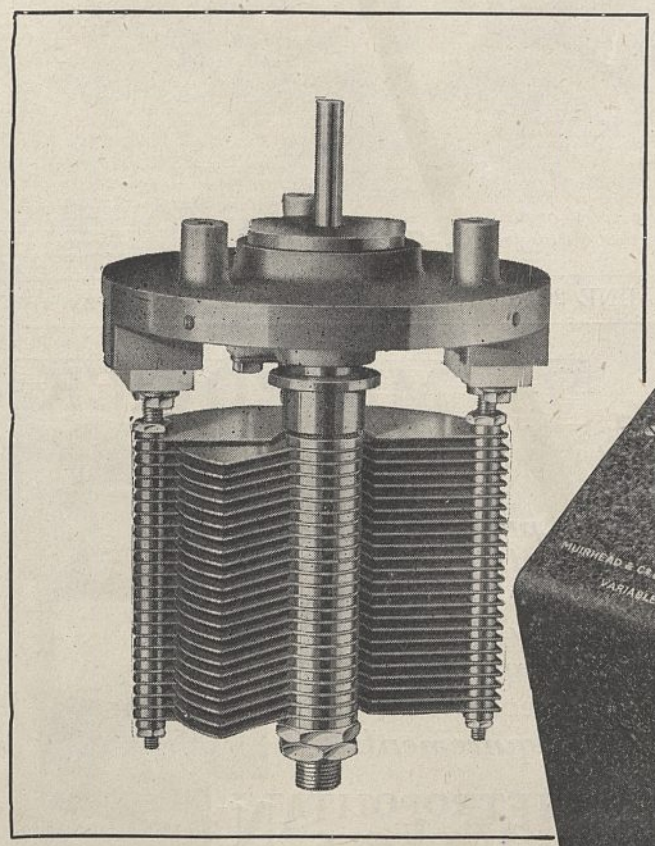
SUPPLEMENT: RECENT SCIENTIFIC and TECHNICAL BOOKS

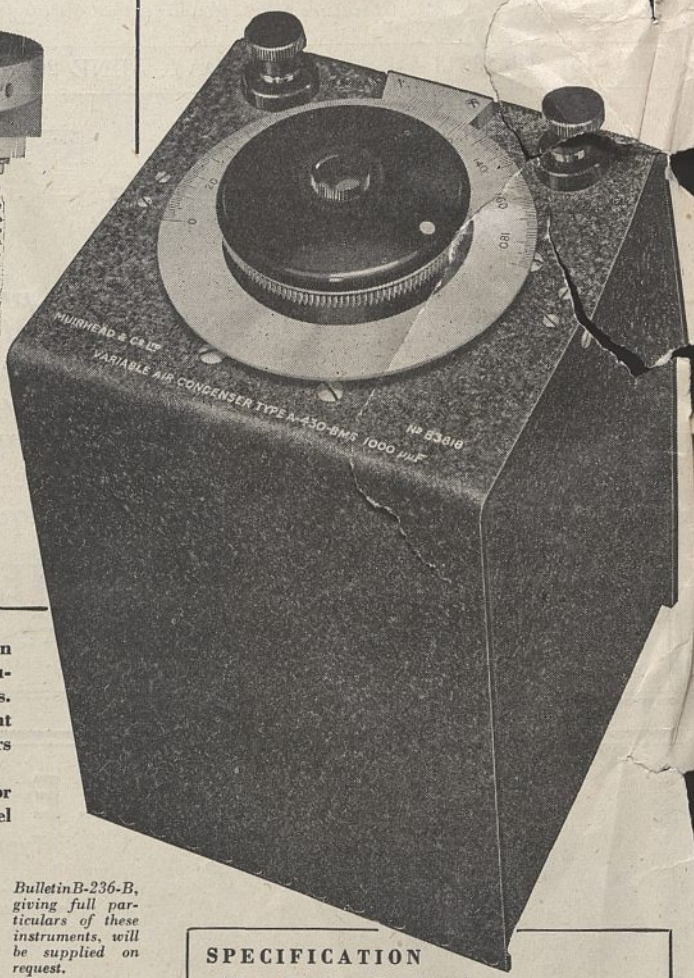
NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

Vol. 151, No. 3843 SATURDAY, JUNE 26, 1943 ONE SHILLING & SIXPENCE

VARIABLE AIR CONDENSER TYPE A-430





Our Type A-430 Variable Air Condensers have been standardised for many high grade instruments, particularly when reasonable size and cost are important factors. Rugged construction, smooth even control and excellent electrical characteristics are reasons why these condensers are selected.

Type A-430 Condensers are supplied in metal boxes for bench use, or with cylindrical brass covers for panel mounting.

MUIRHEAD

Bulletin B-236-B, giving full particulars of these instruments, will be supplied on request.

SPECIFICATION

Main Casting	Gun Metal.
Vanes	..... Brass.
Insulation	..... Frequentite.
Bearing	..... Large single cone.
Drive	..... Direct, or 50 : 1 reduction — 4½" silvered scale.
Sizes	.....From 100 μμF. to 1000 μμF.

MUIRHEAD & CO. LTD., ELMERS END, BECKENHAM, KENT - - - TELEPHONE BECKENHAM 0041-0042

FOR OVER 60 YEARS DESIGNERS AND MAKERS OF PRECISION INSTRUMENTS

C.R.C. 33

NATURE

No. 3843 SATURDAY, JUNE 26, 1943 Vol. 151

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London

Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

NATURE RESERVES

IF one may judge from impressions of casual talk, there is a good deal of confusion in the public mind on the subjects usually grouped under such terms as 'nature conservation' and the like. Many people who have not given much thought to the subject seem to have little more than a vague desire that as much as possible of England's green and pleasant land should be saved from the uglier features of industrial development. There are also many to whom the words 'national parks' suggest only memories of Hampstead Heath on a Bank Holiday, and 'nature reserves' mean only barbed wire and notices threatening the prosecution of trespassers. It may be worth while, therefore, to recapitulate some elementary considerations which, although they have long been familiar to scientific men interested in such matters, are not yet generally appreciated. For this purpose a convenient starting point is given by the recently published report of the Nature Reserves Investigation Committee* which presents, within the compass of a pamphlet of 25 pages, an admirably balanced statement of the purposes of nature conservation and of the methods by which these purposes may be attained.

The objects to be aimed at may be classified under three main headings : amenity, education and scientific study. The report makes a point that is often overlooked when it says that "the beauty and interest of landscape does not depend solely, or even mainly, upon the sculpturing of the earth's surface, but upon the nature of the living carpet which covers and surrounds these physical features". This has only to be stated to appear self-evident. Imagine, say, the Lake District stripped of this carpet, and who would care to visit it for pleasure ? Even the provision of 'national playgrounds', then, involves problems of applied biology.

In speaking of the educational aspect of nature conservation, the authors of the report have in mind chiefly the school teaching of nature study in Great Britain. This subject is now included in the curriculum even of urban schools, and there is already a demand, which is likely to increase, for the preservation of such scraps of wild life as may persist within areas accessible to the pupils. It is suggested that, just as individual schools have their own playing fields, they might also have their own small-scale nature reserves, for the establishment and care of which they would be responsible.

The value of nature reserves for purposes of scientific study scarcely needs to be pointed out, but the report rightly emphasizes the fact that this value is not only academic but also has a very important economic aspect. It requires no great effort of imagination to realize that, as the agriculturist studies in ever closer detail the influence of local differences of climate and soil, valuable indications may be got from the natural or spontaneous fauna and flora of

* Nature Conservation in Britain. Memorandum No. 3 of the Conference on Nature Preservation in Post-War Reconstruction. Issued by the Society for the Promotion of Nature Reserves. (London : British Museum (Natural History), 1943.) 6*d*.

different districts, and "it is also a reasonable assumption that there are still in nature plants or animals of potential, but as yet unknown, value to mankind".

What, then, is this 'Nature' which for these and other reasons we desire to conserve ? There is a very widespread impression that on the cessation of human interference, the animal and plant life of any area will speedily revert to a 'state of Nature', a permanent and unchanging condition undisturbed save by the endlessly repeated cycle of the seasons. Nothing could be further from the truth. The 'balance of Nature' is a phrase that comes so readily to mind that we are very apt to forget that it describes not a static and enduring condition but a swaying and uncertain struggle of opposing forces, in which now one and now another obtains a temporary mastery. Botanists have made us familiar with the idea of a natural succession of plant associations, and, apart from the profound reactions of this succession on the fauna, there is increasing evidence that all animal populations are constantly waxing and waning, sometimes in regular cycles, often with seeming irregularity, under the influence of factors that can only be guessed at. In most instances nature conservation aims at the perpetuation of existing conditions, and it should be realized that this can only be achieved by unceasing and scientifically directed measures of control. To take a single example, Wicken Fen, one of the best-known and certainly the most thoroughly studied of the nature reserves now existing in Great Britain, owes its approximate stability to unremitting management, the regulation of drainage, the cutting of reeds, the eradication of brushwood and so forth, far more than to the mere exclusion of collectors.

Apart, however, from this natural instability of the fauna and flora, it has to be borne in mind that there is scarcely a square mile of Great Britain, except on the tops of the highest mountains and the wilder parts of the sea-coast, that does not owe its present aspect in some measure to the activities of man. It is easy to realize this in most scenes of the English countryside, but when standing on a Scottish moor looking over unending miles ablaze with the purple glory of heather, it is harder to remember that the landscape is as much a product of human cultivation as a cornfield or a cherry orchard. Yet nothing is more certain than that the stopping of heather burning for a few years would cover most of these miles with brushwood and incipient forests. It is above all necessary, therefore, that schemes of nature conservation should start with a clear idea of what it is desired to conserve, and that adequate provision should be made for continuous scientific supervision and management. Without this control there is evidence that unexpected and undesirable results may follow. It has been found, for example, that when a patch of woodland in the midst of an agricultural area was isolated and all shooting within its limits prohibited, the woodland was colonized by predatory birds and mammals, which not only exterminated most of its other inhabitants but also used it as a base of operations for raids on the surrounding countryside.

It is to be hoped that the authorities responsible for nature reserves will discourage any attempts at introduction or re-introduction of animals or plants into areas which they do not now inhabit. It is scarcely necessary to point out the futility of suggestions such as that made some years ago for the sowing on Welsh mountains of the seeds of alpine plants from Switzerland, or the attempt, which is believed to have been partially successful, to add the edible dormouse to the list of British mammals. There is, however, a superficial plausibility in the arguments for the re-introduction of animals once native but now extinct in Great Britain. This has been done successfully, for example, with the capercaillie and less successfully, it is understood, with the Large Copper butterfly. Apart from the unpredictable results from any such interferences with the existing fauna and flora, these experiments amount to a wanton falsification of the records of geographical distribution. Modern taxonomy is working towards an ever finer discrimination of sub-species and local races of animals and plants, and, whatever may have been the case with the capercaillie, we are assured that the continental race of the Large Copper, now breeding at Woodwalton Fen and elsewhere, is quite distinguishable from the extinct British race of the species. It is to be deplored that a recent writer has seen fit to suggest, apparently in all seriousness, that the European beaver, the wild boar and the reindeer might be re-established in the Scottish Highlands.

The report makes the valuable suggestion that geological, no less than biological, features of Great Britain may require protection as nature reserves. This is a matter to which little if any attention has hitherto been given in Great Britain. Almost the only example of a protected geological feature that comes to mind is the "Fossil Grove" in Whiteinch Park, Glasgow, where a striking group of carboniferous tree-stumps has been preserved in a building erected over it by the Corporation of Glasgow. There must be many geological exposures all over the country that deserve protection against destructive quarrying.

One of the few aspects of the subject not touched upon in the report is that of river pollution, which, with the proposed redistribution of industry, must threaten many areas hitherto exempt. On one hand, the aquatic fauna and flora are as much deserving of preservation as those of the land and, on the other, a pure water supply is no less needful for any community of animals and plants than it is for any human settlement. There is no point in trying to set up a nature reserve on the banks of an open sewer.

The acquisition, protection and management of nature reserves involve a complex of problems, economic, legal and administrative, on all of which the report makes constructive suggestions. Starting from the admirable (if somewhat nebulous) principle that "the Government should take formal responsibility for the conservation of native wild life", it is recommended that a single central body should be set up to acquire and manage reserves that are of national importance, and to exercise supervisory and

consultative functions in respect of reserves held or administered by local authorities. The central body "should be distinct from, and have equal and parallel status with, the National Parks authority", the establishment of which has been recommended by successive Government committees. Whatever the administrative machinery, however, the paramount need for continuous scientific supervision cannot be too strongly emphasized.

COAL UTILIZATION RESEARCH AND THE NATIONAL ECONOMY

THE emergence of coal as a factor of major importance in the war effort of the United Nations is one of the outstanding features of the times. Its importance in Great Britain alone can be measured by the establishment of a Ministry of Fuel and Power, concerned not merely with production but also with utilization of fuel. The Parliamentary and Scientific Committee—a non-party and unofficial body formed to link scientific workers with members of Parliament—has attempted to bring matters to a focus at a meeting on May 4 in the House of Commons, when a report on "Coal Utilisation Research and the National Economy" was adopted. Members of both Houses and others concerned with technical and scientific bodies have joined in its preparation. Statements had been received from experts and also from Major Lloyd George, Minister of Fuel and Power. Copies of the report have been sent to the Lord President of the Council and other Ministers in the hope that they might agree to receive a deputation to discuss the implementation of the proposals.

The report stresses the fact that the life of Great Britain as an industrial nation depends on the supply of energy and raw materials for manufacture. Our climate necessitates the use of large quantities of artificial warmth. The declining productivity of our collieries, it is asserted, must be offset by increased efficiency of utilization. New industries must be created to secure us against unemployment and develop exports. "All these vital objectives demand coal research on a scale never before contemplated in this or any other country. Coal research is an investment which will repay this country handsomely."

The report includes a review of the fuel situation as it may appear after the War, in the light of needs and the present position of fuel technology. In general, the arguments are not new but repeated with greater vigour and urgency than hitherto, and it is instructive to look back and recall how they were received and treated in former times. Royal Commissions in succession have found that the national resources of coal are a wasting and, so far as the choicest and most accessible seams in Great Britain are concerned, a wasted asset. In the early days of this century a gentle effort was made to control the export of coal by means of a small coal tax. This raised economic problems, and in an age when trade had to be kept very free, the tax was short-lived. This indicates an important characteristic of the history of the coal industry. Coal has been regarded by the industry as a commodity to be bought and sold, not as a precious material, capable by means of scientific artistry of being fashioned into an infinity of new forms. The War of 1914–18 found the coal trade, actuated by commercial instincts, sinking costly new pits to achieve expanding exports—which, in the event, have not been realized.

Scientific men even then knew that Great Britain would some day have to cultivate greater thrift in the use of coal, and that this thrift would only be achieved by the application of scientific effort. So far back as 1906, the University of Leeds established a professorship of fuel technology, and in succeeding years the example has been followed to a greater or less extent in other universities. Considering their resources, fuel technicians of the past generation can view with satisfaction the results of their efforts, whether on the chemical or the engineering side, as is shown by figures given in the present report. Fuel problems are world-wide and, broadly speaking, there is no absolute secrecy about them. Ideas or achievements in one country can be adopted all over the world if those concerned choose—which is not always done. For example, enthusiasts for smoke abatement have never ceased to make their advocacy heard and yet, since women received the vote, they have not used their political power to bring forward the smokeless city.

Experience shows that there may be a considerable lag between the gaining of technical knowledge and its applications. In Great Britain, the tradition of individual liberty may even cause a retardation of technical progress. The coal-producing industry—employed and employers—has not helped. Left by the War of 1914–18 saddled with unremunerative collieries, it passed through a period of strife and even passive resistance to fuel efficiency, which led in one mining town to the prohibition of the use of gas-heated wash boilers in favour of coal—the object of efficiency in domestic heating took second place to the maintenance of sales. That this 'raw coal' mind still exists appears from the report itself, which links a plea for the burning of raw coal in domestic fires with far-reaching plans for chemical researches on coal. The chemical values in coal are likely to reside largely if not mainly in the volatile matter, which ought not to be ruthlessly burnt.

At one time, the cost of liquid fuel in Great Britain fell so far that imported mineral oil began to make serious inroads into the normal provinces of coal. In one large city in a mining area with idle pitworkers, a municipal building planned for oil-fired central heating was erected. The gas industry, dealing in a fuel which is above all mobile, has remained organized on almost parochial lines, while the uncontrolled competition between gas and electricity has allowed a waste of capital in the supply services. In addition, the country passed through a period of economic slump, which promoted conservatism, or rather conservation, of old plant and equipment.

The remarks above give just a few examples to

show how the application of technical progress may be retarded, especially when the habits and traditions of a nation are involved, as with its methods of heating. It may be a case requiring national action, but State action though powerful is slow. It required the War of 1914–18 to bring about the national Physical and Chemical Survey of Coal Resources of Great Britain. It has required a second World War to evoke a Ministry of Fuel and Power to step in and control or promote efficiency in utilization. This action, which would have seemed revolutionary a few years ago, is a logical consequence of the fuel survey and its revelations of shortages—especially of certain kinds of coal. This fuel economy campaign, launched to secure savings for the war effort, has already had considerable success in stopping the grosser wastes. It provides a survey of utilization conditions in general, and reveals that industry, including the large consumer, if wasteful of fuel, is usually wasteful involuntarily, because it is usually unaware of the inefficiency of its fuel-using installations.

This ignorance of conditions of combustion is unavoidable so long as it is permissible for plant to be installed unprovided with any sort of provision for scientific control. The action of the Ministry's technical staff has aroused increased attention to combustion control, and must, if continued after the War, lead to notable permanent fuel saving. It is an example of beneficent State action which calls merely for the application in industrial practice of existing knowledge, without awaiting the results of long-term research.

This does not preclude the concurrent development of fuel research in Great Britain as widely as is possible or effective. Experiment on a large scale is certain to be slow and may have to await the completion of small-scale preparatory work. The fact that all this takes time is a ground for making an early start. Fuel research is in active progress the whole world over, so that a flood of revolutionary results is not to be expected. Nevertheless, there is always the possibility that men of imagination will make discoveries, but only if they are given the opportunity.

The report makes a survey of the desirable aims for experiment, extending from the cleaning of coal to the preparation of synthetic resins and high-grade aviation spirit—all from coal. The proposals are marked by a prominent interest in the use of raw coal rather out of harmony with the use of coal as a raw material for the manufacture of chemicals. For this latter purpose, it is of course necessary to break up the coal mass into its constituent radicals, which are capable of reassembly to form new and desirable structures. It is very reasonably suggested in the report that an object for a national research policy would be the conversion of coal into fluid fuels (free from ash and sulphur) to the greatest possible extent. It is already permissible to envisage this as a possibility, worthy of a great national effort, to which all the other aspects of coal research now in progress in Great Britain would play a subsidiary part.

APOLOGETIC, OLD AND NEW

Princeps Concordiæ

Pico della Mirandola and the Scholastic Tradition. By Avery Dulles. (Harvard Phi Beta Kappa Prize Essay for 1940.) Pp. xiii+182. (Cambridge, Mass. : Harvard University Press ; London : Oxford University Press, 1941.) 11*s.* 6*d.* net.

Science, Christianity and Truth

By the Rev. Canon A. E. Baker. Pp. 158. (London : Eyre and Spottiswoode, Ltd., 1943.) 6*s.* net.

THERE might not at first sight appear to be very much in common between Mr. Avery Dulles' able and scholarly monograph on the fifteenth century Italian philosopher, Pico della Mirandola (1463–1494), and Canon A. E. Baker's work of modern popular Christian apologetic ; yet it is surprising to find how little the development of the natural sciences has affected the fundamental problems of religion and philosophy. This is all the more remarkable because Mr. Dulles, by his careful examination of the writings of Pico, makes it clear that this philosopher of the Renaissance was not, as some students of his work have maintained, a humanist of the modern type, nor yet an idealist of the Neo-Platonic tradition, still less a Hegel born out of due time. Fundamentally, he was a scholastic, belonging to the medieval rather than the modern tradition, the cleavage between these two being less sharp, in point of fact, than has often been supposed. At the Universities of Padua and Paris, but especially at the former, which in the fifteenth century had become the metropolis of scholasticism, Pico came into fruitful contact with the thought of the medieval philosophers. All his thinking is done in terms of scholasticism, which was by no means the barren fig-tree it has been pictured.

Mr. Dulles has two chapters on Pico's ontology, or theory of being : the first on the ontology of contingent beings, and the second on that of the necessary Being and His existence. In the former chapter it is very interesting to compare Pico's theories about matter with those of modern physics so lucidly stated by Canon Baker in his chapter, "The Story of the Universe". Pico, following Aristotle and Aquinas, was firmly opposed to the idea that formless matter could be real. To affirm the non-reality of matter apart from form is not so far removed from the saying of Sir Arthur Eddington, quoted by Canon Baker at the head of his chapter on modern physical theories : "I am convinced that if in physics we pursued to the bitter end our attempts to reach purely objective reality, we should simply undo the work of creation". Matter and form may both be abstractions from a unity which is indivisible, but the scholastics had in their dichotomy of matter and form an instrument of thought which enabled them to interpret being at all its levels. Pico, Mr. Dulles writes, "saw the whole universe as a hierarchy descending from the simplicity and sovereign reality of Pure Act at the summit, to the virtual nothingness of prime matter at the base".

In his remarkable chapter, "Is There a God ?", Canon Baker writes :

"If there be no other ground and cause of existence than the irrational, the meaningless, the unconscious, the blind, then there is no reason to believe that our reasoning arrives at truth rather than error. Particles of matter in motion, the discharge of quasi-electric forces along the paths of least resistance in the brain, determine all our thoughts."

Here again we have an idea which the scholastics would have grasped at once, namely, that the existence of God is pre-supposed in all our thinking, whether we realize it or not.

One idea is commonly supposed to have been the discovery of the Renaissance humanists—that of the dignity of man. But medieval writers dwelt repeatedly on the theme of man's greatness in God. The last two words are important. With regard to Pico's own views Mr. Dulles writes :

"A careful analysis of Pico's statements on the subject indicates, in my opinion, that he, like the medieval scholastics, conceived man's grandeur to lie essentially in his resemblance to God and in his capacity to perform the religious task of reuniting himself and the world to the Creator".

Such an idea of human dignity, inherited from their medieval predecessors, may well have characterized the Renaissance philosophers. But men of science to-day, however much they may wish to do so, cannot endorse this idea, unless they take other ground than that of their science. Canon Baker's words are only too true :

"The scientists, because they can say nothing more of man than that he is the product of evolution, here to-day and gone to-morrow, have no reply to the Nazi or Fascist or Communist assumption that liberty is only a fad or a prejudice and the individual is nothing compared with the Race or State or Working Class".

At a time when the higher education of our younger generation is predominantly scientific, and 'arts' are temporarily (so we hope) in abeyance, a perusal of both these books under notice would do no harm. The monograph on Pico, it is true, deals with topics unfamiliar in that form to those who know nothing of the history of ideas ; but those topics are still relevant to life ; as for Canon Baker's book, we can imagine no more profitable reading for any young student of science who is attracted by any form of negative dogmatism ; and the short bibliographies at the end of each chapter add to the book's utility.

J. C. HARDWICK.

PSYCHOLOGY OF A PRIMITIVE PEOPLE

Stone Men of Malekula : Vao

By John Layard. Pp. xxiii + 816 + 24 plates. (London : Chatto and Windus, 1942.) 50*s*. net.

HERE indeed is a book, immense, painstaking and prodigious in sheer material. Although not fully competent to appraise its ethnological content, I feel that certain connexions which such a work evokes in the mind of a psychological reader may perhaps be not without interest. An occasion, for example, comes to my mind when visiting Stonehenge with Jung some years ago. Standing at the centre of the mentally reconstructed temple he asked : "What power had that idea which could raise these mighty stones ?" When reading this formidable work a rather similar thought began to take shape in my mind. What power does the primitive still possess that can command such an impressive tribute ? Why, in fact, are we so compellingly attracted to the study of the primitive mind ? The claims of pure knowledge, answers the anthropologist. Maybe, but the passionate character of anthropological controversy makes one sceptical.

These men of Vao, a small island of the New Hebrides archipelago, are still living in the megalithic mentality. Their whole spiritual world is ritually integrated with dolmens, monoliths and stone circles similar to those of the megalithic period in prehistoric Europe. On the outer side, these megaliths are the visible basis of the Maki rite, which is not only the central pillar of their culture, but also lays down their social hierarchy. On the inner side, the rite is connected with a rebirth mystery in which the reborn individual takes on a new name and becomes one with the ancestral dead. It also appears that the stone monuments are erected for the sake of attracting the ghosts who hover near them. They serve, therefore, as a kind of spirit house or consecrated place which tends to localize the ghosts, thus preventing them from interfering with people and making them sick. The dread of ghosts is, moreover, centralized in a monstrous devouring ghost called *Le-hev-hev*, who waylays the souls of the deceased on their journey to join the ancestral spirits in their fiery after-life in the crater of an active volcano. This guardian ghost has to be placated and bought off by the sacrifice of tusked boars with which the souls of the deceased were mystically identified during life. These highly prized tuskers are, in fact, sacrificial substitutes for human victims for whom *Le-hev-hev* still shows a preference in her avid pursuit of human souls.

The lives of these people, social, economic and spiritual, are so intimately bound up with the central rite, and their concern for their fate in the after-life among the ancestral spirits so rules the whole habit of their life, that one is tempted to look for the key to their psychology in this Maki rite.

First, it can be taken as a general postulate that the primitive mind is only loosely integrated. It is not differentiated in the sense of having an organized personality which can preserve the direction and continuity of conscious life. Moral consciousness, in the form of the scrupulous observance of custom and taboo, is invested rather in the social group than in the individual psyche. It is therefore possible to say that the primitive psyche is externalized and, therefore, becomes visible in the form of concrete symbolism, in contrast to the civilized, which is, to some extent, abstracted from the environment, revealing itself in an inner world of images and values. For us, the integration of consciousness is the primary function of education, and the conserving of psychical continuity with the past has in general been taken over by the unconscious psyche. We can observe this vital function symbolized in dreams by running water, or personified in ancestral figures or in the ancestral tree or house. But with the primitives, this unconscious activity is projected outside them in identification with concrete symbols and ritual objects. Layard refers to this condition when he says (p. 255), "And sacrifice in these islands implies the identification of the victim, the sacrifice, and the mythical being to whom sacrifice is made". There is also an identification of the megaliths and the great gongs used in the rite with the souls of the ancestors. The gongs have a face and mouth painted on them. It is clear, therefore, that, like the bull-roarers in other rebirth rites these gongs represent the ancestors speaking. The whole world of magic consists, in fact, in a similar identification of active psychical factors with concrete ritual objects.

The key idea, then, which can guide us intelligibly through the labyrinthine complexity of primitive

ritual and kinship (and which may also explain the fact that Layard is now practising psychology) is to be found in the recognition that the primordial structure and activity of the unconscious is externalized and concretely manifest in primitive social organization. Whether we speak of the handing down of tradition, or the continuity of culture, or the immortality of the soul, or of reincarnation, we are really expressing the same central fact which these men of Vao are expressing in their megalithic identification with the ancestor spirits. All human piety is rooted in this feeling or belief in the continuity of life. The very fact, as Layard points out, that cannibalism has become a vital ethical problem to these people demonstrates how the principle of continuity represents the touchstone of human evolution. For inherent in the ritual cannibal feast is the idea that, by partaking of the body of the slain enemy, one not only participates in the brave qualities of the victim, but one also gives him continuity of life. Through partaking of the Elements in the Communion Christ lives again in us. But if the cannibal feast is eaten for the lust of human flesh without this inherent piety, it is regarded as an ethical relapse. In Egypt the continuity of life was vested in the Pharaohs. Only the king was divine, originating in and returning to the sun, and the paramount importance of this idea was symbolized concretely in the pyramid tombs, labyrinths, mummification and care for the dead. Among the men of Vao it is vested in the megaliths, the tusked boars, the Maki rite of rebirth and the whole complex system concerned in dealing with ghosts.

The powers of light and darkness, or of consciousness and unconsciousness, appear to be personified in *Taghar*, the creative deity, "who is held responsible for the organization of *Pete-hul* into four Quarters" (p. 208) and *Le-hev-hev*, the devourer of souls. We are told that the tusked boar is the animal of *Le-hev-hev* given to man by *Taghar*, both as defence against, and in honour of, *Le-hev-hev*, who seems to represent the primordial inertia of unconsciousness. Because of its relatively low level of integration and differentiation, the primitive mind is constantly threatened by 'loss of soul', in other words, disintegration. *Le-hev-hev* must, therefore, symbolize this ever-present danger; whereas *Taghar*, as the passage above indicates, represents the evolutionary urge towards integration and coherence—in a word, consciousness. Disintegration simply means the severance of continuity, or losing the right path.

But *Le-hev-hev* is also honoured because, through the fear of disintegration, the integrated pattern of life acquires its central value. This is beautifully exemplified by a myth recorded by Deacon (p. 650 ff), as also in the labyrinthine sand-tracings shown in Chapter 25. The patterns are drawn by the finger in sand and they all follow the same fundamental plan. The design consists in tracing round and round and in and out within a framework of straight lines set at right angles, or of small circles set in a regular pattern. In this way a geometrical design is formed of a single continuous line, and the finger must not be withdrawn until the entire figure is completed. Deacon explains the origin of this pastime in a myth. The design is regarded as a kind of maze, and these mazes were connected with a special design called "The Path", the drawing of which was an essential item in the journey followed by the ghost to the land of the dead. According to this belief, "Ghosts of the dead pass along a 'road' to Wies, the land of the dead. At a certain point on their way they come to a rock . . . lying in the sea . . . but formerly it stood upright. . . . Always sitting by the rock is a female ghost *Temes Savsap*, and on the ground in front of her is drawn the completed geometrical figure known as *Nahal* = 'The Path'. The path which the ghost must travel lies between the two halves of the figure, that is, between the opposites. As each ghost comes along the road the guardian ghost hurriedly rubs out one half of the figure. The ghost now comes up, but loses his track and cannot find it. He wanders about searching for a way to get past the *Temes* of the rock, but in vain. Only a knowledge of the completed geometrical figure can release him from this impasse. If he knows the figure, he at once completes the half which *Temes Savsap* rubbed out; and passes down the track through the middle of the figure. If, however, he does not know the figure, the *Temes*, seeing he will never find the road, eats him, and he never reaches the abode of the dead."

I have cited this myth because, to my mind, it contains the essence of the whole problem of the primitive mind. A ghost is, of course, an idea-complex or affect which invades the mind and, through taking possession, alienates the individual from his original nature. If one can know, and remain faithful to, the original pattern, which is, as it were, written in the heart of each man, one cannot be seduced by any ghost, however powerful. But to become obsessed by an idea or affect always means to become fanatical and one-sided: in other words, half the pattern becomes obliterated, and the way between the opposites is lost. This "Path" is the experimental way which each man has to find, and the sand-maze affirms the psychological truth that it is, in a sense, known to each individual. When he is quiet and 'with himself' he knows it. When he gets excited, or is driven by panic fear, he loses it.

However civilized we may have become in our outward appearances, we are nevertheless still primitive beings below the surface. Because of this fact the danger of uprootedness and disintegration remains also for us the greatest peril. We have lost our fear of mischievous and furious ghosts; but we have not yet learned how to deal with the obsessional fantasies and illusions which are liable to sweep through nations like a rushing mighty wind. Instead we project these unconscious ghosts upon our enemies, which is the very root and origin of war.

One of the most important aspects of Layard's research is concerned with the highly complex system of kinship in these islands. I must, however, leave it to the anthropologists to appraise this part of Layard's work at its true value. But the fact that he himself gives it such a prominent place seems to support my idea that the organization of kinship, by its very nature, represents the motive of structural integration and continuity in its most human aspect. Moreover, the diagrams with which he illustrates the system are eloquent, as he points out, of the same principles of balance and quaternity which govern the process of integration in individual therapy.

These New Hebrideans are, as we might expect, bisexual; but whereas the heterosexual component is taken care of by the elaborate rules of kinship, the homosexual is primarily concerned with creating an emotional solidarity among the men who, it is important to note, are exclusively responsible for the Maki rite. As in ancient Sparta, a boy is given to

the man as a lover and to instruct in the whole business of initiation into the man's world. Homosexuality, according to Layard, is intimately bound up with the operation of incision or circumcision, and it seems pretty clear that the importance of homosexuality in patrilinear groups is due to the fact that the inspiration of the ancestral spirits is imparted to the novice through the ritual homosexual act. The operation of incision is an act of sacrifice which invariably precedes the initiation into manhood. Since, therefore, the world of the spirits is, essentially, the spiritual world, we can assume that there are certain phases in the evolution of mankind in which the organization and cultivation of the masculine, spiritual principle needs to predominate over the more material and earthly feminine principle. It was, for example, during the formation and building up of the Greek city-states, when the masculine martial qualities were especially needed, that homosexuality was similarly legalized. In this connexion it is instructive to read that man acquires a soul only through sacrifice. Therefore, women and boys have neither souls nor ghosts. The critical importance given to this idea of sacrifice, first in the operation of incision and, later, in the elaborate cultivation of the tusked boars for sacrifice, seems to point to the conclusion that already the idea of gaining spiritual power through the sacrifice of some part of the animal nature has begun to operate, albeit in the primitive concretistic way.

These stray comments give, I fear, only a very inadequate rendering of the immense labours which the author has put into the work. It is indeed a monument erected by a devoted worker to that vast primordial realm which will ever remain the very groundwork and basis of the human mind.

H. G. BAYNES.

ELECTRICAL TECHNOLOGY

Applied Electricity

By A. W. Hirst. Pp. xi+290. (London and Glasgow: Blackie and Son, Ltd., 1942.) 15*s*. net.

THE mere change of title from 'electrical technology' to 'applied electricity' for the Part I paper in the examination for the University of London degree in engineering means very little to electrical students, who have to study all their subject whatever it is called. That the same course is to be taken by all other engineering students is another matter, and difficulties must arise when the educationist has to decide what amount of his special subject has to be presented to students who are to become civil or mechanical engineers. For the latter, the more subtle aspects of electrical engineering can well be omitted, with more emphasis on the broader issues of economy, types of electric drive, transmission systems, and even protection. The author has used his experience in this matter to present a text-book which covers both this ground and that for the examinations of the Institution of Electrical Engineers—what may be called the step between the electricity of physics and the specialized technology used by the qualified electrical engineer. The selection of material, the examples, emphasis on practical magnitudes, and diagrams are excellent, but one has qualms about non-electrical students taking this course.

There are a large number of footnotes in this first edition, and one wonders why they could not be incorporated in the text, because they are generally highly relevant and give valuable practical hints. There are two criticisms of the author's material which one can make. The first is that electrical engineers are very keen on the difference between electro-motive force and potential difference, and one cannot subscribe to the idea that the terms "ohmic drop" and "resistance drop" are better rendered as "counter E.M.F. of resistance" or "resistance E.M.F." (p. 70). A resistance may have an E.M.F. in it, but the telecommunications engineer would say that it has something to do with the thermal agitation of free electrons. As a consequence, the author deduces from Kirchoff's laws that "the algebraic sum of all the E.M.F.'s in any closed circuit is zero", which, to an engineer, would be highly fortuitous. Again, "the algebraic sum of the E.M.F.'s in the connected circuit is equal and opposite to the supply P.D.", which is exactly opposite to what an engineer would say, because he identifies the magnitudes of the E.M.F. maintaining the P.D. of a supply only when either no current is taken or the supply has no source-impedance. The engineer would likewise reverse "the vector sum of all the E.M.F.'s in the connected system is equal and opposite to the supply P.D.".

The second point at issue is the source of the torque which drives the rotor of an electrical machine. The author says (p. 41) "the force on the conductor produces a torque"; again (p. 46), "Torque is proportional to armature current multiplied by flux per pole"; also, (p. 171) Fig. 24, (*a*) and (*b*) clearly show forces only on stator conductors, and the text states "the armature rotates under the forces acting on the armature conductors". Now this is physically not so. There is certainly a flux-density at the location of any current-carrying conductor opposite a pole, but this conductor is magnetically short-circuited by the teeth of the magnetic material nearly surrounding such conductor, and consequently the flux-density at the conductor is very low in comparison with the average flux-density over the arc of the opposing pole face. With current in the conductor, the co-existing flux augments the pole flux in the tooth on one side and diminishes the pole flux on the other. It is due to this asymmetry of flux distribution with respect to each conductor that the teeth exhibit an unbalanced tangential force which is the actual force, when taken for all teeth, making the rotor revolve in a motor, or oppose rotation in a generator. Each conductor is actually cutting a very weak field at a velocity greatly exceeding that of the circumferential speed of the rotor. It is an unjustifiable assumption that the conductors are cutting the average flux-density at the circumferential speed, although this assumption fortunately leads to a correct calculation of torque and electro-motive force arising from rotation. There is no controversy here between the alleged rival flux-cutting and flux-linking theories, but merely a discussion regarding the source of the torque in a rotor. If there were no iron in the rotor, the torque would obviously be on the conductors. In Fig. 24 (*d*), (p. 171), the author gets to a tangential component of magnetic force but for a different reason, that of maintaining synchronization.

The author has covered a wide field with clarity and conciseness, and his book will certainly be of value to electrical engineering, if no other, students.

L. E. C. HUGHES.

X-RAY ANALYSIS OF HÆMOGLOBIN

By JOY BOYES-WATSON and M. F. PERUTZ

Cavendish Laboratory and Molteno Institute, Cambridge

IT was shown in a previous article in NATURE[1] that some information regarding the shape and dimensions of the hæmoglobin molecule can be derived from examination of the X-ray pattern of horse methæmoglobin crystals at different shrinkage stages. Further development has now led to the computation of direct Fourier syntheses which show a one-dimensional projection of the distribution of scattering matter in the hæmoglobin molecule.

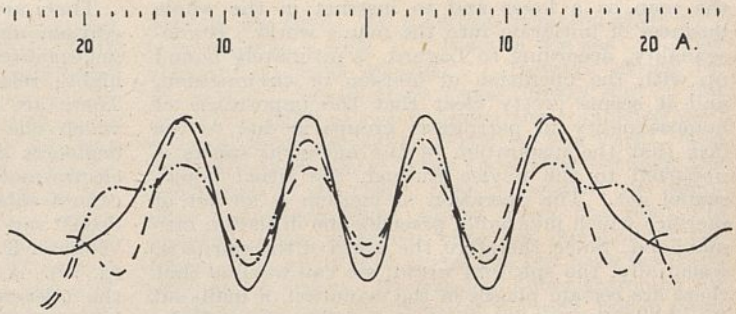


Fig. 2. ONE-DIMENSIONAL FOURIER PROJECTIONS OF HÆMOGLOBIN AT DIFFERENT STAGES OF SHRINKAGE OF THE CRYSTAL.

Each curve represents the electron density distribution in the unit cell projected on to a line which is normal to the c plane. The electron density scale is arbitrary. The plain curve corresponds to the fully wet crystal ($c \sin \beta = 51{\cdot}4$ A.), the dotted one to the first shrinkage stage ($c \sin \beta = 46{\cdot}1$ A.) and the dashed one to the second stage ($c \sin \beta = 42{\cdot}3$ A.).

It had been found that the molecules are platelets about 36 A. thick and 64 A. long. In the crystal, these platelets link up with their neighbours to form coherent layers which remain parallel to the crystallographic c plane at all stages of shrinkage. The liquid of crystallization is distributed in sheets between layers of protein; it was uncertain, however, whether there are one or two layers of liquid per unit cell; in other words, we could not distinguish whether the liquid lies between protein layers one molecule or one half molecule thick.

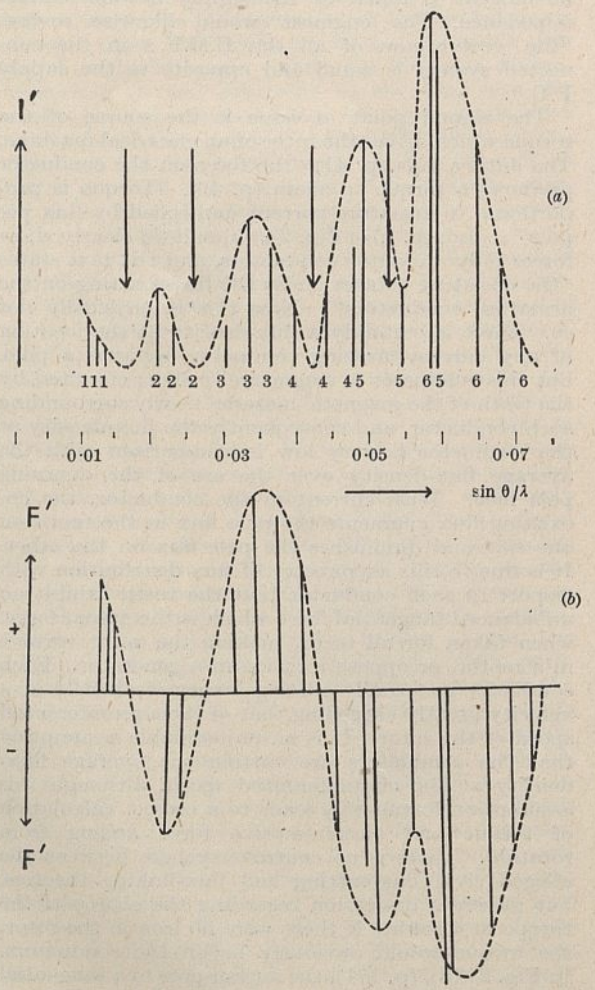


Fig. 1. (*a*) RELATIVE INTENSITIES OF $00l$ REFLEXIONS AT DIFFERENT SHRINKAGE STAGES PLOTTED ALONG c^*.

Each vertical line represents one reflexion. The numbers underneath the horizontal axis indicate the corresponding values of l; the arrows show the possible nodal points. The curve is the 'I curve' finally adopted.

(*b*) F CURVE SHOWING THE DISTRIBUTION OF SIGNS.

Since the layers are parallel to the c plane, a one-dimensional Fourier synthesis using the F_{00l}'s as coefficients of the terms gives a picture of the electron density distribution in the unit cell projected on to a line normal to the layer plane. Several such projections calculated for different shrinkage stages should enable us to recognize the hæmoglobin molecule and distinguish it from the liquid of crystallization. In order to calculate the projections, the phases of the F_{00l}'s have to be found. Since the b axis is a diad, the F_{00l}'s are real, and only their signs have to be determined. This was done in two different ways, which both led to the same result.

To understand the first method, we may consider the reciprocal lattice. Since the crystal contracts by the moving together of layers which remain parallel to the c plane, the reciprocal lattice expands by the moving apart of points along equidistant lines which are parallel to the c^* direction (Fig. 1 of ref. 1). The $00l$ points will move along the c^* axis away from the origin. Supposing we could record the intensities of the $00l$'s at a very large number of different shrinkage stages and plot them on a diagram with the intensity as ordinate and c^* axis as abscissa, then we should get an 'I curve' from which the molecular scattering F curve can be derived. It has been shown in the former paper that this F curve is constant and independent of the degree of shrinkage of the crystal. Wherever the F curve passes through zero and changes sign the 'I curve' touches the horizontal axis. Once we know the nodal points at which this happens, the sign of any individual F_{00l} relative to the others would follow directly from the position of the corresponding reciprocal point on the c^* axis.

In reality we were only able to record four shrinkage stages. The last of these, the air-dried stage, yielded pictures which were too poor for the intensities of the $00l$'s to be measured. If we plot the intensity of the $00l$ reflexions at each of the first three stages along the c^* axis in the way described above, then we obtain the diagram shown in Fig. 1*a*. It is seen that the number of points is insufficient to outline the 'I curve' unambiguously. There is one point,

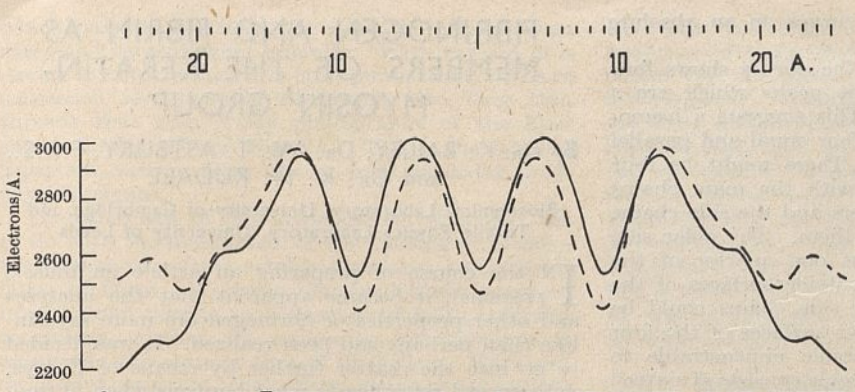


Fig. 3. ONE-DIMENSIONAL FOURIER PROJECTIONS OF HÆMOGLOBIN PLOTTED ON AN ABSOLUTE ELECTRON DENSITY SCALE.

The plain curve corresponds to the salt-free crystal and the dashed curve to the salt-containing one. Both crystals are in the fully expanded state.

however, where we know from the absence of a 002 reflexion that the curve touches the horizontal axis; so this must be a nodal point on the F curve. There are three other points where the 'I curve' might or might not touch the axis. Taking none or any or all of these in turn to be nodal points, eight different F curves can be drawn. These lead to eight different combinations of signs among the F_{00l}'s. Each of these combinations was substituted in turn in three Fourier syntheses corresponding to the first three shrinkage stages.

The first and most striking result was this: whatever combination of signs was used in the syntheses, the solutions were incompatible with more than one layer of liquid per unit cell. Thus the possibility that the hæmoglobin molecule in the wet crystal might consist of two platelets with variable amounts of liquid in between is ruled out; the protein layers in the wet crystal must be one molecule thick and the liquid of crystallization purely intermolecular.

Finally, the correct combination of signs of the F's was found without great difficulty by rejecting all those solutions incompatible with the size and density of the hæmoglobin molecule and its relation to the diad axis. This procedure led to the exclusion of all but one of the sets of curves; this is shown in Fig. 2. The significance of the curves will be discussed below.

Fortunately we were able to derive the signs of the F's more directly by a method which was largely independent of the one described above. Dr. E. F. Hartree supplied us with a new variety of horse methæmoglobin crystals which were prepared by electrodialysis of a highly purified methæmoglobin solution against water, instead of being grown by dialysis against a concentrated solution of ammonium sulphate as before. The new crystals were isomorphous with the usual variety and contained the same volume of liquid, the only difference being that now the liquid was water whereas before it had been ammonium sulphate solution. The X-ray patterns obtained from the two kinds of crystals—salt-containing and salt-free—were practically the same except for striking differences in the intensities of the low $00l$'s. These differences were used to work out the signs of the F's.

The method was similar in principle to that introduced by Cork[2] in determining the signs of the F_{hkk}'s in an isomorphous series of alums containing metal atoms of different weight. Our argument may be outlined as follows. The liquid of crystallization fills the space between the protein layers. Since we know the thickness of the protein layers, both the thickness of the sheets of liquid and their distance apart can be calculated. Hence it is possible to work out which of the F_{00l}'s ought to increase or decrease in value on substituting pure water for ammonium sulphate solution as liquid of crystallization. By comparing the results of these calculations with the observed intensity changes, the signs of some of the F's could be determined. This led to the exclusion of all but two of the possible combinations of signs; one of these was identical with the solution arrived at by the first method, while the other had to be rejected for the reasons mentioned in the last paragraph. In Fig. 3 the electron density curve for the salt-free crystal is compared with the curve for a salt-containing one. Fig. 1 shows the I and F curves which resulted from the determination of the signs of the F's.

In interpreting the curves of Figs. 2 and 3, we take it that the four-peaked structure in the centre corresponds to the protein and the depression at the outside to the liquid of crystallization. In Fig. 2 the width of the depression varies according to the degree of shrinkage of the crystal. In Fig. 3, on the other hand, the depth of the depression differs in the two curves, and is smaller in the case of the salt-containing than in the salt-free one. In the latter case the electron density at the bottom of the depression ought to correspond to that of pure water; this was verified experimentally by measuring the absolute intensity of the 001 reflexion, thus

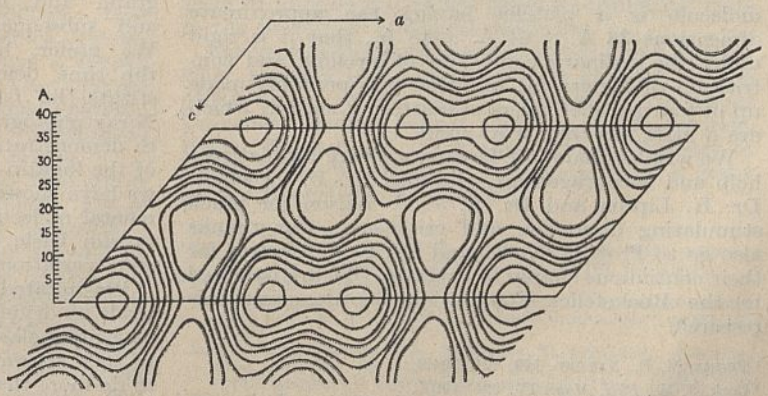


Fig. 4. TWO-DIMENSIONAL FOURIER PROJECTION ON THE b PLANE, SHOWING HÆMOGLOBIN MOLECULES.

The crystal is air-dried. The contours are lines of equal electron density drawn at arbitrary intervals.

putting the electron density curves on an absolute scale.

The protein portion of all the curves shows four roughly equal and equidistant peaks which are a little less than 9 A. apart. This suggests a hæmoglobin molecule consisting of four equal and parallel layers of scattering matter. There might be four layers of polypeptide chains with the main chains folded in the plane of the layers and the side chains protruding at right angles to them. The polar side chains, which make up about one quarter of the total, could occupy the two outside surfaces of the molecule, while the non-polar side chains could be tucked away in the six interior surfaces of the four layers, thus making the molecule impenetrable to water. If the hæmoglobin molecule consists of sixteen separate polypeptide chains, as Chibnall suggests[3], four folded chains extending in the direction of the *b* axis could easily be accommodated in each of the four layers. A molecular model of this type fits in well with all the evidence which has been brought forward up to the present; it is reminiscent of the structure postulated for egg albumen by Astbury some years ago, or of the structure of antibodies suggested by Pauling[4,5]. We should like to emphasize, however, that the model is only one of several possible ones between which there is little to choose as yet, and that it would be premature to draw any final conclusions.

For further progress a two-dimensional projection of the molecule is needed. A first step in this direction has been made by analysing a picture from an air-dried crystal showing four reflections only (001, 200, $\bar{2}01$, $\bar{4}01$). Taking all possible permutations of signs of the corresponding *F*'s, two-dimensional Fourier syntheses were calculated for each of them. We were surprised to find that this led to not more than two different solutions. One of these is highly improbable, because it shows molecules which are much too small and heavy compared with the background. The other solution gives a contour map of dumb-bell shaped molecules (Fig. 4). The resolving power of this method is naturally very poor and is insufficient to show up any detail—indeed, some of the features shown in the picture may be of a spurious nature. Nevertheless, with all its shortcomings, it is the first direct picture of a small protein molecule. The overall dimensions of the molecule on the map agree well with those calculated from other X-ray data; its width along the *a* axis appears to be 48 A.

Summing up, we may say that the hæmoglobin molecule is a platelet having the approximate dimensions 36 A. × 64 A. × 48 A., that it is rigid under the ordinary conditions of swelling and contraction of the crystal, and that it is probably made up of four parallel layers of scattering matter, which are a little less than 9 A. apart.

We wish to thank Sir Lawrence Bragg for his great help and encouragement, and also Dr. D. Crowfoot, Dr. H. Lipson and Dr. A. J. C. Wilson for much stimulating discussion and criticism. Our thanks also go to Prof. D. Keilin and Dr. E. F. Hartree for their continuous supply of crystals. We are indebted to the Rockefeller Foundation for financing this research.

[1] Perutz, M. F., NATURE, **149**, 491 (1942).
[2] Cork, J. M., *Phil. Mag.*, IV, 694 (1927).
[3] Chibnall, A. C., *Proc. Roy. Soc.*, B, **131**, 136 (1942).
[4] Astbury, W. T., NATURE, **137**, 803 (1936).
[5] Pauling, L., *J. Amer. Chem. Soc.*, **62**, 2643 (1940).

FIBRINOGEN AND FIBRIN AS MEMBERS OF THE KERATIN-MYOSIN GROUP

By DR. K. BAILEY, DR. W. T. ASTBURY, F.R.S., and DR. K. M. RUDALL

Biochemical Laboratory, University of Cambridge, and Textile Physics Laboratory, University of Leeds

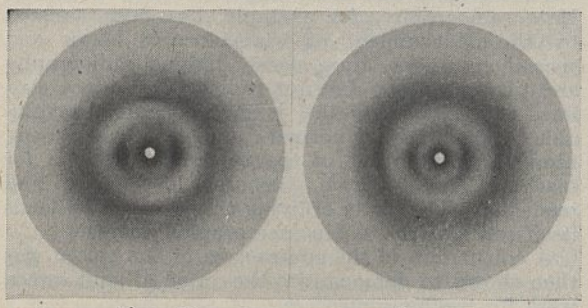
IN the course of preparing an article on muscle proteins[1], it became apparent that the analyses and other properties of fibrinogen are more myosin-like than perhaps had been realized. It was decided to go into the matter further by means of X-rays, with special reference to what happens when fibrinogen is changed to fibrin during the clotting of blood. The problem is of such wide interest that we think it worth while to give a short account of our observations to date, even though confessedly much work remains to be done.

In the first place we have demonstrated that both fibrinogen and fibrin do indeed belong to the keratin-myosin group of fibrous proteins. X-ray and related studies of the keratin-myosin group have frequently been reported on in these columns and elsewhere[2], and we need only recall here that the group has been found to include not only the fibrous proteins of the epidermis of mammals, amphibians and certain fishes[3], and the fibrous structures such as hair, horn, nails, etc., that arise from the mammalian epidermis, but also the principal muscle protein, myosin. All these are endowed with reversible, long-range elasticity, and all give two kinds of X-ray diffraction pattern, so-called α and β, according as they are unstretched or stretched. Fig. 1*a* (cf. Fig. 2*a*) shows an X-ray fibre photograph of oriented fibrinogen, prepared from human plasma by three times precipitation with ammonium sulphate. There is no doubt that this is the familiar α-pattern, though a little obscured by 'extraneous' matter, probably partly lipoid and partly protein unavoidably trapped from other blood constituents. In the ordinary way the fibrinogen photograph—we have examined a variety of preparations—is considerably overlaid with secondary rings and haloes. We are still investigating this point, but we find, for example, that a few minutes treatment of a fibrinogen film with 0·2 per cent caustic soda, followed by washing, both cleans up the photograph and facilitates orientation by stretching and subsequent transformation into the β-form. We prefer, however, to postpone judgment for the time being on such questions as what constitute the 'best' fibrinogen preparations, the 'best' X-ray photographs, etc. Our immediate concern was to demonstrate that fibrinogen is a genuine member of the keratin-myosin group; and in this connexion we have shown over and over again that the fundamental molecular plan of the group (the α-fold) and certain basic elastic properties are conserved over wide variations in chemical constitution[4].

Precipitated fibrinogen, or moist strips of film made by drying a sol on a glass plate, exhibit obvious long-range elastic properties; but the internal cohesion of such specimens is not high, and it is not possible to do more than initiate the α-β intramolecular transformation by direct stretching before rupture occurs. We have overcome this difficulty by falling back on our experience with keratin and myosin, both of

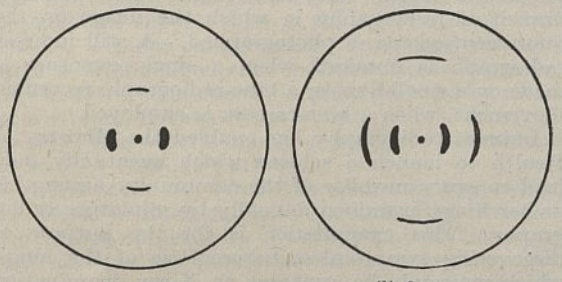
which pass readily from the α- to the β-form when elongated by squeezing laterally. With the aid of a device to be described in a later publication, we have succeeded in squeezing fibrinogen into long thin threads that give X-ray photographs of the kind shown in Fig. 1 *b* (cf. Fig. 2 *b*). This is the familiar β-pattern, arising from almost fully extended polypeptide chains.

The other side of this investigation, of course, has to do with the mechanism of the clotting of blood—the change-over from soluble fibrinogen to insoluble fibres of fibrin. We have examined fibrin prepared from human plasma in a number of ways, and our conclusion is that its molecular configuration is essentially the same as that of fibrinogen. Katz and de Rooy[5] reported that fibrin gave the β-keratin pattern, but it seems clear now that they were misled



(*a*) α-FORM (*b*) β-FORM

Fig. 1. X-RAY FIBRE PHOTOGRAPHS OF FIBRINOGEN.



(*a*) α-FORM (*b*) β-FORM

Fig. 2. ILLUSTRATING CHARACTERISTIC FEATURES OF FIG. 1 THAT ARE DIFFICULT TO REPRODUCE WITH THE CLEARNESS OF THE ORIGINAL X-RAY PHOTOGRAPHS.

by the results of high extension. We have repeated their procedure as described, but even so we find a weak but unmistakable α-pattern besides the β-pattern. Our observations are as follows: that fibrin stretched just sufficiently to produce orientation is mostly in the α-form with always a certain amount of poorly oriented β-form present; but that the amount of β-form increases rapidly on further stretching, though it is not possible by simple stretching to transform all the α-form before rupture occurs.

On the face of it, this could mean that fibrin is intrinsically a mixture of α- and β-forms; but it appears much more likely that primary unstretched fibrin is in the α-form, and that a small amount of β-form is generated inevitably in the rough and tumble of gel formation among the constituents of the plasma, and also in subsequent manipulation for the purpose of obtaining an oriented X-ray photograph. In other words, fibrin is no other than an insoluble modification of fibrinogen without any fundamental change in molecular plan; but also it is in a higher state of aggregation, as is evidenced by its greater internal cohesion and ease of transformation into the β-form by stretching, and by the evolution of visible fibres from the rod-like units that confer on fibrinogen sols their property of flow-birefringence[6]. The appearance of long straight fibres radiating from corpuscles in the blood clot strongly suggests that they are formed primarily by end-to-end accretion of fibrinogen units, but we hope to be able to throw more light on this supposition by examining with the electron microscope the structure of clots that have been freeze-dried before synæresis takes place. Once the primary mechanism of aggregation is established—whether by way of end-groups or by way of side-chains—the way is open to a more detailed chemical study of the phenomenon.

Nature of the Clotting of Blood

A word of warning may not be out of place with regard to other methods of clotting fibrinogen[7], and with regard to conclusions that have been drawn that clotting is only an example of denaturation[8]. Everything depends on what is meant by denaturation. A dried myosin film is denatured in the limited sense that it has become insoluble, but it is *not* configurationally denatured, for it is still in the folded α-form. But when myosin is heat-denatured, for example, it passes into the unfolded β-form, and then it is truly denatured in the configurational sense. When fibrin is produced from fibrinogen by the action of thrombin there is little or no configurational denaturation; for though there is loss of solubility as when myosin is dried, it also remains in the α-form. Some of the kinds of clot other than the physiological may conceivably be, and probably are, aggregates of fibres in the β-form, produced by a different chemical mechanism. At the moment we are studying clots formed *in vitro* from fibrinogen, prothrombin, calcium ions and cephalin[9], and thence we hope to proceed to an examination of non-physiological cases.

It is not necessary, of course, to emphasize the importance of any theoretical or practical contribution to our knowledge of the clotting of blood, but taking the long view, the knowledge that fibrinogen and fibrin are additional members of the keratin-myosin group is of greater significance. The biogenetic implications strike deep. When we consider that the fibrous proteins of the epidermis, the keratinous tissues, the chief muscle protein, myosin, and now the fibrinogen of the blood, all spring from the same peculiar shape of molecule and are therefore probably all adaptations of a single root idea, we seem to glimpse one of the great co-ordinating facts in the lineage of biological molecules.

For part of the work described above, and also for what remains to be done, we are grateful for the collaboration of Dr. W. C. Evans of the Leeds University Medical School, Director of Laboratories, Region No. 2 Blood Transfusion Service, Ministry of Health. The investigation is financed from a grant by the Rockefeller Foundation.

[1] Bailey, K. (in press).
[2] See, for example, Astbury, W. T., *J. Chem. Soc.*, **337** (1942); Astbury, W. T., and Dickinson, S., *Proc. Roy. Soc.*, B, **129**, 307 (1940).
[3] Rudall, K. M. (to be published).
[4] See, for example, Astbury, W. T., "X-rays and the Stoichiometry of the Proteins" in Vol. 3 of "Advances in Enzymology", pp. 63–108 (1943).
[5] Katz, J. R., and de Rooy, A., *Naturwiss.*, **21**, 559 (1933); *Rec. trav. chim. Pays-Bas*, **52**, 742 (1933); Katz, J. R., "Die Röntgenspektrographie als Untersuchungsmethode" (1934), p. 183.
[6] Wöhlisch, E., and Clamann, H. G., *Z. Biol.*, **92**, 462 (1932); Böhm, G., and Signer, R., *Klin. Wochenschr.*, **11**, 599 (1932).
[7] See, for example, Eagle, H., *Medicine*, **16**, 95 (1937).
[8] See, for example, Wöhlisch, E., *Kolloid-Z.*, **85**, 179 (1938).
[9] Ferguson, J. H., *J. Lab. and Clin. Med.*, **24**, 273 (1938–39).

PHOTOGRAPHY AS A SCIENTIFIC INSTRUMENT

THE first meeting of the newly founded Association for Scientific Photography was held at the Royal Institution on June 5. Prof. J. Yule Bogue, in his opening address, on applied photography, said that with the rapid growth of science and technology in the last decade, workers, whether they be in the industrial or purely scientific fields, have found it increasingly difficult to keep in touch with the recent advances in fields other than their own. Any particular branch of industry or science is largely dependent for its own advancement upon the progress made in other branches. In order that the maximum benefits may accrue, it is essential that knowledge of these advancements be disseminated as widely as possible. The Association for Scientific Photography has been formed to do this in respect of the development and application of photography as a scientific instrument in industry, technology, medicine and science. The association will assist its members in the solution of problems of development, production and research, by the application of photographic methods. It caters primarily for those who apply or could apply photographic techniques to their work, as opposed to photographers who are interested in the application of their work to scientific problems. It is essential, therefore, that there shall be close co-operation with those concerned with the technical developments of photographic science, so that the results of their work shall be readily available for application by those working in science and industry.

The applications of photography to industrial work, development, and research are enormous. Some indications of this are given in the questionnaire which members are required to fill in, stating whether they are interested in the application of photography to pure research, for example, tracks of atomic particles ; or industrial research, for example, the study of vibration in air-screw blades ; or production, for example, the radiography of castings ; or recording for instructional purposes, for example, documentary kinematography.

He thinks that one important result of the meetings of the Association would be the bringing together, through a common interest, of workers from widely different fields of industry and science. This will be to their mutual advantage, for not only will they discuss their photographic problems, but also their particular lines of investigation.

Prof. Bogue then dealt with some specific applications of photography, confining his choice to a few examples which incorporated several photographic techniques and had more than one specialized application. By the *Schlieren* photographic method, changes in the refractive index of the atmosphere are made visible. The changes may be sudden, such as those produced by the detonation of explosive mixtures, or they may be slow, such as those brought about by changes in temperature. The method has been used successfully in conjunction with the high-speed camera, in studying the properties of aerofoils. The design of radiators, heating elements, and heat-dissipating surfaces, also lends itself to this form of control. With stroboscopic light sources, using gaseous discharge lamps and oscillating circuits, photographs of the distortion of air-screw blades rotating at high speed can be made. The modern gaseous discharge lamp can be made to give an exposure so short as 1 μsec. (=0·000001 sec.), and can be used with either the still or high-speed camera.

Photo-elastic analysis has obvious uses in the study of components of machines and other structures subjected to stresses. This technique has also proved of value in understanding the stresses set up in the brain as a result of head injuries.

Photo-micrography has a wide range of application, from the control of galvanizing and the study of metal structure, to the study of fibres in the textile industry and histological investigations in medicine. Time lapse kine-photomicrography, for example, has yielded much information on the development of the mammalian ovum, which could not have been obtained by any other means.

Photography has many applications in medicine. Mass radiography, for example, has been assisted by the development of wide-aperture lenses and special emulsions, thus closely linking radiography and photography. Indirect radiography is not confined to diagnostic work ; it has also proved invaluable in the study of normal function. The 16 mm. film has become one of the most useful media for teaching and research purposes in biology and medicine. The study of living things in action lends itself particularly to kinematographic analysis.

A colour film of the contraction of the spleen was then shown to demonstrate the value of split-screen work for teaching purposes.

In her paper on "Indirect Radiography as Applied to Medical Work," Miss K. C. Clark dealt with that branch of radiography in which the image on the fluorescent screen is photographed. A still indirect radiograph is obtained when a single exposure is made on a small film, or a kine-radiograph, recording movement, when a kine-camera is employed.

Indirect radiography has enabled the Ministry of Health to launch a scheme which eventually may lead to every member of the community having his or her lungs examined annually by miniature radiography. This examination is for the purpose of discovering symptomless tuberculosis of the lungs, which may only be apparent on X-ray examination and which may not be discernible by routine medical examination. Such an examination of large numbers at sufficient speed, which was impossible by the direct method, has been solved by the application of miniature radiography.

The first practical application of the method was in Brazil in 1934. It has since been employed for the native miners in South Africa, in the Fighting Services, in Australia and America, and in Germany. It has been left to Great Britain, after employing the method to examine men and women in the Services, to introduce a national scheme, which, beginning with the twenty-five special X-ray units, will eventually and by gradual infiltration service the whole country. New units are being delivered each month and personnel trained in their operation. With one of these units, subjects are being examined at a rate of more than 500 a day. The unit can deal with four persons a minute, and the whole process for each person—undressing, taking information for records and identification purposes, and redressing, takes 10–15 minutes. The size of film used for this work is still a matter for discussion ; the most widely used in Great Britain is the 35 mm. cine film. The lenses have an aperture ranging from *F*/1 to *F*/2. Miss Clark uses the Taylor, Taylor and Hobson *F*/1·5

coated lens. In most units a fluorescent screen is fitted to the wide end of a light-proof tunnel which has an automatic camera at the smaller end. These specially designed cameras are linked with and operated from the X-ray exposure control. Identification is ensured by illuminating the serial number on the subject's card and photographing it on to the base of the film upon which the radiograph is taken. Since the patient hands his card to the operator, there is no possibility of error. The average exposure time is 0·1 sec. or 20 mA.-sec., with a variation of 2 kilovolts for each half inch of chest thickness, with a reduction of time down to 0·05 sec. for smaller thicknesses, and an increase in time to 0·2 sec. for outsize subjects.

Special training is needed in the handling of miniature films, as minute defects show up on projection, especially when the viewer sits within 20 in. of the white matt surface screen. These films are viewed at a rate of 200–450 an hour. A complete radiological interpretation is never given on a miniature film, and a film showing a technical error is never repeated on a miniature. For both reasons, subjects are recalled for full-sized X-ray examination ; about 5 per cent are recalled, but the number found to have tuberculosis does not exceed 1 per cent.

Miss Clark then mentioned points for future discussion, which included various aspects of design of the X-ray equipment, screens, cameras, films and processing. Mention was also made of the 5 in. × 4 in. method used in the United States. This is much slower than the 35 mm. film method, because the individual films have to be handled separately throughout, though there is the advantage of direct viewing without enlargement. The paper concluded with a brief reference to indirect kine-radiography, in which the screen image is photographed by means of a 16 mm. camera fitted with an $F/0{\cdot}85$ lens. At present, this work is chiefly of academic interest and is used for research purposes.

In his paper on "Some Miscellaneous Applications of Industrial Radiography," Dr. L. Mullins described the diverse applications of radiography for inspection and also its use purely as an investigational tool incidental to the main problem. He mentioned that radiography as an inspection technique is playing an ever-increasing part in the national war effort, not only in the well-known application to the examination of castings and welds for porosity, cracks, slag inclusions and other defects, but also in the inspection of such products as electric cables, plastic assemblies, transformer windings on cardboard formers and wireless valves.

The application of radiography to the examination of wireless valves provided Dr. Mullins' first example of the use of X-rays as an investigational tool, since they may be applied in the study of filament distortion while the valve is working. Radiography has also been used in the determination of the rate of increase in the compressive stress in steel due to nitriding. In this work, reported by Betteridge, a flat steel strip, with its underside protected from nitriding by tin plating, was placed in contact with a steel block in the nitriding furnace. Radiographs made through the walls of the furnace prior to and during nitriding revealed the curvature caused in the steel strip and enabled calculation of the stress at the various stages concerned. Additional radiographs made during cooling provided information on the differential expansion of the metal core and the nitride casing.

Further examples of this type concerned the determination of the internal bore of glass tubes, of capillary measurements involving liquids in opaque tubes and of the viscosity of tooth paste, and an investigation of the nature of sodium silicate bonds in corrugated cardboard. This last application provided hitherto unknown information concerning the physical structure of the adhesive joint, the location of the adhesive within, and on, the paper, and the relation of the joint structure to the physical properties of the corrugated board.

As examples of the applications of X-rays in biology, Dr. Mullins cited investigations on the movements of death watch beetle larvæ, and the radiographic method for the vitamin D content of cod liver oil for poultry feeding.

Where rapidly changing phenomena, such as the movement of a piston within an opaque cylinder, have to be examined, kine-radiography has proved of considerable value despite the limitations on its scope, due to the fact that the intensity of the photographic effect on the recording medium is entirely dependent on the output of the X-ray equipment. Two techniques are available : first, the *indirect* method, in which a kine-camera is used to record the fluorescent screen image ; and seondly, the *direct* method in which the X-ray beam, after passing through the specimen, is recorded directly on kine films. In the latter technique greater taking speeds may be achieved by the use of intensifying screens in contact with the film. The direct method was used by Sack in a study of the metal drop formation in electric welding. Previous photographic studies using slow-motion kine techniques had provided incomplete information owing to the presence of hot gases and vapours in the welding zone and the very bright welding arc ; these difficulties had, however, been overcome to some extent by the use of infra-red sensitive materials and suitable filters. X-ray technique not only surmounted these difficulties but also enabled differentiation between the core and coating of coated welding rods. Sack's apparatus was designed to take twenty-five frames every two seconds, and the results obtained provided extensive information on the nature of the drop formation in various circumstances, showing, for example, that, with heavily coated electrodes, the drops form within the coating and fall before their diameter exceeds that of the electrode.

Where the effect being studied takes place in too short a time for kine-radiography to produce useful results, the possibility of high-speed radiography should be considered. Many attempts have been made to produce X-ray tubes capable of generating and withstanding very high instantaneous loads. Steenbeck and also Kingdon and Tanis have described X-ray tubes in which a pool of mercury serves as the target : the disadvantages of this design are that the mercury must be cooled to maintain a low vapour pressure and that the X-ray tube can be used in only one position. Oosterkamp devised an X-ray tube for this purpose in which high instantaneous loads are applied by discharging a condenser across the tube while momentarily increasing the filament current. Recently Slack and Ehrke have described a cold-cathode X-ray tube across which a bank of condensers is discharged by a relay linked with the effect being studied. This tube is capable of providing an electron flow across the tube as great as 2,000 amp. at 100 kV. for a millionth of a second.

With this equipment Slack and Ehrke have already investigated, among other things, the passage of bullets through wood, the movements of the bones in the foot when kicking a ball and the movement of dust in the intake duct of a vacuum cleaner.

In closing, Dr. Mullins said that, as this brief survey would show, the scope of industrial radiography is indeed wide, and he ventured to suggest that, with the active co-operation of radiographers and of the manufacturers of X-ray equipment and X-ray films, even wider applications than are considered feasible at present would become evident.

C. D. Reyersbach's demonstration of "Sub-standard Kine-photo-micrography" was presented by J. Alsop. The purpose of the demonstration was to indicate the application of the kine-camera to photo-micrography for determining and recording the movements of small bodies. This was dramatically shown in a colour film of pond life and the growth of crystals. The film was made by the author in collaboration with Alsop, L. Elliott and A. Sabin. The apparatus required is that used for still photo-micrography, with the addition of a kine-camera. It is desirable and useful to incorporate an optical arrangement enabling the operator to watch the field of the microscope while the exposures are being made; this was done in the case of the film presented.

The method of dark-ground illumination used was a differential one, the object of this being to increase contrast, while at the same time minimizing glare that is apt to arise with rather transparent objects when ordinary dark-ground illumination is used. This illumination is obtained by mounting behind the condenser of the microscope a central disk of one colour with a disk of another colour around it. The colour of the central disk will then provide the background, while the object will be illuminated by light of the colour of the outer disk. In the case of the shots showing the growth of crystals, a polarizer and analyser were used. The examples shown were all low-power work, but the principles are precisely the same where higher powers are required. The problem of exposure is one which requires careful consideration, and it is found that the exposures required are considerably shorter than anticipated. The exposure of short test strips, together with a complete record for future guidance, is advised.

Mr. H. McGregor Ross, in his paper "The Photography of Photo-elastic Stress Patterns", said that photo-elastic stress analysis offers the engineer a most effective method of solving problems of stress distribution. It is not only frequently simpler and quicker than other methods, but also it may be used

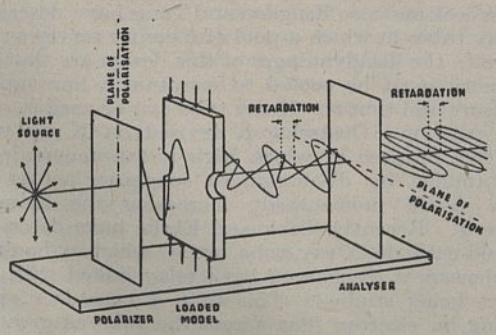


Fig. 1.

Fig. 2.

to solve problems otherwise insoluble or at least demanding tedious computations.

The majority of stress distribution problems may be simplified by considering the two-dimensional system of stresses in a section of the object under investigation. These stresses may be completely determined by finding the magnitude and direction of the two 'principal stresses', and photo-elastic stress analysis is particularly well suited for obtaining this information.

A transparent scale model is made of the section of the object, using a suitable plastic material. Loads which are proportional to the loads in the real object are then applied to the model, and it is viewed by polarized light in a polariscope. If a monochromatic light source is used, a pattern of light and dark lines will be seen in the model, and it is from these lines that the magnitude of the stresses may be determined. Each line may be considered as a 'contour' of stress, the difference between the two principal stresses being the same at every point along each line; the value of this difference is found by a previous simple test. The stresses in the actual object will be proportional to those found in the model.

The optical theory is shown simply in Fig. 1. Light from the source passes through a polarizer and emerges plane-polarized. The material of which the model is made has the property of becoming bi-refringent when stressed, so that the polarized light is split into two components on entering the stressed model. The direction of vibration of these components is the same as the directions of the principal stresses. While passing through the model, one component will travel more slowly than the other, so that it will be 'retarded' on emerging from the model. The extent of this retardation is proportional to the magnitude of the difference between the two principal stresses. The two components are combined by being passed through the analyser, and the interference effects caused by the retardation gives rise to the stress pattern observed in the model. If a white light source is used, the resulting stress pattern will consist of coloured lines, the colours being similar to those given by any interference phenomenon. Photographs in natural colours were shown of typical stress patterns.

At all points in the model where the direction of one of the principal stresses coincides with the plane of the incident polarized light, the light passes straight through the model and is cut out by the analyser. This results in a dark line—the isoclinic line—appearing in the model, from which the direction of

the principal stresses may be found. If it is required to find the magnitude of each principal stress separately, a further technique is required which was not considered in this paper.

In order that these patterns may be photographed successfully, it is necessary to use a suitable polariscope. An instrument which had been found satisfactory was demonstrated, and various points in its design were discussed. With this instrument photographs had been obtained with very short exposures. Consideration was also given to the best photographic materials for this type of work.

A recent development, particularly in Great Britain, has been the combination of photo-elastic stress analysis with the technique of high-speed photography for recording sudden dynamic stresses, carried out at the Research Laboratories of Kodak Ltd. Two methods are available: in the first, a brilliant flash of very short duration is used to record a very rapidly moving phenomenon, and a photograph was shown taken in natural colour with the 'Kodatron' Speedlamp at an exposure of about 1/10,000 sec. In the second method, a cine-film, taken at a very high rate, is then projected at a normal rate so that the action is greatly slowed down. Such a film, believed to be the first of its type taken in natural colour, was shown; in this, the exposures were taken at the rate of 1,000 per second. It showed the stresses found in the chair holding a railway line to the sleeper, and a 'still' from the film is shown in Fig. 2.

Prof. Bogue said, in closing the meeting, the programme must surely have demonstrated that photography is a scientific instrument capable of many and varied applications.

U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

AT the annual meeting of the U.S. National Academy of Sciences held on April 27, the following officers and new members were elected:

President: Dr. Frank B. Jewett, re-elected for a further term of four years. *Home Secretary:* Dr. F. E. Wright, re-elected for a further term of four years. *Members of Council:* W. Mansfield Clark, De Lamar professor of physiological chemistry, Johns Hopkins Medical School (re-elected); Walter R. Miles, professor of psychology, Yale University School of Medicine (succeeding Prof. Oswald Veblen).

Foreign Associates: Alfonso Caso, Instituto Nacional de Antropologia e Historia, Mexico City; Sir Harold Spencer Jones, Astronomer Royal, Royal Observatory, Greenwich; Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, London; Prof. C. E. Spearman, emeritus professor of psychology in the University of London; Sir D'Arcy Thompson, professor of natural history in the University of St. Andrews; Dr. H. J. van der Bijl, chancellor of the University of Pretoria.

New Members of the Academy: L. H. Adams, Geophysical Laboratory, Carnegie Institution of Washington; Dr. A. Adrian Albert, assistant professor of mathematics, University of Chicago; Prof. J. W. Beams, professor of physics, University of Virginia; Prof. A. F. Buddington, professor of geology, Princeton University; Dr. Leonard Carmichael, president of Tufts College, Medford, Massachusetts; Prof. W. H. Chandler, professor of pomology, University of California, Los Angeles; Prof. E. J. Cohn, professor of biochemistry, Harvard Medical School; Prof. J. N. Couch, professor of botany, University of North Carolina; Prof. Th. Dobzhansky, Columbia University; Prof. Lee A. DuBridge, professor and chairman of the Department of Physics, University of Rochester; Dr. L. C. Dunn, professor of zoology, Columbia University; Prof. Wallace O. Fenn, professor of physiology, University of Rochester; Dr. Paul D. Foote, director of research and executive vice-president, Gulf Research and Development Company, Pittsburgh, Pa.; Prof. L. P. Hammett, professor of chemistry, Columbia University; Prof. William V. Houston, professor of physics, California Institute of Technology, Pasadena, California; Prof. Walter P. Kelley, professor of agricultural chemistry, Citrus Experiment Station, Riverside, California; Dr. Warfield T. Longcope, professor of medicine, Johns Hopkins University; Dr. E. K. Marshall, jun., professor of pharmacology and experimental therapeutics, Johns Hopkins Medical School; Dr. L. Michaelis, Rockefeller Institute for Medical Research, New York; Dr. W. Albert Noyes, jun., professor of physical chemistry, University of Rochester; Prof. O. H. Robertson, professor and head of the Department of Medicine, University of Chicago; C. G. Rossby, University of Chicago; Prof. Calvin P. Stone, professor of psychology, Stanford University; Dr. C. V. Taylor, professor of zoology, Stanford University; Dr. H. B. Vickery, in charge of Biochemical Laboratory, Connecticut Agricultural Experiment Station, New Haven, Connecticut; Dr. V. K. Zworykin, director of the Electronic Research Laboratory, RCA Manufacturing Company, Camden, N.J.

Presentation of Medals

The following five gold medals were presented:

Henry Draper Medal for 1942, to Ira Sprague Bowen, of the California Institute of Technology, Pasadena, California, in recognition of his contributions to astronomical physics; more especially his researches on the spectra and chemical composition of the gaseous nebulæ. Best known and one of Dr. Bowen's most brilliant accomplishments was his discovery of the nature of 'nebulium' lines, a most difficult problem solved by him after the ablest spectroscopists had struggled with it for three quarters of a century and had failed. This discovery and the results of his subsequent researches yielding the identification of numerous other forbidden lines in nebular and stellar spectra constitute some of the most important advances in astrophysics within recent years.

The Draper Medal is provided by the income from a trust fund given to the Academy in 1883 by Mrs. Henry Draper in memory of her husband, a former member of the Academy. It is awarded for investigations in astronomical physics. The present award is the twenty-sixth.

Agassiz Medal for 1942, with accompanying

honorarium of 300 dollars, to Columbus O'Donnel Iselin, II, director of the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, in recognition of his studies of the Gulf Stream system, for his leadership in the development of a general programme of the physical oceanography of the North Atlantic, and for his distinguished direction of the activities of the Woods Hole Oceanographic Institution, both in peace and in time of war.

The Agassiz Medal is provided by the income from a trust fund given to the Academy by Sir John Murray in 1911 in honour of Alexander Agassiz. It is awarded for contributions in the science of oceanography. The present award is the nineteenth.

Daniel Giraud Elliot Medal for 1935, with accompanying honorarium of 200 dollars, to Edwin H. Colbert, of the American Museum of Natural History, New York City, in recognition of his "Siwalik Mammals in the American Museum of Natural History", published in the *Transactions of the American Philosophical Society* in October 1935.

Daniel Giraud Elliot Medal for 1936, with accompanying honorarium of 200 dollars, to Robert Cushman Murphy, of the American Museum of Natural History, New York City, in recognition of his "Oceanic Birds of South America", published in two volumes in 1936.

The Elliot Medals are provided by the income from a trust fund given to the Academy by Margaret Henderson Elliot in honour of her father, Daniel Giraud Elliot, in 1917. The award to Dr. Colbert is the eighteenth Elliot Medal to be presented by the Academy; and that to Dr. Murphy is the nineteenth. The deed of gift of the Elliot Fund calls for an annual award for the most meritorious work published during that year upon some branch of zoology or palæontology.

John J. Carty Medal and Award for the Advancement of Science for 1943 (medal and 4,000 dollars), to Edwin Grant Conklin, of Princeton University, Princeton, New Jersey, in recognition of his services to science as zoologist, cytologist and embryologist; philosopher, teacher and man of science; student of life and of growth from lowliest beginnings to highest consummation.

The Carty award is provided by the income from a trust fund given to the Academy in 1930 by the American Telephone and Telegraph Company, in honour of John J. Carty, a former vice-president of that company, who was a member of the Academy. The medal and monetary award, made not oftener than once in every two years, are awarded to an individual for noteworthy and distinguished accomplishments in any field of science coming within the scope of the charter of the Academy. The present award is the fourth to be presented by the Academy.

NEWS and VIEWS

Rothamsted Experimental Station: New Director

In a few months time, Rothamsted, the world's oldest and most famous agricultural research station, will celebrate the centenary of its foundation and another period of useful activity will begin, though under a new director, Dr. William Gammie Ogg. Dr. Ogg is the son of a farmer and is known to farm successfully himself, so that he may be described as close to the soil. It is known that in future Rothamsted will concentrate more closely on soil problems, extending what has been discovered at Harpenden and Woburn to other types of soil, so that the new director is appropriately a soil specialist. Dr. Ogg studied at Aberdeen under Japp, began research in agriculture there, but on the outbreak of war in 1914 became a chemist in the explosives industry, ending up as chief chemist and works manager at Greetland. After 1918 he came back to agricultural research and spent a year in Canada and the United States. On his return he went as a research student to Christ's College, Cambridge, and for four years he was technical adviser to Messrs. Chivers.

In 1924 the soil claimed Dr. Ogg once more, and he was appointed advisory officer in soils at the Edinburgh and East of Scotland College of Agriculture, where he stayed for six years studying soils in various parts of the world. When the Macaulay Institute for Soil Research was founded in 1930 at Craigiebuckler, Aberdeen, he became the first director. In the ensuing decade Dr. Ogg has gathered round him a band of young and keen workers, so that in a short time the Institute has achieved considerable fame in connexion with the many problems of soil survey. The work has involved the development of a technique of quick analysis of the minor constituents of the soil by modern physical methods. His services have been extensively used by the Agricultural Research Council, and he has published quite widely. Dr. Ogg will bring to Rothamsted a full knowledge of the soil and its many problems; he is a proved administrator and leader.

Institute of Fuel: Melchett Medal

The Melchett Medal for 1943 of the Institute of Fuel has been awarded to Dr. E. S. Grumell. This medal is the highest award in the gift of the Institute of Fuel and is being presented to Dr. Grumell in recognition of the outstanding work tending to the economical use of fuel which he has done over a long period. Dr. Grumell has, for many years, been head of the coal research laboratories of the Imperial Chemical Industries, Ltd., and the research and experimental work carried out by him, having been published for the benefit of the community as well as for that of his company, has resulted in improving the design of many combustion appliances and, consequently, in the saving of large quantities of fuel. In addition, Dr. Grumell was appointed chairman of the Fuel Efficiency Committee set up by the Mines Department and later carried on under the Ministry of Fuel and Power. The work of that Committee has undoubtedly contributed very largely to the more economical use of fuel in Great Britain, thus enabling our output of coal to meet the essential demands of both industrial and domestic requirements. The medal will be presented at the annual conference of the Institute of Fuel to be held in October next.

Coal as the Basis of the War Effort

THE eighth report of the Select Committee on National Expenditure for the session 1942–43, dealing with fuel and power, cannot but arouse further misgiving in regard to the fuel situation in Great Britain. The Select Committee thinks it would be unwise to look forward to any increase in production in 1943. The substantial increase in output on which the Government counted in the White Paper on Coal last year is illusory, and the fact that in the event of a European front being formed it may well become necessary to export increased quantities of coal makes economy the more imperative. In recommending therefore that, in addition to all consumers being emphatically and regularly reminded of the need for stringent economy, and continued attempts to bring home to that small section of the miners guilty of avoidable absenteeism how much really depends on them, the Select Committee reiterates that coal is the very foundation of the total war effort. The general conclusions have a bearing of the highest importance upon the war activities of the nation, and are stated in terms which admit of no misunderstanding. The annual loss, due to normal wastage, of some 20,000 or more men, to which the labour force available in the industry is subject, is expected to be offset during the present year by the entry of 'optants' into the industry and by upgrading to the extent of some 4,000 men, leaving a net loss of about 16,000 men. The total number of men engaged in the industry will therefore inevitably be reduced during the next twelve months below the lowest level at which it has stood since August 1941. Moreover, no further relief can be expected from expedients such as the return of miners from the Home Forces, which have recently made good normal annual wastage.

Unless, therefore, the reduced production consequent upon the diminished labour force is counterbalanced by new factors capable of increasing the output of available labour, a dangerous decline in coal production must occur, with repercussions on the price of coal and the output and cost of munitions. The Committee considers that the evidence does not suggest that any such new factors are likely to make themselves felt, and is clearly not satisfied that the introduction of a comparatively novel type of coal-getting machines in Great Britain or concentration are likely to be effective factors in increasing production. Moreover, while recommending that new experiments should be tried to diminish delays in dealing with cases of avoidable absenteeism, it is pointed out that past experience does not encourage optimism as to a solution of this intractable problem. The Select Committee recommends, it is true, that efforts should be made to accelerate production and delivery of machinery urgently required for further mechanization, and that investigations should be continued to achieve further fuel economies by some industrial users. The fuel economy campaign, both domestic and industrial, should be continued without a break and the public advised on the order of priorities of economies in fuel; in particular, the need for greater economies should be impressed on gas and electricity slot-meter users. The aid of managements and miners should be sought in remedying complaints about inferior fuels.

These recommendations are clearly no more than palliatives. The Select Committee is convinced that a serious reduction in output is likely unless measures of a more far-reaching character than any hitherto proposed are found and put into operation without delay. Important as are the Committee's observations on education and guidance of public opinion and on economy by the consumer, the whole trend of the report strengthens the argument for a great expansion of research into the efficient use of coal raised in a recent report of the Parliamentary and Scientific Committee (see p. 709). From that alone is there the prospect of the real fundamental developments to which the Select Committee looks, albeit it must be admitted that such research is more likely to be a long-range affair and unlikely to yield results which will serve the immediate purpose of relieving the present fuel shortage in Great Britain.

Relaxation Methods in Engineering Mathematics

PROF. R. V. SOUTHWELL delivered the Bakerian Lecture of the Royal Society on June 17, taking as his subject, "On Relaxation Methods: a Mathematics for Engineering Sciences". Engineering calls for computations (for example, of stresses) which need not be very exact, but which must not be restricted to particular shapes of boundary. Its needs are not always met by orthodox mathematical analysis, which in many problems offers a precision that cannot be utilized (by reason of the unavoidable uncertainty of physical data) at the cost of limitations that are felt at every turn. On this account solutions are often sought experimentally, use being made of mathematical analogies (for example, of fluid velocities with electric currents in a conducting sheet).

Relaxation methods—a development of the past eight years—aim at providing engineering science with a mathematics more suited to its needs. Computation is made a tentative process, akin to the 'hand-scraping' technique whereby, in engineering, a part is brought to close conformity with a gauge or template. Attention is fixed upon the data of the problem (for example, the loads applied to a structure); and the point of view is adopted that in practice all such data have an unavoidable margin of uncertainty, and therefore 'exact' has no more meaning as applied to computations than it has as applied to measurement. At every stage in a computation effected by relaxation methods, values are recorded of the 'residuals' (that is, 'loads not yet accounted for'). When all such values lie within the margin of uncertainty, further computation is not only unnecessary but also meaningless. Problems concerned with systems of finite freedom have been discussed in earlier lectures: Prof. Southwell dealt in the main with problems governed by partial differential equations in two independent variables. Most of the standard equations have been solved, and without restriction to particular shapes of boundary. Current work is concerned with equations which are non-linear and so present special difficulties.

Welfare of Laboratory Animals

THE Universities Federation for Animal Welfare (U F A W), temporary address, 284 Regent's Park Road, Finchley, London, N.3, as a result of recent correspondence with a number of workers engaged in experiments on animals, finds a widespread desire for experience to be pooled so as to enable the maximum of consideration to be shown for laboratory animals. With the view of helping to give effect to this feeling the Federation has supplied to 130 laboratories, on request, a copy of the recent book "Veterinary Anæsthesia", by Prof. J. G. Wright. At

the suggestion of a number of research workers, the Federation is proposing further to compile information relating to (1) anæsthesia of rats, rabbits, guinea pigs and other animals not covered by Prof. Wright's book; (2) methods of killing laboratory animals; (3) living conditions, housing, diet, etc., and to invite a small number of experienced men to act as a panel for approving or amending the resulting compilation. U F A W would welcome any views or suggestions relating to these proposals, addressed as above.

Institution of Electrical Engineers: Annual Report

SOME of the salient features of the report for the year 1942–43 of the Council of the Institution of Electrical Engineers may be cited as follows. At the twelve months ending March 31, 1943, the total membership numbered 22,315, and of those there were 11,097 corporate members; 2,106 elections to all classes of membership were made during the period. During the same year 534 meetings were held in London and at the local centres. The Wireless Section held 12 meetings, the Measurements Section 8, the Transmission Section 8, the Installations Section 9; and there were six informal meetings. There are nine students sections, and extensive programmes have been arranged by the respective committees during the year.

A number of interim reports has been submitted to the Council by the various special committees and panels appointed to study post-war problems, among the subjects dealt with being "Service Arrangements in Houses, Flats and other Buildings", "The Availability of Electricity Supply", "Domestic Electrification" and "Telecommunication Engineering". Reports on education and training for engineers and the organization of post-war electrical research have since become available. The subject of standardization has received consideration, and papers relating to this aspect of industrial electrical instruments, single-circuit overhead lines up to 33 kV., and integrating electricity meters have been presented. A fourth, on the standardization of motor dimensions, has since been published. The report also deals with various phases of the Institution's war effort, with joint activities with other institutions, and with the subject of education.

Institute of Fuel: Students' Medal

To encourage the preparation of papers by students of fuel technology, the Council of the Institute of Fuel has decided to make an annual award of a medal, together with a prize consisting of books and/or instruments, to the value of £5. The award will be made annually for a paper submitted by a student member of the Institute or by a student of any university or technical college in the United Kingdom less than twenty-five years of age, dealing with some subject relating to the preparation or utilization of fuel or allied subjects. Papers must be submitted under a *nom de plume*, the name and address of the author being enclosed in a sealed envelope and sent with the paper, and must be received by the Secretary of the Institute, 30 Bramham Gardens, London, S.W.5, on or before September 1 in any year. In judging the papers submitted, consideration will be given to (*a*) subject-matter; (*b*) evidence of analytical power and logic; (*c*) construction of paper in so far as it gives evidence of an orderly mind and shows continuity of argument with an orderly development of the theme; (*d*) English.

Samuel Hahnemann (1755–1843)

SAMUEL CHRISTIAN FRIEDRICH HAHNEMANN, the founder of homœopathy, was born at Meissen in Saxony on April 10, 1755. He studied medicine at Leipzig and Vienna, and after qualifying in 1779 at Erlangen, settled in Leipzig, where he translated Cullen's "Materia Medica" into German. He first set forth his doctrine of similars in Hufeland's *Journal* in 1796 and elaborated it in his chief work entitled "Organon der rationellen Heilkunde" in 1810. The characteristic theories on which the system was founded were first 'the doctrine of signatures', according to which diseases or symptoms were cured by the drugs which produce similar morbid changes upon the body, and secondly the view that the action of drugs was intensified by the administration of infinitesimally small doses. He died in Paris on July 2, 1843.

The Night Sky in July

NEW moon occurs on July 2d. 12h. 44m. U.T. and full moon on July 17d. 12h. 21m. The following conjunctions with the moon take place: July 4d. 08h., Jupiter 2° N.; July 6d. 16h., Venus 0·4° S.; July 24d. 23h., Mars 4° N.; July 28d. 07h., Saturn 3° N. In addition to the above occultations, Venus is in conjunction with Regulus on July 6d. 19h., Venus 0·3° N. The following occultations of stars brighter than magnitude 6 occur: July 6d. 16h. 12·6m., α Leo (*D*); July 6d. 17h. 27·5m., α Leo (*R*); July 13d. 21h. 05·7m., 49 Lib (*D*); July 27d. 2h. 29·0m., 264 *B*. Tau (*R*); July 27d. 4h. 15·0m., α Tau (*D*); July 27d. 5h. 23·6m., α Tau (*R*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance respectively. Mercury is in superior conjunction on July 18 and is unfavourably placed for observation. Venus can be observed as an evening star during the month. The planet sets about 2h. 10m. after the sun at the beginning of the month and about 45m. after the sun at the end of the month. Mars moves from the constellation of Pisces to Aries during July. A remarkable effect is produced by its movement in north declination. At the beginning and end of the month it sets at nearly the same time—about 13h. 40m. Jupiter is in superior conjunction with the sun on July 18. Saturn, in the constellation of Taurus, is a morning star, rising at 1h. 50m. and setting at 17h. 50m. in the middle of the month. Times are given approximately for the latitude of Greenwich. The earth is at aphelion on July 4, being a little more than 94½ million miles from the sun on that date.

Announcements

THE Lord President of the Council has promoted Dr. B. A. Southgate to be acting director of water pollution research in the Department of Scientific and Industrial Research, to fill the vacancy arising from the appointment of Dr. A. Parker to be director of fuel research.

FIVE Turkish undergraduates have just arrived in Britain to study British machine, electrical and mining engineering with scholarships given by the British Council. They are Mustafa Necati Ozişik, Turhan Necat Çetinkale, Halil Sancak, Cavit Erginsoy and Fuat Mericelli. With them is Mr. Mehemet Ali Pamir, an inspector from the Turkish Ministry of Economics, who is taking a course of public administration at the London School of Economics.

LETTERS TO THE EDITORS

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

Electron-Microscopic Examination of Tissues

To obtain a better insight into various fundamental vital processes, for example, the stimulation of nerves and the contraction of muscles, we require a more thorough knowledge of the morphological substratum than can be acquired by the use of visible-light microscopy and various indirect methods for the study of submicroscopic structures. The electron microscope with its great resolving power affords theoretical possibilities of making direct studies of sub-microscopic structures of almost molecular sizes.

The lack of a suitable method of preparing the tissues has hitherto been an obstacle to the practical use of the electron microscope for consistent studies of tissues. Contrary to what is the case in histology, this method can be limited to the preparation of very thin objects (0·05 μ thick), since the tissues themselves possess sufficient contrasting factors, thus making staining of the tissues superfluous. These contrasting factors—differences in density, an irregular distribution of light and heavy atoms, variations in the thickness of the specimens—exclude *inter alia* the use of the common fixing methods. Altmann's technique of freezing-drying is the method that best fills the requirements.

The upper limit of the thickness of the specimens is 0·05 μ and is determined *inter alia* by the chromatic error, which renders impossible a fully profitable use of the resolving power of the electron microscope when the specimens are thicker, even though the electrons, by the use of high acceleration-voltage, can penetrate considerably thicker objects.

In order to obtain this thickness of the specimens a cutting method has been elaborated, the principle of which is that an ordinary microtome slip is cut afresh, so cutting away within a limited area most of the thin section. This thin part is supported by the surrounding thicker parts during the handling of the section.

Fig. 1 is a stereophotograph (magnification 15,000) of a skeletal muscle fibre from a guinea pig, fixed according to Altmann's technique of freezing-drying. The picture was taken with an electromagnetic electron microscope with a high resolving power constructed at the Research Institute for Physics of the Royal Academy of Sciences, Stockholm, by Prof. Manne Siegbahn. In spite of the low accelera-

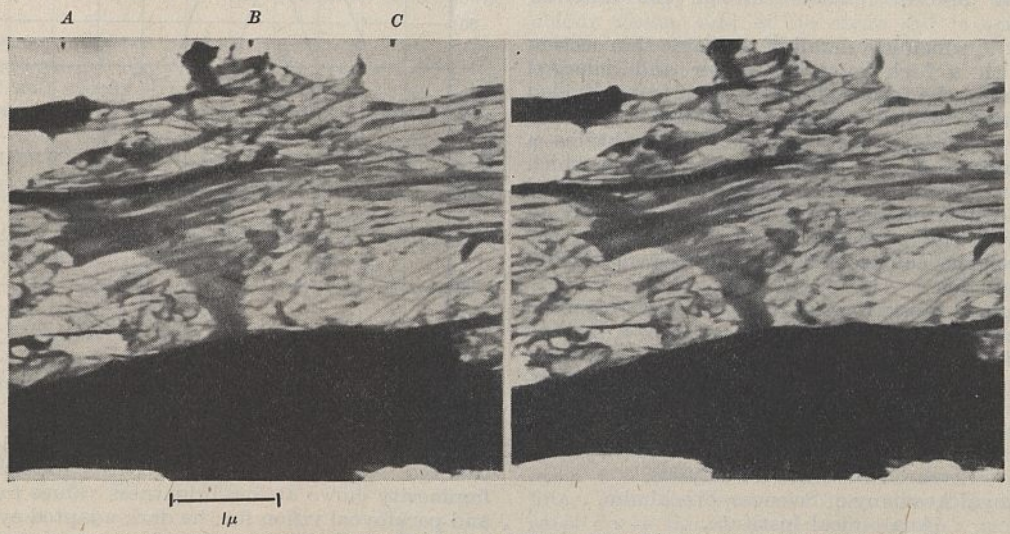


Fig. 1. ELECTRON-MICROSCOPIC STEREOPHOTOGRAPH OF A SKELETAL MUSCLE FIBRE, FIXED ACCORDING TO ALTMANN'S TECHNIQUE OF FREEZING-DRYING. MAGNIFICATION 15,000, ACCELERATION-VOLTAGE 60 KV., THICKNESS OF SECTION WHERE THINNEST ABOUT 20 mμ.

tion-voltage, 60 kV., the electrons penetrate the thin part of the section very well, the thickness of that part presumably being only about 20–30 mμ. Only small parts which are properly supported by adjoining thicker parts can remain intact when so thin.

The detailed interpretation of the electron-microscopic pictures must at this stage be subject to

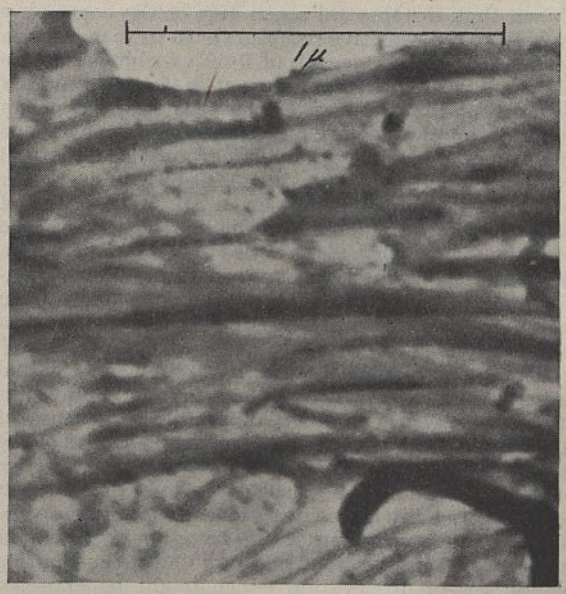


Fig. 2. DETAIL OF FIG. 1, MAGNIFICATION 50,000 TIMES.

reservations. Stereoscopically the folding stands out beautifully in the thin part of the section. The thickness of the object varies somewhat and the different resolving power in the thicker and thinner parts of the slip is readily observed. A fibrillar structure can be seen with the thinnest fibres 5–10 mμ thick.

Striation with some fibres either running more regularly in a longitudinal direction or arranged as an irregular network can also be traced between the marks *A* and *B* and *B* and *C*. Other distinct fibres run in a uniform manner through the different segments.

In Fig. 2, which is a detail of the same thin section taken with a high resolving power and enlarged 50,000 times, the former fibres are seen to be divided into lighter and darker segments, whereas the latter are not divided in that manner. One obtains a strong impression of a complicated structure, which is in good agreement with optical polarization and röntgenometric observations, but a direct study of which will lead considerably farther than to the simple scheme constructed on the basis of the indirect methods.

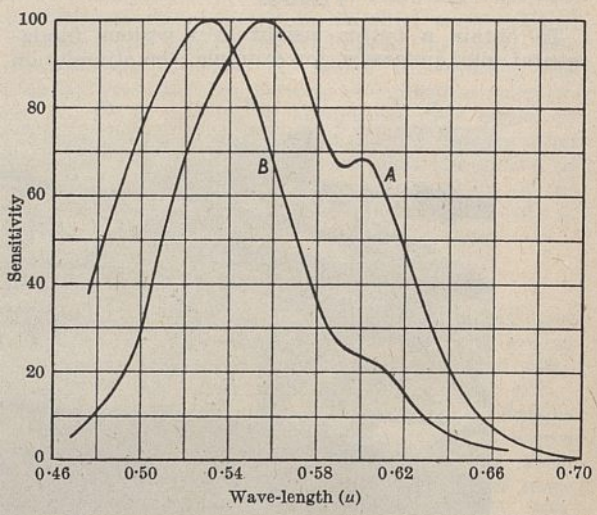
The figures must, for the time being, be regarded merely as demonstrations of the value of a method that is still being elaborated and as good examples of what can be found by the use of the electron-microscope, which on the whole is remarkable for its very simple and neat construction.

FRITIOF SJÖSTRAND.
Research Institute for Physics,
Royal Academy of Sciences, Stockholm.
Anatomical Institute,
Royal Caroline Medico-Surgical Institute,
Stockholm.

Spectral Sensitivity of the Retinal Receptors

RECENT measurements by Granit[1] on the electrical response of individual receptors in the retinæ of various animals—frog, rat, cat, snake, etc.—have shown that the spectral sensitivity of the cones may vary from red-sensitive receptors with their maximum response at a wave-length of 0·60 μ to blue-sensitive elements with their maximum at 0·45 μ. Granit has found four main groups of cones, the largest group (dominators) having a maximum sensitivity at about 0·560 μ, and the three smaller groups (modulators) with maxima in the ranges 0·58–0·60 μ, 0·52–0·54 μ and 0·45–0·47 μ. Without considering the pros and cons of Granit's dominator-modulator theory, the question arises why, if the cones in the human retina have similar properties, some evidence of their individual sensitivity curves is not obtained from measurements of the luminosity curve by human observers.

The answer must be, in part, that any visual observation necessarily involves a number, and generally a very large number, of receptors, because of the area of the retina covered by the usual size of the photometric field, and because of the involuntary eye movements which take place even when the observer is gazing steadily in one direction. But it also appears that luminosity measurements have not, with one or two exceptions, been carried out under the limiting conditions of observation which might be expected to reveal the composite nature of the luminosity curve. Observations by Sloan[2] have shown that the spectral sensitivity curve of the fovea at low intensities develops a hump on the red side of the curve and this has also been observed recently by Walters and Wright[3]. This hump has been analysed by Forbes[4] on the assumption that it is due to the more prolonged functioning of the red receptors than the green receptors as the illumination is reduced.



In an attempt to produce still greater isolation of the red response, I have recently measured the luminosity curve at low brightness values for foveal and parafoveal vision for the dark-adapted eye, using a pair of small circular spots of light as the matching fields. Two sizes of test object have been employed, with angular diameters of 20′ and 5′ respectively. Typical results for one brightness level for the larger test object are shown in the accompanying diagram, both for foveal vision (curve *A*) and for a retinal area 2° from the fovea (curve *B*). The curves record the sensitivity of the retina at each wave-length, the sensitivity being proportional to the inverse of the energy required in one spot of light to produce a brightness equal to that of a similar spot illuminated by light of a given wave-length at a fixed brightness. The wave-length of the comparison patch was chosen to be 0·63 μ, so as to aid foveal fixation, while its brightness, for the experiment illustrated in the diagram, was $5{\cdot}8 \times 10^{-6}$ ergs per square degree per second, when expressed in terms of the energy density of the 0·63 μ radiation on the retina. (The ordinary photometric units have very little meaning at these levels owing to the Purkinje effect.)

The interesting features of curve *A* are the absence of any Purkinje shift of the curve as a whole, which may be attributed to the absence of rods at the fovea, and the appearance of the small peak at a wave-length of 0·60 μ, which provides striking evidence of the composite nature of the luminosity curve. If the peak is the result of the simple addition of the sensitivity curves of the red and green processes of the Young-Helmholtz theory, then the maximum of the red response curve must occur at a wave-length slightly longer than 0·60 μ. The development of the peak at low brightness levels presumably means that the green receptors reach their limiting sensitivity at a higher brightness than the red receptors.

Extension of the range of observing conditions to lower brightness levels and to the smaller pair of test objects has not resulted in the peak becoming

more pronounced. At higher levels and with larger fields, the peak reduces to a hump and then disappears altogether.

Curve *B* shows the marked difference in the phenomenon when a mixed rod-cone area of the retina is used compared to a pure cone area. There is a decided shift of the curve as a whole towards the blue end of the spectrum, and the hump which appears in the same region of the spectrum as the peak in curve *A* now occurs much lower down the curve. This is a result of the greater sensitivity of the rods compared to the cones at the brightness level being used.

These experiments give some promise that, under still more varied conditions of observation and with normal and colour defective observers, some useful information should be obtained which can be correlated with electrophysiological results. A fuller account of the present work will be given when there has been opportunity for further experiments on these lines.

My thanks are due to the Medical Research Council for assistance with an expenses grant.

W. D. WRIGHT.

Imperial College of Science,
London, S.W.7.
June 3.

[1] Granit, R., NATURE, **151**, 11 (1943).
[2] Sloan, L. L., *Psych. Mon.*, **38** (1928).
[3] Walters, H. V., and Wright, W. D., *Proc. Roy. Soc.*, B (in course of publication).
[4] Forbes, W. T. M., *Amer. J. Psychol.*, **41**, 517 (1929).

Physiology of Colour Vision

MR. WILLMER has replied[1] to Prof. H. Hartridge (and incidentally to me, when I had made the same point in discussion) that the impossibility of obtaining greens and yellows by mixtures of extreme red and blue might be due to the impossibility of so obtaining high enough intensities to evoke a yellow or green sensation, rather than indicating the incorrectness of his (Mr. Willmer's) theory. Since then, the following simple and, I believe, crucial, experiment was tried.

Light passing through a yellow or green filter illuminated one side of a plaster Ritchie prism and was adjusted to give a reasonably bright and subjectively indubitable yellow or green. By illuminating the other side of this block with white light from a standard lamp until a match was obtained, its brightness was found to be 1 equivalent foot candle. Such heterochromatic photometry, though sometimes difficult for the inexperienced, is well known to be possible and to give reasonably consistent results. For example, mixtures of colours, each matched with a white and added to each other, give a heterochromatic match with a white having the physical intensity of the sum of the whites which matched each separately; and although two different colours never look exactly the same, it is possible, within narrow limits, to say whether one is darker or brighter than the other. Flicker photometry can also be used to give more exact results.

A lamp in a box the front of which was covered half with a red filter transmitting only light longer than 600 mμ and half with a blue filter transmitting only below 500 mμ was then substituted for the white light. No difficulty was found in obtaining a brightness-match between the purple light falling from this on to the prism and the yellow or green by varying the distance of the red-and-blue light box. Intensities equal to those of a 'good' yellow or green can thus easily be obtained from a mixture of red and blue. By rotating the mixed-light box slightly about the axis joining the filters, its lamp could be made to shine mainly through one or other filter and the relative proportions of the two falling on the Ritchie prism altered. The colour changed from red to blue through a series of lilacs, mauves and purples, in conformity with classical data and theories of colour vision, and at no stage did it approach a match with the light from the yellow or green filter, or even look yellow or green.

Subjective judgments of colours, seen in isolation, instead of *colour matches*, have been considerably used by Mr. Willmer, and are notoriously unreliable, partly on account of selective colour fatigue and partly because our judgments of colours are relative to the general colour of our perceptual field at the time. These two effects can be separated by seeing which effects are peculiar to the colour-adapted eye, that is, are selective adaptation of the retina, and which are shared with the unfatigued eye. Thus, if we look for long at a landscape through a red filter with one or both eyes and then remove the filter, the landscape looks strongly tinged with green to the fatigued eye or eyes; this is a mixed retinal and central or psychological effect. If we look at the scene through one eye with the filter, keeping the other eye closed, for some time, then remove the filter, close that eye, and open the other, the landscape looks faintly tinged with green; this is presumably a central or psychological effect. It is known that every visual perception—whether of size, movement, position, or distance—is largely influenced by the framework of the rest of the visual field, and that the discriminatory abilities of the eye are best studied by comparative, not absolute, judgments; hence the value of colour matches in the present instance as a crucial test.

The red and blue used in the present experiments had photopic/scotopic ratios of approximately 12 : 1 and 0·15 : 1 respectively, so that any ratios between these two could be obtained, covering very easily the regions required for yellows and greens in Mr. Willmer's theory (namely, about 4 : 1 and 1 : 1), and the attainment of a brightness equal to that of a good yellow or green separately produced showed that lack of brightness was not the trouble; yet a match with a yellow or green was impossible. Indeed, it is known that a red-blue mixture (purple) is actually complementary to green.

Another objection to Mr. Willmer's theory is the sensation of white. On the traditional theories the reason why white does not appear in the spectrum is that it requires a mixture of three variables which do not appear in the required proportions in the spectrum. But on Mr. Willmer's theory there are only two variables, rods and cones, and as white represents, in his view, a 1 : 1 ratio of these responses, a spectral wave-length of about 560 mμ (greenish-yellow) should look white. Mr. Willmer again contends that the intensities obtained by spectral lights are not high enough, and points out that such a wave-length, at extremely high intensities, does indeed look white. But he overlooks the fact that very good whites can be obtained from mixtures of three spectral hues, or from a continuous spectrum, at much lower intensities where no single spectral

hue, or mixture of red and blue, looks white. The matching method above described again shows the failure of his theory.

K. J. W. CRAIK.
Psychological Laboratory,
University of Cambridge.
May 30.

[1] NATURE, 151, 632 (1943).

Temperature of the Solar Corona

IT is quite possible that a temperature of the order of 2,300,000° K., mentioned in Dr. A. Hunter's article on this subject[1], may be maintained in the solar corona by collisions of atoms, accelerated from distant regions by the gravitational field of the sun. It is difficult to estimate the resulting temperature without exact knowledge of coronal density, but if the radiation losses of the corona are neglected and equipartition of kinetic energy between ions and electrons is assumed, calculation gives a temperature of the order 20,000,000° K. for atoms of iron, accelerated from infinity to the surface of the sun. Radiation losses increase with the density and might be considerable in the inner corona, and equipartition of the energy might not be reached, so that the ionization maintained in the inner corona might be of the correct order, as required by Edlén's proposals; but there is a possibility that in a more distant region there will be a layer of higher kinetic temperature and that the temperature decreases to that of the surface of the sun, as the sun is approached.

The question arises whether the sun is trapping enough matter to produce the observed density in the corona. According to my investigations, there might be an appreciable evaporation of finely divided interplanetary matter in the vicinity of the sun. Under gravitational force only, the resulting cloud of vapour would follow the original path of the solid particle, and very little matter would be trapped. However, more complicated forces are in action on single atoms. There would be a repulsive force due to the pressure of radiation, but as the atoms would be ionized by the photo-effect of the ultra-violet solar radiation and so become transparent to the radiation responsible for the pressure, this force becomes inoperative soon after the evaporation of the particles, and the remaining forces would be due to the gravitational, magnetic and electric fields. If the magnetic field is sufficiently strong, the path of a charged particle becomes a spiral, which follows magnetic lines of force and thus in most cases ends on the surface of the sun. As the magnetic field of the sun is fairly strong in its vicinity, it seems possible that the amount of matter so trapped would be sufficient to produce the observed density of the corona.

The variations in the shape and intensity of the corona and its line spectrum, which closely follow the sunspot cycle, may be explained tentatively by the variation of the sun's magnetic field over sunspot regions, and so by the amount of matter trapped. There might be a marked escape of high-speed electrons from the corona, and considerable electric fields may develop. These, together with the forces due to the diamagnetism of the ions, may complicate considerably the theory of the corona. More detailed results will be published elsewhere.

I should like to thank Dr. A. Hunter for valuable suggestions and criticism.

V. VAND.
32 Temple Fortune Hill,
London, N.W.11.

[1] Hunter, A., NATURE, 150, 756 (1942).

Rheological Series

A REMARKABLE series of changes in rheological properties may be observed when 10 gm. of powdered Surrey fullers' earth are well mixed in a mortar with 170 gm. of commercial sodium silicate solution (for example, *P*. 84 supplied by I.C.I., Ltd.).

At first, the mixture is a viscous fluid-like treacle, but it soon begins to thicken. After about 15 minutes, it has the consistency of warm pitch, and after half an hour signs of elasticity appear; the mixture shakes like a jelly when the mortar is tapped, but it still flows quite readily. At this stage, the gel is torn when strongly stirred with the pestle, yet the pieces will flow together and coalesce. The material can be formed into balls which bounce like rubber when thrown on to the ground. If left on the bench they flow to form circular disks. These become less fluid and more brittle, until, after standing overnight, they are as brittle as toffee. The glass-like material which is eventually formed cements glass microscope slides strongly together.

The changes take place quite slowly and every stage in the series fluid-plastic-elastic can be studied one after another.

Other rheological series which come to mind are pitch over a temperature range, plastics containing different proportions of plasticizer, clays with different moisture contents, and so on, but the series described seems to show a wider range of rheological phenomena than most of the other series.

It is suggested that rheological series of this kind might be useful in testing the validity of two- or three-dimensional diagrams which are designed to show the relationship between the different rheological phenomena.

ROBERT H. S. ROBERTSON.
The Cedars, Bath Road,
Taplow, Bucks.
H. W. J. HATHAWAY.
The Fullers' Earth Union, Ltd.,
Redhill, Surrey.
May 22.

Paraxanthine as a Natural Antithyroid Substance

MANY substances have been found to have antithyroid activity in the vertebrate body, some of them natural constituents of the body. But it has never been clear to what extent these substances exert their antithyroid properties in normal life. In this letter we report some results which have led us to the conclusion that the basal metabolic rate is normally controlled in the rat not by the concentration of the thyroid secretion in the internal medium alone but by interaction between this secretion and an antithyroid substance which we have identified as paraxanthine (1 : 7-dimethylxanthine). The results also give some indication of the nature of this interaction.

In a previous paper[1] it was shown that the temperature - heart-rate curve of the winter frog's heart could be altered to the form typical of a summer frog's heart by adding thyroxine to the medium in which the heart was beating. Further work showed the presence in ox and whale liver and in human urine of a substance which had the opposite, antithyroid, effect—conversion of the summer form of the curve into the winter form. This action was found to be

extremely consistent both in the effect produced and in the quantity of the extract required to neutralize a given quantity of thyroxine. In addition, the heart is extremely sensitive to the presence of the antithyroid substance. We thus found that the action could be used as a very reliable and sensitive biological test for the active substance. Less than 0·1 μgm. can be readily estimated.

By use of this test the substance was fractionated from the extracts and identified. The substance in urine was concentrated and finally isolated by successive precipitation with cupric chloride, mercuric chloride and auric chloride under carefully controlled conditions, the precipitate with each salt being collected, washed and decomposed with hydrogen sulphide before precipitation with the next salt. The crude product was purified by recrystallization first of its picrate and then of the regenerated substance itself. The pure product had a melting point of 295°. Its identity as paraxanthine was confirmed by analysis and by a direct comparison with a sample of paraxanthine which had been synthesized by a modification of Fischer and Ach's method[2,3]; the natural and synthetic paraxanthines had the same melting points (mixed and unmixed), and identical absorption spectra, the latter being kindly measured for us by Dr. C. B. Allsopp.

It should be emphasized that the above laborious isolation of the paraxanthine was due to the fact that the identity of the antithyroid factor was obviously unknown when this treatment was worked out: paraxanthine can be isolated more expeditiously from urine by the method of Kruger and Salomon[4].

Paraxanthine was also isolated similarly from an aqueous extract of papainized whale liver.

Synthetic paraxanthine was found to give precisely and quantitatively the same action on the frog's heart as the active substance in the extracts—0·22 μgm. per l. of either the natural or synthetic substance will neutralize 1 mgm. thyroxine per l. We have tested on the heart a number of substances related to paraxanthine (caffeine, theobromine, theophylline, 1-methylxanthine, xanthine, adenine, guanine) and find none to have more than 1/1,000 of the activity of paraxanthine. We think there can be no doubt that the active substance of the extracts is paraxanthine.

In another way the actions of the natural and synthetic substances on the heart are identical. We have found that for any given concentration of thyroxine there is an optimum concentration of paraxanthine that gives complete neutralization. If this optimum concentration is exceeded, the effect diminishes until with double the optimum concentration there is no effect, the form of the curve being the same as with thyroxine alone. Thus, if a heart is giving the summer form of the curve in a medium containing thyroxine 1 mgm. per l., and is then made to give the winter form by adding to the medium paraxanthine 0·22 μgm. per l., it can be made to give the summer form again by raising the paraxanthine concentration to 0·44 μgm. per l., the same thyroxine concentration being retained throughout. Further, the heart again returns to the winter form if the thyroxine concentration is now raised to 2 mgm. per l., while the paraxanthine is kept at 0·44 μgm. per l. The reversal can be repeated by alternately raising the paraxanthine and thyroxine concentrations still higher. All these effects are given equally by the natural and synthetic paraxanthines.

It seems to us necessary to conclude from these results that the behaviour of the heart is determined not by the separate concentrations of thyroxine and paraxanthine in the medium but by the presence or absence of a definite *proportion* between their concentrations. When the concentrations are in this proportion—that of 1 mgm. thyroxine per l., and 0·22 μgm. paraxanthine per l.—the form of the curve is that of a winter heart. It remains so as long as the proportion between their concentrations is kept the same, even if the absolute concentrations of the two substances are changed greatly. On the other hand, when *either* thyroxine or paraxanthine are present in excess of these proportional concentrations, the form of the curve is that of a summer heart. We shall call concentrations in the proportion that gives the winter form of the curve 'balanced' concentrations.

Having obtained these results, we proceeded to examine the action of paraxanthine on the basal metabolic rate of the rat. The rats used were piebald males of the Wistar Institute strain, and the apparatus was that of Richards and Collison[5], which was found suitable for use with the rat by Gaddum[6].

When a rat is given small doses of paraxanthine daily by mouth, there is a fall of basal metabolic rate which becomes greater as the dose is increased to an optimum. For a rat of 200–250 gm. weight the optimum dose is 20–25 μgm. per day, and the basal metabolic rate with this dose is 70–75 per cent of the normal. If the dose is increased above this optimum, the basal metabolic rate rises again until with double the optimum dose it reaches the normal value. With still larger doses the effects are complicated and are still being investigated. It may, however, already be said that large overdoses (up to 1 mgm. per day to a rat) may be given without any large rise in the basal metabolic rate above the normal. Nor is the rat clearly unhealthy. These last results, whatever the reason may prove to be for the contrast between them and the results of adding excess thyroxine to the internal medium, explain why (if our results on the rat may be transposed to man) no marked effects on the basal metabolic rate have been observed when large doses of paraxanthine have been used in clinical practice.

We have estimated the paraxanthine content in the plasma of ox blood and find it to be about 0·2–0·6 μgm. per c.c. The total amount present in the blood of a rat (supposing it to have a similar content) would be 5–15 μgm. From this it appears that the natural concentrations of paraxanthine in the body are within the range in which changes in the concentration make large changes in the basal metabolic rate. An oral dose of 25 or 50 μgm. would make a large proportional change in the blood content.

Within this range it seems to us that our results on the frog's heart and on the basal metabolic rate of the rat are strictly parallel. Comparing the two sets of results, we must conclude that a low basal metabolic rate is characteristic of 'balanced' proportions between the concentrations of thyroxine and paraxanthine, for either thyroxine or paraxanthine given to a rat in this condition causes a rise of basal metabolic rate*. Excess paraxanthine, here as in the heart, has the same effect as excess thyroxine. Also, excess thyroxine can be neutralized by raising the

* The normal rat must always be on the thyroxine side of the balanced condition, since administration of paraxanthine to it always lowers the basal metabolic rate if the doses are small enough.

paraxanthine concentration. This is shown by the results of some experiments in which rats were given thyroxine until their basal metabolic rates reached 200 per cent of the normal, and were then given paraxanthine while the dosage with thyroxine was continued. If the dose of paraxanthine was appropriate (about 100 μgm. daily for this basal metabolic rate), the basal metabolic rate fell, sometimes nearly to the normal level. Similarly, excess paraxanthine may be neutralized by thyroxine. If a rat has a normal basal metabolic rate as a result of being given excess paraxanthine, an appropriate dose of thyroxine causes a *fall* of the basal metabolic rate; thyroxine has the opposite of its usual effect. This was an especially striking result, since an action of thyroxine opposite to that which occurs in all normal circumstances has never, so far as we know, been observed.

We think these results allow us to conclude that paraxanthine behaves as an antithyroid substance in the body under normal conditions, and that the control of the basal metabolic rate in the rat is by the presence or absence of certain 'balanced' proportions between the concentrations of paraxanthine and the thyroid secretion and not by the concentration of either independently. If the concentrations are balanced, the basal metabolic rate is low; excess of either substance raises the basal metabolic rate. We do not wish to suggest that in normal life changes in the paraxanthine content of the internal medium are used by the body to control the basal metabolic rate. We have no evidence at present whether the body has or has not any means of controlling the concentration of paraxanthine in the medium, as it has of controlling that of the thyroid secretion.

Work is being continued on these subjects, especially on the physiological activity of further purine derivatives akin to paraxanthine and on the distribution of paraxanthine in the body.

G. S. CARTER.
Dept. of Zoology,
University of Cambridge.

F. G. MANN.
J. HARLEY-MASON.
Dept. of Chemistry,
University of Cambridge.

G. N. JENKINS.
Dept. of Physiology,
St. Bartholomew's Medical College.
May 20.

[1] Carter, G. S., *Brit. J. Exp. Biol.*, **10**, 256 (1933).
[2] *Berichte*, **39**, 423 (1906).
[3] *Berichte*, **31**, 2622 (1898).
[4] *Z. Physiol. Chem.*, **24**, 376 (1898).
[5] *J. Physiol.*, **66**, 299 (1928).
[6] *J. Physiol.*, **68**, 383 (1930).

Liver Vacuoles and Anoxæmia

DURING an investigation, carried out on behalf of the Air Ministry in 1940, into the effects on animals of a sudden reduction in atmospheric pressure, one of our findings was the formation of large watery vacuoles in the cells of the liver. We have no access to the current German literature, and Dr. Ladewig's letter[1] was our first intimation that somewhat similar findings had been published in 1942 by Büchner and his colleagues and also by Hesse. We think, therefore, that we should briefly report our findings and compare them with those of the German workers in so far as these are given in Dr. Ladewig's epitome.

The vacuoles which we found in the cytoplasm of liver cells were 2–12 μ in diameter, most commonly about 7 μ. While some were perfectly spherical, many were slightly ovoid or polyhedral. The number in each cell varied from 1 to 12 and was most commonly 2–3. They were more commonly found adjacent to the nucleus than in the more peripheral cytoplasm. Some vacuoles were indented by the nucleus while others themselves indented the nucleus and distorted it to a crescentic shape. Their relative numbers varied a good deal in the different lobules, and in most, but not all, cases they were more numerous at the centre of the lobule. In paraffin and frozen sections they appeared as optically empty spaces containing neither fat nor glycogen. This description agrees with that given in Dr. Ladewig's epitome. We further showed that the vacuoles can be seen in living liver cells suspended in serum, and from their optical properties under these conditions we concluded that they were watery vacuoles, certainly neither gaseous nor lipoid.

The German workers found these vacuoles in airmen dying from the effects of high altitude, in animals exposed to an atmosphere of reduced oxygen content at normal pressure, and also in humans dying under conditions of acute anoxæmia (suffocation, drowning). They believed that in all cases the vacuoles were the result of anoxæmia.

In our experiments, vacuoles occurred in animals (rat, guinea pig, rabbit, monkey) which were explosively (that is, instantaneously) decompressed from a pressure of 1·0 to 0·016 atmosphere, in an atmosphere approximating to pure oxygen, the animals being kept at the low pressure for 2 hours before being sacrificed. A few of the animals died after 5–20 minutes exposure to the low pressure, and they, too, showed vacuoles. In these experiments we tried to prevent anoxæmia by passing oxygen through the chamber throughout the experiment, but we know from other evidence that the animals did suffer some degree of anoxæmia during their exposure to the low pressure. In these experiments, therefore, the vacuoles might have been due to anoxæmia, or to exposure to low pressure, or to the sudden reduction of pressure (decompression); though in the case of the animals dying after five minutes at low pressure the duration of the anoxæmia must have been very short.

We also found similar liver vacuoles in animals which were explosively decompressed from 6·0 to 1·0 atmospheres. In these experiments some of the animals died almost instantaneously as a result of the decompression, and vacuoles were found in them as well as in those which survived. In those animals which died instantaneously, both anoxæmia and exposure to low pressure seem to be excluded, and we reached the tentative conclusion that in all cases the vacuoles were the result of the sudden reduction of external pressure (decompression).

It seems likely, therefore, that these liver vacuoles can be produced by factors other than anoxæmia, and the contention that they afford a histological criterion for the occurrence of anoxæmia will require further investigation.

This work was part of a larger investigation carried out by I. de Burgh Daly, P. Eggleton, S. R. Elsden, C. O. Hebb and O. A. Trowell. As the histologist, I have in this instance acted as spokesman for the team.

O. A. TROWELL.
Department of Physiology,
University of Edinburgh.
June 1.

[1] Ladewig, P., NATURE, **151**, 558 (1943).

WILLIBALD VON BESSER (1784–1842)

By VLADIMIR C. ASMOUS

Librarian of the Arnold Arboretum, Harvard University

WILLIBALD VON BESSER belonged to that large group of German botanists who spent most of their lives in Russia and contributed very much to the progress of botanical science in their adopted country. Some of them outrank von Besser in the importance of their achievement, but still Russia owes a great debt to this indefatigable and conscientious botanist, the hundredth anniversary of whose death occurred on October 11, 1942.

Willibald Swibert Josef Gottlieb von Besser was born on July 7, 1784, in Insbruck in the Tirol, his father being a retired army officer. Both his parents died when he was thirteen years old. A relative of his mother, S. B. Schivereck, who was professor of botany in the University of Lemberg, took the boy into his family and helped him through *Gymnasium* and the University. Schivereck was the man who inspired the love of natural history in Besser and directed his first steps in field work. When Schivereck died in 1806 he bequeathed his large herbarium to Besser, and this was a great help and inspiration for the youth in his botanical studies. Besser studied first in the University of Lemberg and graduated in medicine from the University of Cracow in 1807, almost immediately taking a position of an assistant in the Cracow Clinic.

Although Besser was a skilful physician and practised medicine all his life, he did not enjoy medical work. At his first opportunity, in 1808, he accepted an offer to become a teacher of zoology and botany in the Volhynia *Gymnasium*. His schedule was heavy, but still he was able to find time to complete within two years one of his most important works—his "Flora of Galicia".

In August 1809 Besser was appointed a teacher of natural history in Krzemieniec *Gymnasium* (later a *lycée*) and director of the botanic garden in that town. This was the beginning of his long activity in Russia, to which country he devoted thirty-three years of indefatigable work. He became one of the most prominent specialists on the flora of south-western Russia. He travelled extensively in Volhynia, Podolia, Kiev and adjoining provinces and assembled a very large herbarium, which he extended and enriched by exchanges with many other botanists. He was a successful teacher despite a minor defect of speech which made him a rather unattractive lecturer. Some of his students, especially A. L. Andrzejowski and Jundzill, later contributed much to his herbarium. He made the botanical garden in Krzemieniec one of the best in Russia, although he was always handicapped by a very meagre allowance for the upkeep of the institution.

In 1834 Besser was appointed professor of botany in the University of St. Vladimir in Kiev. He was the first professor to occupy that chair, and he had the difficult task of organizing the Botanical Department. Overwork impaired his formerly robust health, and he resigned in 1837 to return to his beloved Krzemieniec, where he lived and worked until his death on October 11, 1842.

Before his retirement Besser presented his extensive entomological collections to the University of Kiev. He was an enthusiastic collector of insects from his boyhood until his death and the author of some works on entomology. His very large herbarium and excellent library of natural history books were sold by his widow to the University of Kiev.

Besser was an unusually hard-working, conscientious and painstaking botanist, who always chose the most difficult families and genera for study and clung tenaciously to each task until it was finished. He was considered one of the best experts of the classification of the genus Artemisia, to the elucidation of which he contributed greatly. In his private life he was a quiet, simple and good-natured man, very much liked by his numerous pupils and patients.

Besser's most important contributions to botanical literature are: "Primitiæ floræ Galiciæ", 2 vols. (1809); "Enumeratio Plantarum hucusque in Volhynia, Podlia, Gub. Kiovensis, etc." (1822); "Ueber die Flora des Baikals" (1834); eight monographs of the genus Artemisia and many other minor works, including some articles on entomology and medicine. Most of Besser's works are in Latin and German. Having been educated in Galicia, where a large proportion of the population are Poles, Besser spoke excellent Polish, but he did not master Russian so well. He lectured most of his life in Krzemieniec in Polish, but delivered his lectures in the University of Kiev in Latin.

Four different genera Bessera have been named in his honour, including Bessera Schult. f. (in Liliaceæ), which is a valid name.

PLYWOOD CONTAINERS

THE demand for various kinds of containers, hitherto made of metal, has increased enormously in India as a result of the War. With the increased demand, an acute shortage of metal sheeting has aggravated the position, so that manufacturers were finding it very difficult to dispatch their manufactures owing to the want of containers. The Forest Research Institute at Dehra Dun was in its infancy when war broke out in 1914, but by 1918 it had firmly established its position as an indispensable branch of the Indian Forest Department. It is fulfilling the same purpose in the present War. To assist in alleviating the shortage of containers, the Institute has been engaged in designing and testing many different types of containers made of ordinary commercial plywood. They range from small powder and pill boxes to large drums and barrels for oils, paints, greases, and dry goods. Indian Forest Leaflet No. 24, "Plywood Containers", published by the Forest Research Institute (Dehra Dun, 1942), describes the investigations.

These plywood containers are easy to make and are durable. The chief qualities required are that the container should be strong enough to stand journeys by rail, road or sea and that it should hold its contents safely without leakage and without contamination and spoiling. Metal serves these purposes admirably and cheaply; but for certain types of drums, more especially the more expensive types which are made of galvanized or sheet iron, plywood is a good substitute and compares favourably in cost. The plywood drums are not difficult to make. They consist of a cylinder of plywood, with a top and bottom of thicker plywood (or solid wood) round which the cylinder is fixed. If extra strength is required, metal bands are added; and if required

for liquids, they can be adequately coated internally to render them leak-proof. So far, plywood containers have been made at Dehra Dun for paints, oils, greases, dry goods, foodstuffs, medical stores and water. In addition, they have been kept filled with kerosene and petrol for several months without showing any signs of evaporation or leakage. A variety of inner coatings have been tested.

The leaflet is chiefly concerned with a description of the methods of manufacturing plywood drums, a detailed description with diagrams being given. The glue used for container work is a casein cement which can be prepared according to a formula of the Forest Products Laboratories, Madison, U.S.A.; this is recommended by the Dehra Dun Institute and is given in the leaflet.

Owing to the fact that the round containers take up much space in storage and transit, a rectangular plywood container has been designed by the Forest Research Institute. This is described in Leaflet No. 26, "Rectangular Plywood Containers" (Dehra Dun, 1942). The four sides are made of ordinary commercial 3-plywood. These are joined together by bent plywood corner pieces, rivets being used for fastening the corner pieces to the side sheets. Top and bottom are of 7-plywood and are fixed in the same way as the round wood container described in leaflet No. 24. Full details with diagrams are given.

SOME BRITISH EMPIRE TIMBERS

UNDER the auspices of the Department of Scientific and Industrial Research, the Forest Products Research Laboratory has issued a War Emergency Supplement to the "Handbook of Empire Timbers" published in 1939, edited by Mr. H. A. Cox (London: H.M. Stationery Office, 1943). In Part 1 some additional information on many of the timbers already dealt with is given, especially in connexion with insect attacks, though in the case of teak the data given have been known for many years.

In Part 2 sixteen species not previously described are dealt with under the heads of brief description of tree, its timber, seasoning properties, wood bending and mechanical properties, natural durability, insect attack, preservative treatment, working qualities, uses and supplies—the last-named a most important piece of information in the absence of which the rest has, from a commercial point of view, little more than an academic value. Some of the West African timbers in this list are of interest since the French were exporting them to Western Europe before the French Colonial Exposition held in Paris in 1931. The information given here on some of these species on this head is too qualified and guarded to be of much practical use.

The following hardwoods are dealt with: *Mitragyna stipulosa*, equatorial forests of Nigeria, Liberia, Ivory Coast, Cameroons and Gamboon, most frequently in association with *Sarcocephalus diderrichii*; *Piptadenia africana*, rain and mixed deciduous forests of Nigeria; also in Gold Coast, Ivory Coast, Cameroons, Belgian Congo and Angola; *Betula papyrifera*, moist slopes in eastern North America from the southern shores of Hudson's Bay to Labrador in the north to approximately 40° N. in the south; *Canarium schweinfurthii*, Sierra Leone to East Africa; *Celtis soyauxii*, West Africa, Central Africa, Uganda, Tanganyika and parts of Kenya; *Acer rubrum* and *A. saccharinum* (soft maples), eastern Canada, *A. rubrum* extending to Newfoundland. *A. macrophyllum*, the Pacific maple; *Terminalia amazonia* (Nargusta), Central American rain-forest region including British Honduras and Trinidad; purpleheart—various species of *Peltogyne*, Trinidad, British and French Guiana and Surinam—probably a wider distribution the limits of which are not definitely known; *Beilschmiedia tawa* (Tawa), lowland and mountain forests in North Island and to a very limited extent in the northern part of South Island, New Zealand.

The softwoods are limited to *Abies grandis*, Vancouver Island and on mainland opposite, extending southward into the United States as far as California; *Tsuga canadensis* (eastern hemlock), lower basin of St. Lawrence and Nova Scotia, with much more extended range in the United States; *Pinus ponderosa*, with its varieties extending from California, New Mexico and Western Texas in the south to southern British California in the north; *Picea engelmannii* from Alaska to New Mexico, attaining its greatest size in British Columbia; *Larix laricina* (tamarack) and *Larix occidentalis* (western larch), upper basin of Columbian river in British Columbia stretching southwards into United States as far as Oregon and Montana; *Podocarpus totara* and *P. Lallii* (totara), lowland and mountain forests in North and South Islands of New Zealand, and *P. Lallii* also in Stewart Island.

Some kiln schedules for a number of species are given in a series of appendixes. It is emphasized that these schedules are approximate only and represent conditions suitable for average qualities of timber intended for normal use. It is added that experience with timber from particular sources of supply destined for specific purposes will generally enable modifications to be made.

COASTAL RADIO TELEPHONE

IN an article with this title (*Bell Lab. Rec.*, 21, No. 7; March 1943), H. M. Pruden describes the present status of the radio telephone service between shore and vessels off the coast of the United States or within its harbours, which has undergone considerable growth and development during the past decade. The development work leading to the present successful system was begun more than twenty years ago, and as a result of this a complete coastal radio system is now in use. It consists of fourteen basic shore stations so located as to cover the entire coast from Maine, through the Gulf of Mexico, and up the Pacific coast to Seattle.

Each of the shore stations includes a radio transmitter, two or more radio receivers, and terminal equipment for associating each with the other and with their signalling and control circuits. The terminal equipment is installed in the toll office, and the transmitter is installed in a small building erected for the purpose or in a telephone building or leased property. The receivers, however, are usually at some distance from the transmitters and are generally mounted on poles. Since the transmitting equipment aboard ship is not so powerful as that on shore, the shore receivers are spaced at shorter intervals than are the transmitters. In general, the receivers

are so placed that any ship that can be reached satisfactorily by a shore station can in turn be picked up satisfactorily by one of the receivers associated with that shore transmitter.

Transmission from the shore station is at a frequency within the band 2,504–2,600 kc., while the shore receivers operate at between 2,108 and 2,208 kc. To call a shore station, the desired frequency is selected, the headset aboard ship is lifted, and the 'talk' switch on the handle is pressed. This turns on the ship's transmitter, and the radiated carrier causes a carrier-operated relay in one or more of the shore receivers to operate and light a lamp in front of an operator.

Two methods are available for calling ships. The more completely equipped vessels have a selective signalling system. The operator dials the ship as he would any shore subscriber, and a bell is rung aboard the vessel called. For ships not equipped for dial calling, the operator transmits a 1,000-cycle tone over the carrier from the shore transmitter, and then calls the ship by name or by its call letters. Such vessels have a loudspeaker associated with their radio receiver, and the tone serves as an attention signal. Besides completing calls between ship and shore, the terminal facilities also permit radio telephone conversations between ships through a shore station. The operating procedure is for the ship to call shore and ask for a connexion to some other ship. The shore operator then calls this other ship, and having reached it, plugs into a by-pass jack, which, through suitable contacts, rearranges the circuit. The output of the radio receiver is connected to the input of the transmitter through a network, so that speech is re-transmitted at a frequency that can be detected by either vessel.

One of the innovations in the new terminal equipment is the ability to make contact with the emergency radio equipment of the telephone companies. This emergency equipment is designed to take the place of wire facilities that are temporarily out of service. The ability of the shore stations to communicate with these emergency sets is very helpful at times in establishing the original connexion, since then only one of the emergency sets is required, the shore station taking the place of the other. A second emergency equipment is put into use as soon as possible, however, and the operating frequency changed, so as not to tie up harbour equipment. The shore station radiates carrier continuously while handling calls with vessels, while for the emergency equipment the carrier must be under voice control. To make this possible, the technical operator is provided with a key that rearranges the circuit. The switching relay operates under control of the incoming carrier, to connect the shore circuit to the radio receiver. Under these conditions, there is no speed input to the vogad and hence none to the amplifier-detector. As a result there is no current through the winding of the voice-holdover relay, and a circuit through its back contact disables the radio transmitter. When incoming speech ceases, the switching relay is released, thus connecting the shore circuit to the transmitter. Voice signals from the shore circuit result in a current in the output of the amplifier-detector that operates the voice-holdover relay, and causes the transmitter to radiate carrier. The same current also operates the echo-holdover relay, thus opening the circuit to the switching relay so that incoming speech cannot interfere with outgoing signals.

CLIMATE AND ANIMAL DISEASE IN INDIA

IN his presidential address read before the Section of Medical and Veterinary Sciences of the thirtieth Indian Science Congress held at Calcutta last January, Dr. F. C. Minett, director of the Imperial Veterinary Research Institute, Muktesar, United Provinces, discussed the influence of climate on the incidence of disease.

At the outset, Dr. Minett emphasized the value of the association of medical men and veterinarians in research, as is exemplified in the Indian Science Congress and in the Section of Comparative Medicine of the Royal Society of Medicine. While admitting that veterinary science has gained more than it has given by contact with medicine, he dwelt on the enormous extent to which medical science has had to rely upon experiments on animals in connexion with elucidation and prevention. As regards the effect of climate and weather conditions on animal health and disease, Dr. Minett mentioned the influence of air temperature and humidity on the spread of such diseases as filariasis, malaria and plague. On the other hand, climate may not be the only environmental factor at work; other complex influences, such as naturally acquired immunity and conditions of crowding, may be still more important. Climatic factors might be neutralized by the occurrence of improved facilities for disinfection, as in the case of cholera. As the relation between weather effects and disease in man cannot always be determined by statistics, experiments on animals are needed, with results which may or may not confirm previous deductions.

Although a good deal is known of the effect of environmental factors, including climate, on human beings and small experimental animals, comparatively little is known with regard to domesticated animals like sheep and goats. In order to obtain more exact information, figures are being collected through provincial directors of veterinary services relating to the prevention of animal diseases during the monsoon period, just as has been done on the medical side with cholera, typhoid, etc. As regards the monsoon prevalence of disease, wet conditions are a sore trial to many animals in some tropical countries, even to such water-loving animals as buffaloes. The effect of rainfall on animals has recently been studied by artificial showers. Sheep inoculated intramuscularly with very small doses of spores of *Cl. chauvoei*, the causal agent of blackwater in cattle and sheep, showed symptoms of the disease and died after exposure to a shower, while control sheep remained healthy. On the other hand, guinea pigs injected with the spores and then treated in an incubator at 40° C. are more likely to escape the disease than controls. A similar effect has been produced in the case of anthrax.

Dr. Minett next dealt with the deterioration or degeneration of cattle, which it is hoped will be investigated by the Imperial Council of Agricultural Research. Whether the deterioration is solely or mainly due to climate is not yet known; but if it is, it will have to be determined whether climate is exerting a direct effect on the animal physiology, or whether the effect is indirect and is more properly to be attributed to a hot atmosphere.

In conclusion, Dr. Minett referred to the control of disease in India, which is hindered by religious

prejudices whereby the survival of useless animals and active dissemination of disease are permitted. Further, there is the undeveloped legislation for controlling animal diseases and the extensive movements of cattle, sheep and goats which are made annually for food to escape the monsoon. In spite, however, of shortage of staff and difficulties of communication, Dr. Minett considers that much success has been obtained both in the laboratory and in the field.

FORTHCOMING EVENTS

Tuesday, June 29

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 8 p.m.—Mr. J. A. Lauwerys: "Education in the U.S.A.".

Friday, July 2

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. O. T. Jones, F.R.S.: "The Yellowstone National Park, U.S.A.".

Saturday, July 3

NUTRITION SOCIETY (JOINT MEETING WITH THE FOOD GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "Milk" (Chairman: Prof. H. D. Kay).

LONDON MATHEMATICAL SOCIETY (JOINT MEETING WITH THE LONDON BRANCH OF THE INSTITUTE OF PHYSICS) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2 p.m.—Dr. A. C. Aitken, F.R.S.: "Matrices in Practical Mathematics"; Dr. L. J. Comrie: "Computational Methods and Mathematical Tables"; Mr. H. L. Blackburne: "Mathematical Solutions by Models"; Dr. S. Whitehead: "Applications of Elementary Mathematical Processes, with special reference to Circuit Theory".

Saturday, July 3—Sunday, July 4

TOWN AND COUNTRY PLANNING ASSOCIATION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 10.30 a.m.—Conference on "Town Planning, Housing and Full Employment".

APPOINTMENTS VACANT

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

ASSISTANT MASTER, able to offer Technical Drawing and/or Engineering Science and/or Practical Mathematics—The Headmaster, Millom Junior Technical School, Millom, Cumberland (July 3).

HEAD OF THE MATHEMATICS AND PHYSICS DEPARTMENT in the Rutherford Technical College—The Director of Education, Education Committee, Newcastle-upon-Tyne (July 3).

PRINCIPAL OF THE BARNSLEY MINING AND TECHNICAL COLLEGE—The Director of Education, Education Department, Town Hall, Barnsley (July 7).

PROFESSOR AND HEAD OF THE DEPARTMENT OF ELECTRICAL TECHNOLOGY, and a PROFESSOR AND HEAD OF THE DEPARTMENT OF APPLIED MECHANICS AND AUTOMOBILE ENGINEERING—The Registrar, Indian Institute of Science, Bangalore, India (September 15).

ASSISTANT LECTURER IN BOTANY—The Principal, Swanley Horticultural College for Women, Swanley, Kent.

AGRICULTURAL ORGANIZER to the National Federation of Women's Institutes—The General Secretary, 39 Eccleston Street, London, S.W.1.

LECTURER IN ENGINEERING, for Achimota College, Gold Coast—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1737), Alexandra House, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series B: Physiology, No. 15: (1) On Diurnal Variations in the Mineral Content of the Leaf of the Cotton Plant, by E. Phillis and T. G. Mason; (2) Studies on Foliar Hydration in the Cotton Plant (i) The Effects of Potassium Supply and Size of Plant (ii) Preliminary Observations using the Disc Culture Method, by T. G. Mason and E. Phillis; (3) Studies on the Partition of the Mineral Elements in the Cotton Plant (iii) Mainly concerning Nitrogen, by E. Phillis and T. G. Mason. Pp. 437–486. (London: Empire Cotton Growing Corporation.) 2*s.* 6*d.* [175

Report of the Marlborough College Natural History Society for the Year 1942. (No. 91.) Pp. 24. (Marlborough: Marlborough College.) 2*s.*; to non-Members, 5*s.* [185

The Limitations of Statistics in the Field of Public Opinion Research. By J. G. Ferraby. Pp. 25. (Manchester: Manchester Statistical Society.) [185

Education and Training for Engineers. Pp. ii+22. (London: Institution of Electrical Engineers.) [195

A Budgetary and Dietary Survey of Low Income Families, Aberdeen, August 1942. By a Sub-Committee of the Aberdeen Branch of the Children's Nutrition Council. Pp. 28. (Aberdeen: Aberdeen University Press.) [205

Royal Society for the Protection of Birds. Fifty-second Annual Report, January 1st to December 31st, 1942; with Proceedings of Annual Meeting 1943. Pp. 48. (London: Royal Society for the Protection of Birds.) 1*s.* [245

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 11, 1942. Pp. vi+136. (London: Brompton Hospital.) 5*s.* net. [245

Carnegie United Kingdom Trust. Twenty-ninth Annual Report, 1942. Pp. 8. (Dunfermline: Carnegie United Kingdom Trust.) [245

Board of Education: Scottish Education Department. Youth Registration in 1942. (Cmd. 6446.) Pp. 28. (London: H.M. Stationery Office.) 6*d.* net. [255

Medical Research Council. War Memorandum No. 9: The Determination of Blood Groups. Pp. 20. (London: H.M. Stationery Office.) 4*d.* net. [275

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Seasons 1941–1942; Programmes of Experiments, Season 1942–1943. Pp. ii+183. (London: Empire Cotton Growing Corporation.) 3*s.* [275

British Rubber Producers' Research Association. Publication No. 31: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, 4: The Isolation and Constitution of Photochemically-formed Methyl Oleate Peroxide; 5: Observations on Fish-Oil Acids. By E. H. Farmer and D. A. Sutton. Pp. 8. Publication No. 32: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, 6: The Peroxidation of Rubber. By E. H. Farmer and A. Sundralingam. Pp. 9. (London: British Rubber Producers' Research Association.) [275

Recommendations of the British X-Ray and Radium Protection Committee. Sixth Revised Report. Pp. 15. (London: British X-Ray and Radium Protection Committee.) [275

Other Countries

Smithsonian Institution. War Background Studies, No. 10: Poisonous Reptiles of the World; a War-time Handbook. By Doris M. Cochran. (Publication 3727.) Pp. v+37+17 plates. (Washington, D.C.: Smithsonian Institution.) [175

Smithsonian Miscellaneous Collections. Vol. 103, No. 10: A Remarkable Reversal in the Distribution of Storm Frequency in the United States in Double Hale Solar Cycles, of Interest in Long-range Forecasting. By G. J. Kullmer. Pp. ii+20. (Washington, D.C.: Smithsonian Institution.) [175

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 151: The Control of St. John's Wort (*Hypericum perforatum* L. var. *augustifolium* D.C.) by Competing Pasture Plants. By R. M. Moore and A. B. Cashmore. Pp. 23+5 plates. Bulletin No. 153: Pelagic Tunicates in the Plankton of Southeastern Australian Waters, and their Place in Oceanographic Studies. By Dr. Harold Thompson; with a Statistical Analysis of Data on Total Plankton, by G. L. Kesteven. (Division of Fisheries, Report No. 8.) Pp. 56+1 plate. Bulletin No. 157: Studies in the Biology of Australian Mullet. 1: Account of the Fishery and Preliminary Statement of the Biology of *Mugil dobula* Gunther. By G. L. Kesteven. (Division of Fisheries, Report No. 9.) Pp. 147+2 plates. (Melbourne: Government Printer.) [185

Smithsonian Institution: United States National Museum. Bulletin 182: Monograph of the West Indian Beetles of the Family Staphylinidæ. By Richard E. Blackwelder. Pp. viii+658. (Washington, D.C.: Government Printing Office.) 1 dollar. [185

U.S. Department of Agriculture. Miscellaneous Publication No. 401: Geographical Guide to Floras of the World; an Annotated List with Special Reference to Useful Plants and Common Plant Names. Part 1: Africa, Australia, North America, South America, and Islands of the Atlantic, Pacific and Indian Oceans. By S. F. Blake and Alice C. Atwood. Pp. 333. (Washington, D.C.: Government Printing Office.) 75 cents. [205

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 150: The Soils of the Parishes of Longford, Cressy, and Lawrence, County Westmorland, Tasmania. 1: A Soil Survey of the Area; 2: Pot Experiments with Subterranean Clover on the Cressy Shaley Clay-loam. By C. G. Stephens, J. G. Baldwin and J. S. Hosking. Pp. 40+6 plates. Bulletin No. 155: Friction and Lubrication Report No. 2: The Lubricating Effect of Thin Metallic Films and the Theory of the Action of Bearing Metals. By Dr. F. P. Bowden and Dr. D. Tabor. Pp. 24+5 plates. (Melbourne: Government Printer.) [245

Public Library of South Australia. Annual Report of the Libraries Board of South Australia, July 1941 to June 1942. Pp. 6. (Adelaide: Public Library of South Australia.) [245

Smithsonian Institution. War Background Studies, No. 11: Egypt and the Suez Canal. By Frank H. H. Roberts, Jr. (Publication 3728.) Pp. iv+68+25 plates. (Washington, D.C.: Smithsonian Institution.) [255

University of Denver: Department of Anthropology. Archæological Series, Fourth Paper: Archæological Sites of the Cuchara Drainage, Southern Colorado. By Prof. E. B. Renaud and Janet Chatin. Pp. 62+4 plates. (Denver, Colo.: University of Denver.) 75 cents. [285

Proceedings of the United States National Museum. Vol. 92, No. 3156: The Type Species of the Genera and Subgenera of Bees. By Grace A. Sandhouse. Pp. 519–620. (Washington, D.C.: Government Printing Office.) [315

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

THE INSTITUTE of CHEMISTRY of GT. BRITAIN & IRELAND

(Founded 1877)

(Incorporated by Royal Charter, 1885)

APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates and Senior Registered Students), who are available for appointments or who are seeking to improve their position, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology. A list of Laboratory Assistants is also available.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to the Registrar.

All communications to be addressed to The Registrar, the Institute of Chemistry, 30 Russell Square, London, W.C.1.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)

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

Applications are invited from men and women holding degrees in Physiology or Medicine for the post of DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT, from October 1, 1943, at an initial salary of £250 per annum, with superannuation benefits and war allowance.

Further particulars may be obtained from the Warden and Secretary, to whom applications should be sent by July 16, 1943.

THE EVANS BIOLOGICAL INSTITUTE, RUNCORN, CHESHIRE

Applications are invited from male registered medical practitioners for the appointment of Bacteriologist at the above Institute. Applications giving particulars of qualifications, experience, and salary required, should be addressed to the Medical Director.

CUMBERLAND EDUCATION COMMITTEE

REQUIRED FOR THE AUTUMN TERM

MASTER for CHEMISTRY. Good opportunities for a man prepared to be interested in industrial chemistry, particularly metallurgy.

Knowledge of Games useful. Active interest in corporate life of School. Burnham Scale.

Application (no forms) should be sent as soon as possible to the Principal.

VETERINARY EDUCATIONAL TRUST

ELECTION TO A JUNIOR WELLCOME FELLOWSHIP

Applications are invited for the appointment to the above Fellowship from any person who is under 36 years of age at the date of Election and has taken the Membership Diploma of the Royal College of Veterinary Surgeons or a Degree in any Faculty in any University in the British Empire; or who, if a female, has passed an examination which would have entitled her, if a male, to take any such Degree.

The Fellowship, to the value of £400 per annum, is tenable for one year and for a subsequent period of two years at the discretion of the Advisory Committee. The Election will take effect as from October 1, 1943. Applications must be received before July 14, 1943.

Forms of application are obtainable from The Honorary Secretary, Wellcome Fellowship for Veterinary Research, 10 Little College Street, Westminster, London, S.W.1.

SWANLEY HORTICULTURAL COLLEGE FOR WOMEN, SWANLEY, KENT

Required in September a Lecturer in Botany who can teach this subject to students taking the Course leading to the University of London Degree of B.Sc. Horticulture, those reading for the College Diploma and Certificate.

Full particulars may be obtained from the Principal of the College, to whom applications should be submitted as soon as possible.

UNIVERSITY OF LEEDS

DEPARTMENT OF AGRICULTURE

Applications are invited for the post of FIELDMAN to assist the Advisory Chemist. Candidates should possess an agricultural degree or equivalent qualification. Experience in soil sampling and soil analytical methods will be added qualifications. Salary £260 plus bonus.

Applications together with copies of three recent testimonials should reach the Registrar, The University, Leeds, by July 5, 1943.

Cambridge graduate requires chemical research or devt. work of war value. Preferably organic. Salary £300-600. Box 969, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Secretary-Assistant required for Technical Library in Essential War Works, ½-hour from London. Typing essential, previous library experience preferred. No person within the scope of the Employment of Women (Control of Engagement) Order 1943, need apply. Write stating age, experience and salary required to Box W. 743, Willings, 362 Gray's Inn Road, W.C.1.

Fully qualified bacteriologist with research experience required by old established firm working in the medical field. Applicant must be able to plan independent and fundamental approach to research problems. Write in first instance giving full details of qualifications, experience and salary required to Box 968, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Russian Technical Translations by qualified chemist. For rates, etc., apply Box 970, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Polyglot Translation Service Ltd., Terminal House, 52 Grosvenor Gardens, S.W.1. Sloane 7059. Translations in all languages. English and Foreign Secretarial work.

Ido, the History of our Language, by Otto Jespersen, 4d. post free from The International Language (Ido) Society of Great Britain, 3 Spareleaze Hill, Loughton, Essex.

Colorimeter, Photo-electric or Optical—Klett, Hellige, Duboscq or other good make, urgently required.—Details and price to E.C.D. Limited, Priory Works, Tonbridge, Kent.

Wanted: X-ray Tubes with Cu, Fe, or Cr Anti-Cathodes and Powder-Type Diffraction Camera.—Box 966, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Magnifying Glass. Cylindrical Lens, High Power for reading. Vercyl or similar make.—Box 965, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Geiger-Mueller Counter tube for detection of Gamma Rays.—Box 971, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

For sale: Hearson Centrifuge, 4 head, 50 ml, tubes, 0.1 h.p., 200/220 volts D.C., 3,000 r.p.m., complete, as new.—Offers to Box 967, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, second-hand, a large selection of instruments in perfect condition; 3d. stamp for list. Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN CO., 60-62 Fifth Avenue, New York—Saturday, June 26, 1948.