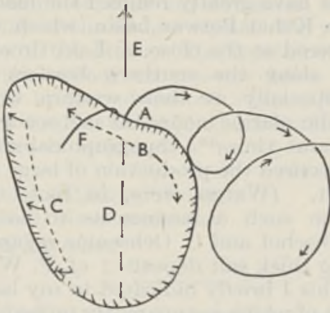
Jan. 24.

[1] Ranzi, S., and Tamini, E., *Naturwiss.*, **27**, 566 (1939).
[2] Citterio, P., *Rend. R. Ist. Lombardo* (*Cl. Sci.*), **75**, 142 (1942). Bartolazzi, C., *Rend. R. Ist. Lombardo* (*Cl. Sci.*), **75**, 474 (1942). Ranzi, S., *Boll. Soc. Ital. Biol. Sper.*, **18**, 314 (1943).
[3] Lehmann, F. E., *Roux' Arch.*, **138**, 106 (1938).
[4] Tamini, E., *Roux' Arch.*, **142**, 455 (1943).
[5] Lindahl, P. E., *Acta Zool.*, **17**, 179 (1936).
[6] Waterman, A. J., *Biol. Bull.*, **75**, 376 (1938). Tamini, E., *Monit. Zool. Ital.*, **52**, 81 (1941).
[7] Ranzi, S., and Tamini, E., *Rend. R. Ist. Lombardo* (*Cl. Sci.*), **73**, 525 (1940).
[8] Beatty, R. A., de Jong, S., and Zielinski, M. A., *J. Exp. Biol.*, **16**, 150 (1939).

Swimming of *Monas stigmatica*

Recently it was discovered at Plymouth that *Monas stigmatica*, E. G. Pringsheim, which is a small flagellate organism with a length of 6 μ, was, under the proper conditions, capable of traversing a length of 260 μ in a second. Thus the organism has a relative speed of more than forty, or in other words it traverses forty times its own length in a second, and on this simple calculation the organism has a relative speed which is twice that of the most modern 'Spitfire' and a thousand times that of a modern destroyer.

The principle by which this high speed is attained is that of the rotating inclined plane or the propeller, and since these flagellate organisms represent what is probably the most primitive of all free-swimming organisms it indicates that the principle of the rotating inclined plane or the propeller has existed on the earth ever since living organism first existed near the surface of the ocean, which was probably two or three hundred million years ago. It was not, however, until the year 1842 that the Admiralty owned a steamship driven by a propeller.



Monas stigmatica WITH ITS TWO FLAGELLA. DIAGRAMMATIC.

Waves pass along the long flagellum, from base to tip, in a spiral manner with an increase in velocity and amplitude. The force generated is transmitted to the surface of the cell at *A*. This causes the organism to rotate and gyrate about the axis *D*. (The edge *B* going below the surface of the paper and *C* being raised above it.) Thus the organism is converted into a rotating inclined plane and moves forward more or less in the direction indicated by the arrow *E*. The very short flagellum *F* appears to act as a guiding or sensory organ during normal swimming.

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Porphyrin Formation by Yeast

In a recent communication, Rimington[1] has described his investigations into the formation of porphyrins by autolysing yeast and by yeast press juice, in which he demonstrated an increase in coproporphyrin in a cell-free medium prepared from yeast.

In our experiments we first of all attempted to find conditions under which yeast would produce optimum amounts of porphyrin pigments. To this end, fresh top-fermentation brewer's yeast was allowed to autolyse at 19–22° C. alone and with the addition of various substances which were considered possible porphyrin precursors. The best yield of porphyrin was obtained, however, by addition of solid ammonium carbonate to the yeast cells, when a yield of ninety-five times the value from yeast alone was obtained.

Table 1. Coproporphyrin formed by Yeast after Addition of Ammonium Carbonate.

450 gm. fresh top-fermentation brewer's yeast. Duration of experiment, 96 hours.

Experiment	Coproporphyrin found (μgm./gm. fresh yeast)
Yeast alone	0·9
With 10 gm. $(NH_4)_2CO_3$	85·5
„ 10 gm. $(NH_4)_2CO_3$ + 2 gm. KH_2PO_4 + 2 gm. Na_2HPO_4	59·0
„ 10 gm. $(NH_4)_2CO_3$ + 30 ml. amyl alcohol	43·8

When the rate of porphyrin production was studied under these conditions, it was observed that a rapid linear rise until approximately 60 hours was followed by a very sharp fall after 90 hours until porphyrin had almost disappeared from the medium. During the first period, the yeast cells were very active and the disappearance of porphyrin coincided with the onset of true autolysis of the cells.

Table 2. Rate of Coproporphyrin Formation by Yeast after addition of Ammonium Carbonate.

250 gm. fresh yeast, 5 gm. $(NH_4)_2CO_3$ added, kept at 19–22° C.

Duration of experiment (hr.)	Coproporphyrin found (μgm./gm. fresh yeast)	Relative amounts of isomers present (μgm./gm. yeast) Copro. III	Copro. I	Copro. III / Copro. I
0	3·65			
6	13·2			
22	27·6	0·10	12·5	0·008
43	53·2	24·5	6·6	3·7
66·5	56·7	34·6	3·2	10·8
90·5	47·0	21·2	5·80	3·66
114	7·1			
162	3·2			
186	5·1	1·2	2·2	0·54
234	19·1			

The difference between the total coproporphyrin value and the sum of the two isomers is due to losses incurred in methylation and separation of the pure methyl esters.

When glucose, mannitol and other sugars were added to the yeast, it was observed that with prolonged activity of the yeast the porphyrin content also remained at a high level.

Table 3. Coproporphyrin Formation by Yeast after Addition of Ammonium Carbonate and Sugars.

250 gm. fresh yeast + $(NH_4)_2CO_3$ + sugar.

Experiment	Coproporphyrin found (μgm./gm. fresh yeast) 24 hr.	48 hr.	168 hr.	Relative amounts of isomers present after 168 hours (μgm./gm. fresh yeast) Copro. III	Copro. I	Copro. III / Copro. I
5 gm. $(NH_4)_2CO_3$ + 5 gm. glucose	16·8	24·0	60·0	0·0	33·2	0·0
5 gm. $(NH_4)_2CO_3$ + 10 gm. glucose	15·6	16·8	84·0	0·0	64·0	0·0
4·4 gm. $(NH_4)_2CO_3$ + 25 gm. glucose	16·8	5·7	84·0	9·4	46·0	0·2
5 gm. $(NH_4)_2CO_3$ + 25 gm. mannitol	9·3	18·7	100·8	1·5	67·2	0·02

Brewer's wort 284 (72 hr.).

As a result of these and other experiments under varying conditions, it is concluded that the maximum formation of porphyrins by yeast is associated with great cellular activity, and the amounts here found are much greater than those resulting by changes occurring after death of the cells.

Intracellular poisons, such as sodium fluoride and even 1 per cent toluene, caused a rapid decline in the porphyrin content by slowing down the metabolism. Samples of brewer's wort collected at intervals during fermentation exhibited the same changes as with ammonium carbonate alone, with the accumulation of 284 μgm. porphyrin per gram of original yeast at the end of the active fermentation period (72 hr.); but all this pigment was used up in the ensuing forty-eight hours.

Fractionation of the porphyrins showed that traces only of proto- and deutero-porphyrins were present, insufficient for identification of isomers. Coproporphyrin comprised in most instances a mixture of isomers I and III which were determined by ultra-violet fluorimetry and identified by crystallography and melting point of the methyl esters. The relative proportions of the two isomers varied within wide limits; it is interesting to see that coproporphyrin I predominates when sufficient carbohydrate for respiration is present, but in conditions of carbohydrate starvation (after 66 hours, Table 2) coproporphyrin III appears in large amounts, and is responsible for practically all the porphyrin present under these conditions. Thus the isomers III or I may predominate in yeast according to the nature of the nutrient medium.

Further investigations are being carried out to determine if, and how, these changes are related to cytochrome synthesis and rate of respiration.

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[1] Rimington, C., *Nature*, 151, 393 (1943).

Geology of the Punjab Salt Range

WITH reference to Sir Cyril Fox's interesting article under the above heading[1], I wish to make certain comments. I think that nobody maintains that the Kohat-Potwar Saline Series is of post-Eocene age. As Prof. Sahni says[2], his "fossil evidence is consistent with any geological age from the Lower Tertiary to the recent. But since on stratigraphical grounds the Saline Series cannot be younger than early Tertiary, the conclusion is that it is of Eocene age". I have shown[3] that the latest marine beds of that region are of Upper Khirthar (Auversian) age; so there were apparently no marine waters to desiccate, in that region, after the Eocene.

Again, aridity alone seems to be stressed when discussing the production of thick salt deposits. Thus Sir Cyril says (p. 259) that "an arid period almost certainly prevailed . . . in early Cambrian or pre-Cambrian times, which, according to Mr. Gee, . . . was soon after the rock-salt deposits had formed in the Punjab area"; and he adds that "there is little such evidence in support of an Eocene age for these deposits". But the main essentials for producing thick salt deposits are topographical rather than climatical. So far as climate is concerned, it is only necessary that evaporation should dispose of all waters in, or entering, the area concerned; but the production of an excessive accumulation of salt is not a simple matter—it demands rare topographical conditions like, for example, those now existing in the Dead Sea region, or those on the eastern borders of the Caspian Sea (Karaboghaz Gulf), etc.[4]. Nobody has yet attempted to show that the pre-Cambrian topography of the Kohat-Potwar region was of one of these exceptional kinds.

On the other hand, I have shown[5] that topographical conditions of such a kind did apparently exist, in that region, in Lower Chharat (basal Khirthar, or earliest Middle Eocene) times. So I must point out that Dr. West's summary of papers[6], to which Sir Cyril refers (p. 258), is incomplete in this respect. For it was not until 1936 that I finished surveying the Eocene beds of the Kohat district, and realized that Laki (Lower Eocene) elements disappear *from below upwards* to the west, and do not exist in Waziristan[7]. French geologists, working from the opposite (Afghanistan) side, soon afterwards made corresponding observations[8], showing that what I call a "Waziristan ridge" rose at the close of Ranikot (Palæocene) times. The emergence of this ridge must have greatly reduced the marine connexions of the Kohat-Potwar basin, which were yet more fully severed at the close of Laki times[9]. It is obvious that along the southern borders of that basin—and especially at their western extremity, where spasmodic marine incursions still occurred even in Lower Chharat times[10]—topographical conditions would have favoured the production of large accumulations of salt. (Waters were, in fact, trapped; and trapped in such a manner as to satisfy the theory of G. Bischof and C. Ochsenius regarding one way of forming thick salt deposits; *cf.* F. W. Clarke, as above[4].) This I briefly indicated in my last letter, the main point of which is apparently missed by those who refer to it[11] only to stress Mr. Gee's change of mind as to whether the fossils which I identified for him had, or had not, been found by him *in situ*.

To discuss further points would unduly extend this letter; so I merely emphasize, here, the need for considering the topographical essentials for producing thick salt deposits. Whether or not suitable conditions existed in pre-Cambrian times (a matter which seems never to have been worked out, and may not be capable of demonstration) I can scarcely agree that they did not exist in Eocene times. The Eocene is the one period when known structural evidence indicates that they did exist.

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Grant Institute of Geology,
University of Edinburgh.
March 19.

[1] *Nature*, 155, 258 (1945).
[2] *Proc. Nat. Acad. Sci. Ind.*, 14, 86 (1944).
[3] *Quart. J. Geol. Soc. Lond.*, 96, 199 (1940); 99, 63 (1943).
[4] Cf. Clarke, F. W., "Data of Geochemistry", 215ff (1920).
[5] *Nature*, 154, 53 (1944), etc.
[6] *Curr. Sci.*, 3, No. 9 (March 1935).
[7] Davies, L. M., *C.R. Soc. Géol. France*, 2, 22; 15, 294 (1938); *Nature*, 142, 296 (1938), etc. For diagram showing east-to-west succession see *Quart. J. Geol. Soc. Lond.*, 99, 65 (1943), Fig. 1.
[8] Cizancourt, Mme. de, *Mém. Soc. Géol. France*, N.S., 17, Fasc. 1, *Mém.*, 39, 14 (1938).
[9] See palæogeographical diagrams, *Proc. Sixth Pac. Sci. Congress* (1939), 2, 489, 494, etc. (1940). The delta of the proto-Kurram river was shifted eastwards, as its contemporary deposits show, by the emergence of this ridge, and may have further tended to block the marine connexion. Wind-rounded sand-grains (found by Dr. R. M. Craig in collections from these deposits) indicate more local aridity than some suppose to have existed at that time.
[10] Cox, L. R., *Ann. Mag. Nat. Hist.*, ii, 1, 172 (1938).
[11] *Nature*, 155, 267 (1945).

'Rubber Acid' Damage in Fire Hoses

READERS of the article on the above subject by Thaysen, Bunker and Adams[1] may be interested in my experience when called upon to suggest means of preventing or delaying the relatively rapid deterioration of war-time fire hoses.

It was early realized that this deterioration was of bacterial origin and associated with the formation of sulphuric acid, although no attempt was made to isolate or identify the organisms concerned. On the strength of the information available, however, I decided to try the effect of sterilizing the hose after use. Calcium hypochlorite bleach liquor was therefore added to a static water tank so as to produce a residual free chlorine content of 5–10 p.p.m. (*o*-tolidine test). The contents of the tank were pumped through the hose (by means of a trailer pump) and back again into the tank. This circulation was continued for about 15 min., after which the free chlorine had fallen to 1 p.p.m. or less. The hose was then drained and stored.

There was no evidence of damage due to the chlorine. Comparative tests with lengths of similar hose which had been treated as described above, using chlorinated and unchlorinated water, showed that the life of the former was 50–100 per cent longer than that of the latter. The treatment had little or no beneficial effect on pre-war hose, which had a longer life in the untreated state. The treatment should, of course, be applied each time the hose is used, before it is stored.

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[1] *Nature*, 155, 322 (1945).

A Colonial Scientific Service

I AM much interested in the idea of a Colonial biological service, as an independent organization or as part of a wider Colonial scientific service, that my friend Mr. K. H. Chapman has recently put forward[1].

What impresses one most often about the work of the scientific specialist serving overseas under the present system is the actual isolation in which his work is carried out, and the acute sense of this isolation which he often develops. One deleterious effect of this is that it may restrict research to problems for which facilities are available, and which may be relatively less important and perhaps not those for which the specialist's individual aptitudes are best suited.

Many particular problems would be more rapidly solved if either additional specialist help could be made temporarily available, or the worker and his problem could be transferred to some laboratory or research institute in Great Britain. Some specialists manage to arrange the latter either by persuading their superiors to grant special leave of absence to work at home or by sacrificing part of their normal leave to the work. Admirable as the spirit of the latter solution is, it is wrong in principle, and the former may be dependent on sympathetic consideration by a non-specialist superior. Some of Mr. Chapman's remarks are relevant to this last point.

A most important feature of a Colonial biological service with a centralized headquarters would be, as Mr. Chapman points out, the possibility of concentrating selected specialists as a team on any specific problem and preventing overlap of unco-ordinated individual efforts in different regions. An example of this kind of arrangement is the work of the Anti-Locust Centre in London[2], in connexion with which workers, scattered over a huge area, are all carrying out pieces of work in a pattern designed to solve the general problem of the locust pest. This particular project has drawn personnel from many sources not always immediately available in peace-time, but this only shows the resources which a centralized service might draw upon.

That biologists who intend to spend most of their active lives attached to research and teaching institutions in Britain would benefit from a temporary seconding to overseas work can scarcely be doubted. A centralized service would enable such secondings to be made in the most profitable way.

Another example is the work of the International Health Division of the Rockefeller Foundation. The Foundation's annual reports show how a cadre of experts has been moulded and remoulded to form the basis of a series of teams that have been sent all over the world to tackle problems in tropical medicine, especially those relating to insect-borne disease, a method yielding some quite spectacular results[3,4].

Whether a centralized service such as Mr. Chapman has suggested would, as he seems to hope, equalize the inequalities of status that he has found between medical and veterinary practitioners and biological specialists is difficult to know. Surely the solution of this problem lies in the direction of making biology an organized profession. Chemists and physicists are moving in this direction with their respective institutes. If medical men, veterinarians, chemists, physicists, accountants, librarians and others can do this, surely it would not be beyond the wit of biologists to do likewise.

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British Museum (Natural History),
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[1] Chapman, K. H., *Nature*, 155, 146 (1945).
[2] Uvarov, B. P., *Nature*, 151, 41 (1943).
[3] See Smart, J., *Nature*, 153, 765 (1944).
[4] See Smart, J., *Nature*, 152, 279 (1943).

Wax Pencils for Writing on Cold Wet Glassware

THE wax pencils supplied commercially for writing on glass are unsatisfactory when the glass is cold, or covered with a film of moisture.

Pencils which will write on cold wet glass can, however, be prepared by the addition of 5–10 per cent of a detergent, preferably cationic, to the wax and pigment mixture forming the pencil 'lead'. Of the many possible formulæ, the following can readily be made up in the laboratory without special skill.

Hard paraffin wax (m.p. 65° C.)	100 gm.
Beeswax	20 ,,
'Vaseline'	20 ,,
C.T.A.B. (Cetyl trimethyl ammonium bromide)	10 ,,
Fat soluble dyestuff (for example, Sudan III)	0·5–1·0 ,,

The mixture is heated on a water bath and stirred until the waxes have melted and the dye and detergent dissolved; 20 gm. of titanium oxide or other white pigment are then stirred in. The pencils are made by casting the mixture in sticks about 6 in. long by ½ in. in diameter and wrapping in paper.

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SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

ANNUAL MEETING

THE Society of Agricultural Bacteriologists held its fifteenth annual meeting at Leeds during December 17–19. The papers and the discussions covered a much wider field than is implied by the Society's title, a tendency which has become increasingly apparent each year since the Society adopted a policy of opening its membership to workers in all branches of bacteriology. Dr. W. T. Astbury gave an address on the electron microscope, followed by a demonstration of the instrument.

A contribution to the subject of disinfection dealt with the fundamental processes leading to the death of bacteria. In this work *Bacterium coli* was used as the test organism and phenol as the disinfectant. Special precautions were taken to avoid environmental changes during the tests, the phenol being added to cultures of the organisms grown in a special apparatus designed to ensure stable conditions throughout the period of the experiment. The experiments covered a range of phenol concentration from 3·48 to 8·0 gm./l., and a temperature range of 20–42° C. The results obtained led to the conclusion that the logarithmic curve of disinfection is really only an approximation, due to the process of disinfection proceeding too rapidly in the early stages to be estimated. The true disinfection curve indicated a slow initial death-rate, followed by a rapid rise to a high value ; the peak value was followed by a rapid and then by a slower decline, the death-rate becoming constant at the extreme end of the process of disinfection.

Starr's aniline blue medium for the detection of lipolytic organisms has been improved by staining the butterfat substrate with Waxolene Red 111S (I.C.I.), which ensures optimum colour differentiation between lipolytic and non-lipolytic colonies. Tests on forty-four cultures of lipolytic and non-lipolytic bacteria showed the new medium to be equal in discriminating powers to the copper soap method while possessing the added advantage that colonies could be subcultured following differentiation. It gave less false-positives than tributurin agar. Details of its preparation were given.

A study of methods suitable for assessing the sterility of equipment used in dairy and food manufacturing operations has shown the value of swab methods for this purpose. Colony counts on swab solutions from surfaces were normally much higher at 32° C. than at either 37° C. or 22° C., especially in the case of plant used for raw milk, meat canning, and in the bakery. The results emphasized the desirability of incubating plates at more than one temperature, and indicated 32° C. to be the temperature of choice when only one incubator was available. The predominating flora of swab solutions from the various types of plant examined was described, and the value of the swab technique in tracing the source of specific fault-producing organisms in large equipment was emphasized.

Since the adoption of the methylene blue test as an official method for the examination of heat-treated milk, increasing interest has been taken in the use of dye-reduction tests for this purpose. The results of various bacteriological methods of testing pasteurized milk were related to keeping quality in a study of 505 samples of pasteurized milk distributed by twenty-seven dairies during a period of twelve months. Neither the colony count at 37° C., the methylene blue test, nor the resazurin test were suitable measures of keeping quality when applied on the day of distribution ; but the dye-reduction tests proved suitable for detecting milk with a poor keeping quality, when the samples before testing were stored at 18° C. from 3 p.m. on the day of distribution until 10 a.m. the next morning. The value of the coliform test for the examination of pasteurized milk was also once more confirmed. A simple lagged water bath, utilizing mains water for cooling, with thermostatically controlled electrical heating, was used for maintaining a temperature of $18 \pm 1°$ C.

The examination of raw milk by the resazurin test continues to receive attention as a means of grading milk. The suitability of this test as a measure of keeping quality was assessed by comparison with the methylene blue test, the colony count and the titratable acidity, the results being subjected to statistical analysis.

In an attempt to explain occasional discrepancies between the results obtained by the resazurin and other tests on raw milk samples, the effect of pure cultures and of cells on the reduction of the dye has been investigated. Pure cultures of bacteria were found to vary markedly in their power to reduce both resazurin and methylene blue, although the more active milk-souring organisms reduced the dyes faster than organisms not possessing this property. *Streptococcus agalactiæ* and *Bacillus subtilis* were notable exceptions, the former being a poor reducer, and the latter reducing resazurin at an appreciable rate. Methods of measuring the relative reducing activity of cells and bacteria were discussed, and the difficulties emphasized. Neither the enzyme inhibitors used nor the temperature effects tried provided a satisfactory solution to the problem.

Theoretical consideration has been given to the possibility of developing a more rapid and equitable method for testing large numbers of raw milk samples. Since souring is the predominating cause of defects and difficulties in handling, it was assumed that measurement of the increase in acidity under standard conditions of storage was most likely to offer a solution. Of the three methods available, titratable acidity was considered too cumbersome for routine purposes, and conductivity measurements, though technically relatively simple, were not considered a sufficiently sensitive measure of increase in acidity. It was eventually decided to depend on pH value, determined with a glass electrode. A close relationship was found to exist between decrease in pH value and increase in titratable acidity.

The cleansing and sterilization of milk bottles and other surfaces in which the strength of detergents governs the efficiency of the processes is a problem of immense commercial importance. Titration methods are normally used for estimating and controlling the strength of detergents, but a method involving a direct-reading meter has obvious advantages. Preliminary work indicated the suitability of a direct-reading conductivity meter, and the construction of an apparatus suitable for use in detergent solutions in dairy equipment was described. Owing to variations in the constituents of commercial detergents, calibration of the instrument was found to be necessary for each detergent. The method had the further disadvantage that it was less sensitive to changes in the concentration of sodium hydroxide than it was to those of other salts, although it was pointed out that the majority of commercial detergents consist largely of carbonates and phosphates.

An extensive survey, covering the period 1930–44, of the incidence of *Mycobacterium tuberculosis* and *Brucella abortus* in herd bulk milk from individual farms in mid- and west-Wales was reported. Some figures for school supplies of pasteurized milk, for bulk creamery skim milk, both raw and pasteurized, and for udder samples from suspected cows were also included. Reasons were advanced for the very low incidence of tubercle infection (0·74 per cent for 2,155 samples) in farm supplies. No tubercle bacilli were found in any of the twenty-eight samples of pasteurized milk supplied to schools, nor in the thirty-eight samples of pasteurized bulk creamery skim milk examined. Of the sixty-six samples of bulk raw creamery skim milk, 6·06 per cent contained tubercle bacilli; legislation prohibiting the return of raw by-products to farms was considered essential for the development of areas of tubercle-free herds. A much higher proportion (8·91 per cent) of raw milk samples was found to be infected with *Brucella abortus*, designated supplies showing a higher incidence than milk from undesignated farms. No positive results were obtained with the pasteurized samples.

In a paper dealing with the spoilage of marine fish, the sources and types of bacteria responsible were discussed. The existence in marine bacteria isolated from fish of an enzyme system, triamine-oxidase, which is not generally present in similar bacteria from other sources, was suggested as a basis for differentiating the various species of marine bacteria. The changes in flora which occurred during a 21-day period of storage on ice were also studied. Although anaerobes were not considered to be as important as aerobes in causing spoilage, the types isolated were described, and the isolation of a new serological type of non-pathogenic tetanus bacillus, Type X, was recorded.

With the demand for canned foods for use by the Armed Forces in hot climates, new problems have had to be faced by the canning industry, since storage temperatures may be high enough to permit the germination and growth of spore-forming thermophilic organisms capable of causing spoilage. New methods of control have had to be introduced so as to reduce to a minimum the risk of infection before canning, as it is not always possible to increase the time or temperature of sterilization sufficiently to ensure destruction of the highly resistant thermophilic spores. Difficulty in sterilizing a mixture of meat and vegetable with a relatively high fat content was thought to be due to protection of the thermophiles by the fat. Cases of spoilage in canned vegetables were rare. Difficulty in canning potatoes late in the season was thought to be associated with the use of large tubers, which had to be cut before canning, the sterilization process being inadequate to kill spores at the centre when two cut surfaces came together again.

In a paper dealing with the bacteriology of canned bacon, a novel method of canning was described. Difficulties in sterilization led to a proportion of domed cans. A gas-forming aerobic spore-former capable of utilizing nitrate as a source of oxygen, which was isolated from both spoiled and sound cans, was regarded as the causative agent, although other unknown factors were thought to play a part in the production of gas.

For several years, bacteriologists have necessarily been concerned with the more pressing practical problems; but at this meeting a refreshing change was noticeable in that a few papers of a more fundamental character were included. A much happier blend resulted, which augurs well for the future of the Society.

Proceedings of the Society, containing full abstracts of the papers read, may be purchased from the Hon. Treasurer, Mr. L. J. Meanwell, United Dairies, Ltd., Ellesmere, Salop.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

IT was inevitable that the work of the London School of Hygiene and Tropical Medicine, which has exerted so profound an influence on the teaching and practice of tropical medicine by both British and other medical men, should have been radically affected by the War. The report of the School's work during 1943–44 shows how much its normal activities have been altered. Not only have thirty-six members of the staff been engaged on full-time war service, but also specific war problems have been studied at home, and the School has provided accommodation for members of the staff of the Medical Research Council and of the University of London, who are doing work of national importance. Nor have the School's buildings escaped war damage. Yet, during the year, it has been possible to give courses in tropical medicine to some five hundred Service medical officers and other special courses to 151 students. The acting dean, Prof. M. Greenwood, and the whole School are to be congratulated upon the year's work. It is gratifying to know that it has been possible to do, as well as war work, some fundamental research of a kind which is vital to the very existence of science, yet is, in the words of Prof. Greenwood, "slighted in war-time because the results may not be of immediate technological importance".

Prof. Greenwood refers to the difficulties which the School will have to face after the War, and he doubts whether national post-war needs will allow the School to resume normal teaching until, at the most optimistic estimate, the autumn of 1945–46, perhaps not until a year later. He suggests that the resumption of teaching will not be easy, for the returning staff will have lost touch with the normal problems of academic work and will have to teach a generation trained somewhat hurriedly and under difficulties.

The brief departmental reports indicate the effects of departures of staff for war work and also of the national value of the work which has been accomplished in spite of these losses. Thus the Department of Entomology has been much concerned with work on D.D.T., which was originally brought to the School by a representative of the Swiss firm which placed this remarkable insecticide at the disposal of the British and American Governments (see *Nature*, Nov. 11, 1944, p. 600). Methods of impregnating clothing with D.D.T. for the control of human lice were devised, and this method of applying D.D.T. is now general. The use of D.D.T. for the control of the bedbug is also being studied. Much work has been done on fumigants and mosquito sprays, and a formula for the latter containing D.D.T. has been generally adopted. The physical and chemical problems involved in the control of insects by means of sprays are also being investigated. This Department has lost the services of Dr. V. B. Wigglesworth, who has been appointed director of the Insect Physiology Unit of the Agricultural Research Council; but co-operation between these two departments continues. Dr. Wigglesworth has studied the part played by waxes in maintaining the impermeability of the insect cuticle to water and has found that some chemically inert dusts abrade the wax and thus kill insects by causing them to dry up (see *Nature*, **153**, 493; **154**, 333 (1944)). His Unit is also studying the action of insecticides used as sheep dips against the sheep tick, *Ixodes ricinus*, the water relations of this tick and the physiology of the sheep blowfly, *Lucilia sericata*. Field trials of D.D.T. as a sheep dip are also being made. The possible importance of work of this kind to all those who are concerned with world supplies of meat, wool and other animal products can scarcely be over-estimated.

The head of the Department of Biochemistry, Prof. H. Raistrick, has given much time to work with penicillin; he is honorary scientific adviser to the Ministry of Supply on penicillin production. This Department has also studied the deterioration of service equipment in the tropics due to the action of moulds and is searching for antibiotic substances of microbiological origin. Although patulin, prepared by the Department from *Penicillium patulum*, proved unable to control the common cold (see *Nature*, **154**, 807, Dec. 30, 1944), two other metabolic products of this mould have been isolated, namely, gentisic acid and the hitherto unknown gentisyl alcohol; the latter has been synthesized. A new antibacterial substance has been isolated from cultures of "a somewhat rare mould" which has not yet been identified with certainty; this substance appears to belong to a new type of organic compounds and its properties are being studied. Diplococcin, a new antibacterial substance formed by some strains of milk streptococci, has been isolated. It is probably, the report says, identical with a substance independently isolated at the National Dairy Research Institute, Shinfield, and described by A. T. R. Mattick and A. Hirsch (*Nature*, **154**, 551, Oct. 28, 1944). Mattick and Hirsch found that the substance isolated by them protects mice against strains of hæmolytic streptococci virulent to mice and suggest that it may be useful for the treatment of bovine mastitis.

The appointment of Prof. J. M. Macintosh to the University of London chair of public health assures the School of vigorous and able leadership. The Association of Industrial Medical Officers is using the School more and more as its headquarters. Among researches done at the School's Department of Industrial Physiology are those on the insulating properties of clothing materials, the important question of portable sources of light, such as reading lamps, the results of which study have been published in the *Transactions of the Illuminating Engineering Society*, and the dangers to health of industrial dusts; advice given on the working conditions in factories has brought benefit to many workers.

The Library of the School has been busier than ever. It has increased its stock of books and pamphlets, but has experienced the difficulty of obtaining American books which is the subject of an Annotation in the *Lancet* (217, Feb. 17, 1945). The School also houses the Bureau of Hygiene and Tropical Diseases, the painstaking and indefatigable work of which, published in the pages of the *Tropical Diseases Bulletin*, the *Bulletin of Hygiene* and the *Bulletin of War Medicine*, makes available abstracts of the medical literature of every country in the world. These abstracts are done by a panel of experts, whose experience adds a critical quality which is absent from many other publications of this kind.

The Institute of Agricultural Parasitology, directed by Prof. R. T. Leiper, professor of helminthology in the School, has done much work at Winches Farm, St. Albans, on the nematode parasites of valuable crops. A catalogue of more than six hundred species of helminths parasitic in birds of economic importance has also been compiled. A method has been devised for the identification of certain nematode species from the females alone, which should be of great value to parasitologists; and the nature and development of cestode hooks has been studied. It is at Winches Farm also that the work of that other invaluable source of information, the Imperial Bureau of Agricultural Parasitology, is done.

Everyone will wish the School a speedy return to its normal activities when the completion of its war work makes this possible.

RACIAL PROBLEMS IN AUSTRALIA

WITH the progress of civilization and the continued penetration by the white man into the domain of the coloured peoples, there comes the problem, ever increasing in intensity, of the contact and clash of conflicting customs. Men in the stone or iron age are caught up into the complicated machinery of the Western world, and the results are necessarily difficult to regulate and often disastrous to the simpler peoples.

The Anthropological Society of South Australia at its meeting in May 1944 held a conference arranged by the South Australian Division of the Australian Association of Scientific Workers, during which there was a discussion on racial problems to which Prof. J. B. Cleland contributed a valuable address. He pointed out that the Australian aborigines, contrary to popular belief, present a high order of intelligence, and had they not settled in a country which provided very few amenities, they would probably by now have reached a much higher stage of civilization. But what could they do in a country boasting no animal life higher than the marsupial and practically no cultivable plants? They were forced to remain nomads and with the arid conditions so frequently obtaining could make no permanent habitations.

Potentially, however, judging by a complex language and by the attainments of certain individuals, the Australian aborigine has a mental make-up not appreciably below that of the white man, though he has specialized in a different direction. There is nothing to show that crosses between them and good-class whites are likely to produce undesirable half-breeds; the fact that many half-castes are inferior being probably due to the low-class and often vicious white men of whom they are the offspring.

There have always been attempts to guide the aborigines into European ways, but these have heretofore led to rapid decline and death, owing in great part to lack of interest in living when removed from their native mode of life with its frequent ceremonies. It seems, in fact, impossible for the full bloods to maintain themselves in a white community, and the only hope for them is to make the few places they can call their own as inaccessible as possible to the white man. There will naturally always be certain adventurous spirits who will roam away and, through contact with the whites, lose touch with the old life. These newly detribalized men should be assisted to maintain themselves as respectable members of the community and to do suitable work, as much in the country as possible, on the cattle and sheep stations. They should be under some sort of supervision and be encouraged to keep up their tribal customs and corroborees.

The completely detribalized aborigines of long-standing separation from their own communities are a more difficult problem, having mostly become urbanized and of mixed blood. Prof. Cleland considers that they should not be segregated from the whites and regarded as inferiors, but should be educated to become good citizens and take their share of community life. K. RISHBETH.

PREHISTORY IN THE CONGO*

THE prehistoric archæology of the Congo is very little known. The researches of Dr. Cabu were in part published at the International Congress held in Brussels in 1935; but most of his discoveries are still unknown to the average prehistorian. Yet the Congo is probably a key area, linking as it does the north with the south of the African continent. The only bit of information on the subject which had become current among prehistorians concerned an alleged new culture, the Tumbrian; but now even this latter seems actually to be non-existent, and the industry in question merely a *mélange* of early, middle and later stone age material, somewhat corresponding to the Sangoan of Uganda.

It is, therefore, of very great interest to have such studies as these under notice from the pens of prehistorians of the eminence of Profs. Breuil and van Riet Lowe. Alas, there are no illustrations. Both Breuil's articles are technical, and describe in detail the industries found at a number of stone age sites and their cultural affinities. An intriguing reference occurs at the end to discoveries of painted rock-shelter sites. The paintings are in red and conventionalized. Prof. van Riet Lowe also describes in detail the industries and compares them with those occurring in South Africa and in the Uganda-Kenya regions. He, too, claims that the Tumbrian consists of "advanced Acheul, La Micoque and Combe Capelle bifaced tools (i.e., Fouresmith), ? proto-Stillbay, Sangoan picks, Stillbay points, Aterian and Sbaikian bifaced points (including pedunculate forms), ground and polished axes and pottery"; quite a mixture! He also notes the occurrence of Smithfield tools. This reinforces the contention that this culture is not purely a South African product, and backs up Archdeacon Owen's finds of a Smithfield industry in western Kenya.

Quite obviously we shall have to await the end of the War for a full account of the prehistory of the Congo. But enough is here given to make it clear that this important area is likely to be critical for any general appreciation of the Stone Ages in Africa. M. C. BURKITT.

* "Le Paléolithique du Congo Belge d'après les recherches du Docteur Cabu". By l'Abbé Henri Breuil.

"Les industries paléolithiques de la terrasse de 15 Metres et d'un chenal secondaire comble, Plaine de Piemont de Leopoldville, d'après les fouilles et photographies du Docteur Cabu". By l'Abbé Henri Breuil.

"Notes on Dr. Francis Cabu's Collection of Stone Implements from the Belgian Congo". By Dr. C. van Riet Lowe.

Reprinted from *Trans. Roy. Soc. S. Africa*, 30, Pt. 2 (1944).

STRAY LOSSES IN SYNCHRONOUS ELECTRICAL MACHINERY

P. RICHARDSON, in a paper read before the Institution of Electrical Engineers in London recently, discusses the problem of eddy currents from the point of view of the effect of the physical arrangement of an alternator on the stray losses, and deals afterwards with the components of stray loss. Since the latter can be classified conveniently in accordance with their position in the alternator, the stray losses which occur in the stator are considered first.

It is shown how the arrangement of the end-windings influences the shape of the end leakage field and thus the intensity of loss in the adjacent metallic structures, and how the loss in the core-end-plate can be estimated. The effect of magnetic and non-magnetic shielding arrangements is discussed, together with details of their arrangement. Experiments in connexion with eddy-current losses in the stator end connexions are described. Consideration is given to the iron loss which occurs in the stator core under steady three-phase short-circuit conditions owing to the flux-wave shape, and the indications are that this provides at least a partial explanation of why the stray losses can be so appreciably greater on short-circuit than on load.

The stray losses in the rotor, generally grouped under the heading of rotor surface losses, are shown to be due to several effects, notably to the concentration of ampere-conductors in one slot and to the irregularities present in the stator magnetomotive force wave. Consideration is also given to the surface or pole-face losses resulting from the 'tufting' of flux under the stator teeth, which loss is experienced under conditions of no load and is normally measured with the stator iron loss. The factors affecting the surface losses are discussed, together with methods for reducing the losses to a minimum. An indication is given of the relationship between the stray losses at the ends and those located within the core-length of an alternator, together with a description of the effect of load conditions on each of the components of stray loss.

FORTHCOMING EVENTS

Saturday, May 12

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

Monday, May 14

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (joint meeting with the ROYAL NETHERLAND INSTITUTION OF CIVIL ENGINEERS AND THE SOCIETY OF DANISH CIVIL ENGINEERS) (at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Prof. K. W. Mautner: "Extension Work on the Harbour of Dunkirk, 1930–1938" (Lantern Lecture).

Tuesday, May 15

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (joint meeting with the ROYAL AFRICAN SOCIETY) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Malcolm Guthrie: "East Africa's Reactions to European Culture".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Characteristics of Luminescent Materials for Cathode-Ray Tubes" (to be opened by Mr. C. G. A. Hill).

Wednesday, May 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. J. D. Bernal, F.R.S.: "The Social Relations of Science" (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

Thursday, May 17

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. F. H. Andrews: "An Oriental Cultural Centre in London".

LONDON MATHEMATICAL SOCIETY (Royal Astronomical Society's Rooms, Burlington House, London, W.1), at 3 p.m.—Dr. K. Mahler: "Lattice Points in n-Dimensional Star Bodies".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 5 p.m.—Prof. J. D. Bernal, F.R.S.: "The Past and Future of Crystal Chemistry" (Hugo Müller Lecture).

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—F. Jones and R. Sear: "The Measurement of Cable Characteristics at Ultra-High Frequencies".

Friday, May 18

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. H. D. Kay, F.R.S.: "The Secretion of Milk".

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Sir Lawrence Bragg, F.R.S.: "Magnetic Materials".

APPOINTMENTS VACANT

FUEL TECHNOLOGIST for steelworks in north-west England—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia House, London, W.C.2, quoting F.2230.A (May 15).

RESEARCH ASSISTANT IN INDUSTRIAL OPHTHALMOLOGY at the Institute of Ophthalmology, Royal Eye Hospital, London, S.E.1—The Secretary (May 15).

ENTOMOLOGIST in the Research Division, Department of Agriculture and Forests, Sudan Government—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2, quoting F.3969.A (May 16).

TEMPORARY SENIOR TECHNICAL OFFICERS (Ref. C.2578.A) and TECHNICAL OFFICERS (Ref. C.2579.A) in the Ministry of Aircraft Production for the development of civil transport aircraft—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2, quoting appropriate reference number (May 16).

DIETITIAN (female) at the Middlesex Hospital, London, W.1—The Secretary-Superintendent (May 19).

CHIEF CHEMIST AND METALLURGIST, for works in north-east England, preferably with experience of the aluminium industry—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2 (quoting F.3905.XA) (May 22).

TECHNICAL DIRECTOR OF A FOOD ORGANIZATION—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2 (quoting Ref. F.3831.XA) (May 26).

PROFESSOR OF MATHEMATICS at the University College of North Wales, Bangor—Acting Registrar (May 31).

ABSTRACTORS FOR RADIO AND ALLIED SUBJECTS at the National Physical Laboratory—Ministry of Labour and National Service, Appointments Dept. (A.3), Sardinia Street, London, W.C.2 (quoting Ref. P.N.122).

SECRETARY to the University of Edinburgh—The Secretary.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 12: The Blind Seed Disease of Rye-Grass and its Causal Fungus. By Dr. Malcolm Wilson, Dr. Mary Noble and Dr. Elizabeth G. Gray. Pp. 327–340+1 plate. 4*s*. Vol. 61, Part 2, No. 14: The Kalsilite-bearing Lavas of Kabirenge and Lyakauli, South-West Uganda. Part 1, by A. D. Combe; Part 2, by Dr. Arthur Holmes. Pp. 359–379+1 plate. 6*s*. (Edinburgh and London: Oliver and Boyd, 1945.) [94

Imperial Forestry Bureau. Technical Communication No. 2: Co-operation in Forestry. By Dr. I. Kissin. Pp. 72. 4*s*. Technical Communication No. 3: Forestry Credit. By Dr. I. Kissin. Pp. 28. 2*s*. 6*d*. (Oxford: Imperial Forestry Bureau, 1944–1945.) [94

South-West Essex Technical College and School of Art. Annual Report, Session 1943–44. Pp. 32+4 plates. (London: South-West Essex Technical College and School of Art, Walthamstow, 1945.) [174

Royal Aircraft Establishment. Education and Training. Pp. iv+28+12 plates. (Farnborough: Royal Aircraft Establishment, 1945.) [174

Ministry of Education. Memorandum on the Building Regulations: Being the Regulations dated March 24, 1945, prescribing Standards for School Premises, made under Section 10 of the Education Act, 1944. (S.R. and O. 1945, No. 345.) Pp. 25. (London: H.M. Stationery Office, 1945.) 6*d*. net. [174

British Industry and Commerce: its History and Reconstruction. Pp. 56. (Sheffield: Central Library, 1945.) 6*d*. [174

The Future of University and Higher Education. A Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp. 16. (London: National Union of Students, 1945.) [174

Leeds University. University Extension Lectures and Tutorial Classes: Thirty-fifth Annual Report, 1943–44. Pp. 6. (Leeds: The University, 1945.) [174

Proceedings of the Royal Irish Academy. Vol. 49, Section B, No. 14: Note on the Physiology of the Mammalian Epididymis and Spermatozoon. By Lawrence Collery. Pp. 213–223. 1*s*. Vol. 50, Section B, Nos. 1, 2, 3: The Electrical Production of Semen in the Guinea Pig (*Cavia cobaya*) and the Characters of the Ejaculate; Note on the Sudanophile Fat in the Testis of the Dog; Non-septic Spermophagia in the Male Guinea Pig (*Cavia cobaya*). B. L. Collery. Pp. 38+5 plates. 3*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1944.) [174

Association of University Professors and Lecturers of Allied Countries in Great Britain. Second Educational Conference, April 15, 1944: Some Comparisons between Universities. Pp. ix+64. (Oxford: Basil Blackwell, 1944.) 2*s*. 6*d*. net. [184

Report of the Seafarers' Education Service for the Year 1944. Pp. 4. (London: Seafarers' Education Service, 1945.) [214

Paint Research Association 1926–1945: General Information. Pp. 53. (Teddington: Paint Research Association, 1945.) [214

Report of the Joint Conference of the Institute of Fuel and the National Smoke Abatement Society held in London on February 23rd, 1945. Pp. 32. (London: Institute of Fuel and National Smoke Abatement Society, 1945.) [214

The New I.L.O.? Pp. 20. (London: British Association for Labour Legislation, 1945.) 9*d*. [214

Society for Freedom in Science. Occasional Pamphlet No. 1: Is the Progress of Science Controlled by the National Wants of Man? By Dr. F. Sherwood Taylor. Pp. 15. (Oxford: Society for Freedom in Science, University Museum, 1945.) 1*s*. 6*d*. [214

Other Countries

U.S. Office of Education: Federal Security Agency. Pamphlet No. 97: Inter-American Cooperation in the Schools—Student Clubs. By Esther Brown. Pp. iv+32. (Washington, D.C.: Government Printing Office, 1944.) 10 cents. [94

Occasional Papers of the Bernice P. Bishop Museum. Vol. 17, No. 23: Dentition of Six Syncerid Genera; Gastropoda, Prosobranchiata, Synceridae (Assumineidae). By Yoshio Kondo. Pp. 313–318. Vol. 18, No. 1: Incidence of Fouling in Pearl Harbour. By Charles Howard Edmundson. Pp. 34. Vol. 18, No. 2: Callianassidae of the Central Pacific. By Charles Howard Edmundson. Pp. 35–62. Vol. 18, No. 3: Notes on Fijian Euphorbiaceae. By Leon Croizat. Pp. 69–72. Vol. 18, No. 4: A New Hawaiian Polyclad Flatworm associated with Teredo. By Libbie H. Hyman. Pp. 73–76. Vol. 18, No. 5: Revision of Cardamine and related Cruciferae in Hawaii, and Nasturtium in Polynesia. By Harold St. John. (Pacific Plant Studies, 3.) Pp. 77–94. (Honolulu: Bernice P. Bishop Museum, 1944.) [94

Bernice P. Bishop Museum. Bulletin 181: Geology of Lau, Fiji. By Harry S. Ladd and J. Edward Hoffmeister. Includes Petrography of Igneous Rocks, by Harold L. Alling; Petrography of Limestones, by Geoffrey W. Crickmay; Chemical Composition of Limestones, by J. W. Sanders, Jr., and Geoffrey W. Crickmay; Larger Foraminifera, by W. Storrs Cole; Echinoidea, by Hubert Lyman Clark; Barnacles, by H. A. Pilsbry; Decapod Crustacea, by Mary J. Rathbun. Pp. vi+400+62 plates. (Honolulu: Bernice P. Bishop Museum, 1945.) [94

South Australian Museum. Report of the Museum Board, July 1st, 1941, to June 30th, 1942. Pp. 7. Report of the Museum Board, July 1st, 1942, to June 30th, 1943. Pp. 8. Report of the Museum Board, July 1st, 1943, to June 30th, 1944. Pp. 8. (Adelaide: South Australian Museum, 1942–1944.) [114

New Zealand Museums: Present Establishment and Future Policy. By Dr. W. R. B. Oliver. Pp. 39. (Wellington: Dominion Museum, 1944.) [174

State of California: Department of Natural Resources Thirty-Seventh Biennial Report of the Division of Fish and Game for Years 1940–1942. Pp. 128 (1 plate). Fish Bulletin No. 60: A Systematic Study of the Pacific Tunas. By H. C. Godsil and Robert D. Byers. Pp. 132. (Sacramento: California State Printing Office, 1944.) [214

Origin of the Electromagnetic Field in a Corpuscular Theory of Light. By Dr. Charles L. Mayer. Pp. 22. (New York: Author, 243 Riverside Drive, 1945.) Free. [214

Smithsonian Institution: Institute of Social Anthropology. Publication No. 1: House and House Use of the Sierra Tarascans. By Ralph L. Beals, Pedro Carrasco and Thomas McCorkle. Pp. x+37+8 plates. (Washington, D.C.: Government Printing Office, 1944.) [214

Gold Coast Colony. Report on the Forestry Department for Year 1943–1944. Pp. 6. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1944.) 1*s*. [214

The Journal of Meteorology. Vol. 1, Nos. 1 and 2. Pp. 56. (Milton, Mass.: American Meteorological Society, 1944.) [214

Carnegie Institution of Washington. Publication 556: Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Capt. J. P. Ault. Oceanography—II: 1. Marine Bottom Samples Collected in Pacific Ocean by *Carnegie* on its Seventh Cruise, by Roger R. Revelle. 2. Radium Content of Ocean-Bottom Sediments, by Charles S. Piggott. Pp. viii+196 (13 plates). Publication 565: Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Capt. J. P. Ault. Biology—V. The Genus Ceratium in the Pacific and North Atlantic Oceans. By Herbert W. Graham and Natalia Bronskovsky. Pp. vii+209. (Washington, D.C.: Carnegie Institution, 1944.) [214

U.S. Department of Agriculture: Technical Bulletin No. 879: The Mushroom Mite (*Tygrophogus lintniri*) (Osborn) as a Pest of Cultivated Mushrooms. By A. C. Davis. Pp. 26. (Washington, D.C.: Government Printing Office, 1944.) [214

Proceedings of the United States National Museum. Vol. 95, No. 3185: Summary of the Collections of Amphibians made in Mexico under the Walter Rathbone Bacon Travelling Scholarship. By Edward H. Taylor and Hobart M. Smith. Pp. 521–613+plates 18–32. Vol. 96, No. 3187: A Revision of the American Clingfishes, Family Gobiesocidae, with descriptions of New Genera and Forms. By Leonard P. Schultz. Pp. 47–77. (Washington, D.C.: Government Printing Office, 1944.) [214

Transactions of the San Diego Society of Natural History. Vol. 10, No. 8: The Sidewinder, *Crotalus cerastes*, with Description of a New Subspecies. By Laurence M. Klauber. Pp. 91–126+plates 6–7. (San Diego, Calif.: San Diego Society of Natural History, 1944.) [284