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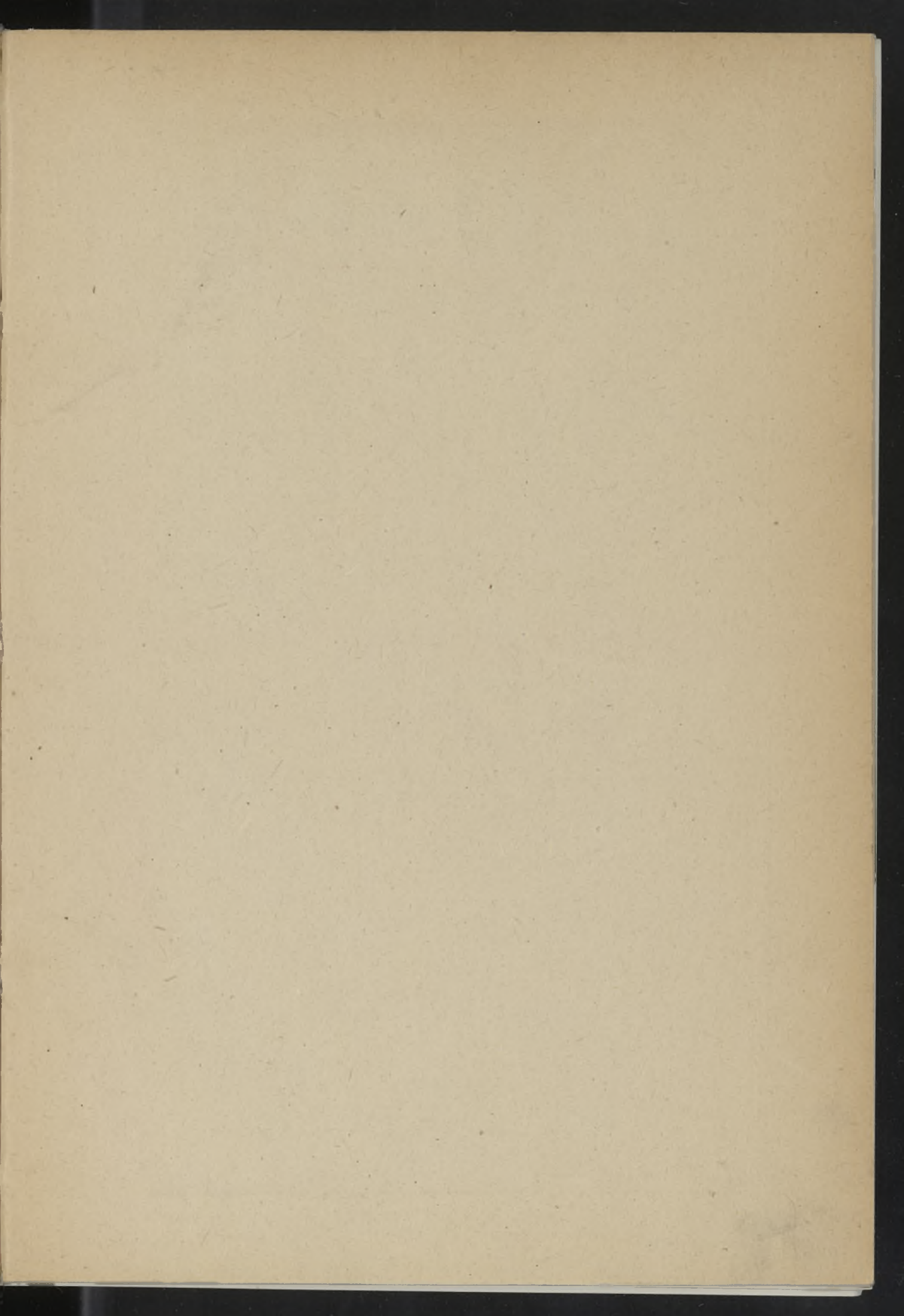


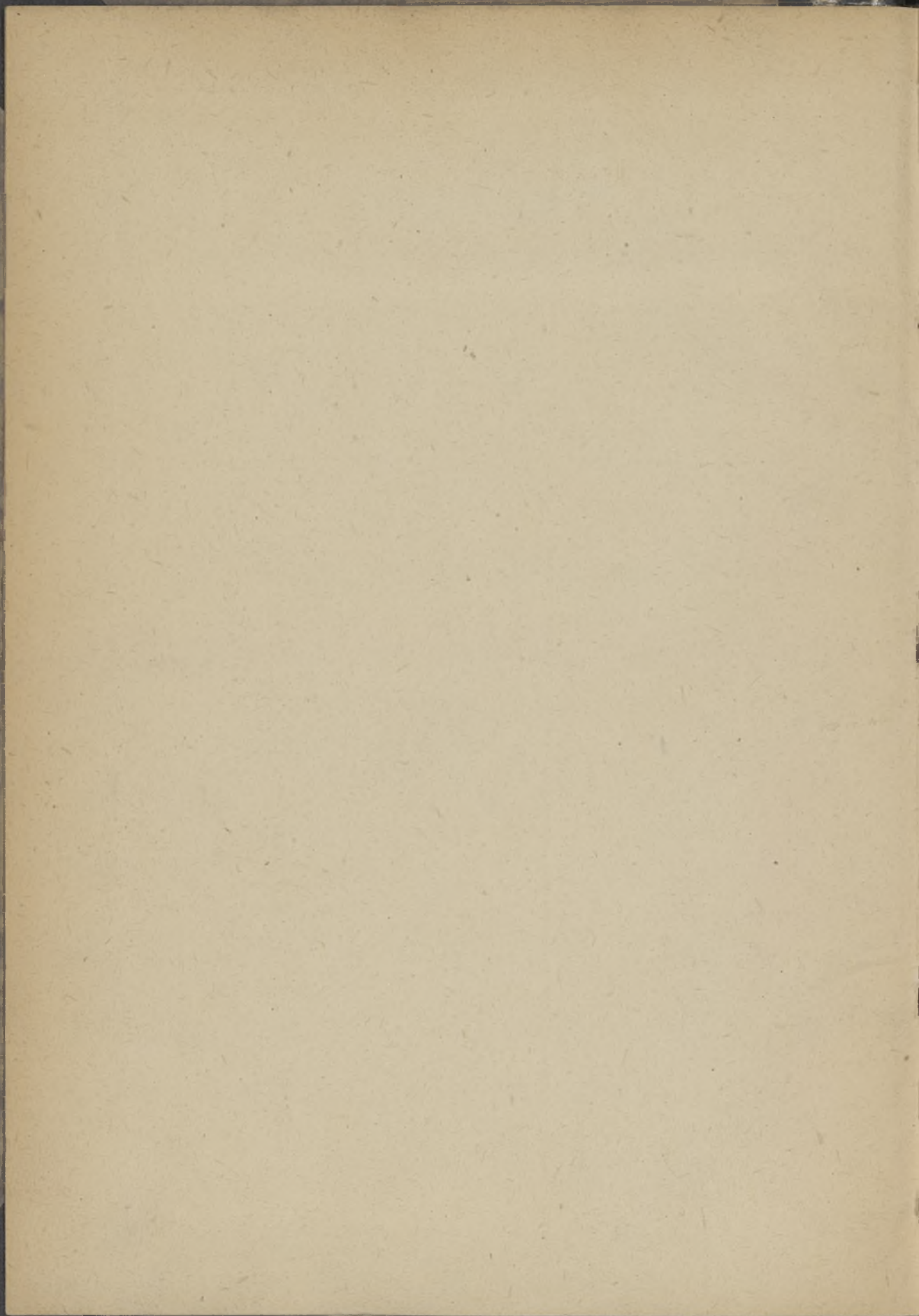
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Of nature trusts the Mind that builds for aye"* —WORDSWORTH

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CARTOGRAPHY AND THE UNIVERSITIES

THE primary concern of geography is to take accurate note of the spatial relationship existing between environmental phenomena which are significant in the organized life of mankind, and its philosophy is devoted to interpreting the interaction of man and his habitat. Cartography has a special and close relationship with geography.

Modern geography is becoming more and more an exact science using quantitative methods in regional analysis. To studies of this kind the map, chart and diagram are fundamental and, because of this, cartographical studies rightly occupy an important place in the geographer's training. The map is the geographer's chief tool. In its simplest conception it is a conventionalized representation of some aspect of the earth's pattern so that the larger patterns are reduced in such manner that they can be comprehended in one person's view. The geographer seeks to interpret, understand and account for the facts displayed. To bring these fundamental materials for study into existence, two phases are involved. First there must be measurement by the *surveyor* of the elements of the total environment that are to be portrayed: the configuration of the land or of the sea bottom, the weather, climate, geology, social, cultural and demographic features, etc. The organized measurement of the elements of environment is properly the work of specialists such as the topographical and hydrographic surveyor, the meteorologist, geologist, economist, anthropologist and so on, each developing a high degree of specialist skill in technique and refinement of equipment, and also often finding government authority and support necessary for the adequate performance of their duties. This being done, it is the *cartographer's* business proper to collect and use these measurements, and render the data in such a way that they may be accurately and fully but clearly depicted. Many sciences provide the cartographer with his material, and although he is not primarily concerned with observational practice, yet he must possess a knowledge of the methods of the sciences sufficient to enable him to check or appraise the value of the data supplied.

A geographer intending to carry out his own investigations into man's physical environment and his relationship with it will often need to make his own measurements, and though he may not do so with the refinement and equipment of the professional specialist surveyor or investigator, he will none the less be using exactly the same methods and principles. The geographer, too, needs to be able to give clear and correct graphic expression to his ideas. Hence a knowledge of, and some working practice in, the methods, technique and limitations of both the survey and cartographic aspect become essential if the geographer is to obtain and give a true interpretation of the information he is handling.

In order to ascertain if adequate training were being given in these aspects, it was decided after a discussion during the Cambridge meeting in 1938 of the

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British Association for the Advancement of Science, that the Conference of Heads of University Departments of Geography should endeavour to obtain information about cartographical work conducted in British universities and the universities of the Empire. A *questionnaire* on 'laboratory work' was accordingly drawn up and sent out to departments of geography in the various universities.

So far as the universities of Great Britain are concerned, it is probably true that most departments devote an adequate amount of time to cartographical studies, such work representing 30-40 per cent of the geography time-table in each of the three years of an honours degree course. But generally speaking, the topics treated are very similar, resulting in a surprising lack of differentiation among departments which in other ways work on distinctive lines. The general scheme is practical map work, map reading and the interpretation of topographical sheets; the cartographic analysis of maps (British and foreign) on different scales; the cartographic representation of economic and other statistical data; geological, meteorological and climatological maps, and exercises based on them, and varying amounts of surveying. No doubt the quality of the cartographic work could be improved, but this would be conditional on equipment and properly qualified staff being available.

That cartography in university departments of geography in Great Britain has been thought mainly to consist of map reading and interpretation, an understanding of the properties of different projections, the elementary methods of survey and the construction of statistical maps and diagrams is understandable, in that these ought, if properly taught, to provide the geographer with a training sufficient to enable him to carry out simple surveys and to use and appreciate maps scientifically. The major deficiency in the courses offered lies in the paucity or absence of training in those special techniques, judgment, style, etc., that characterize the range of operations that must take place between the completion of the survey and the placing of the published map or chart in the hands of the geographer.

An improvement in the quality of cartographic instruction could be secured without an extension of time already devoted to this side of the geography course by the adoption of a carefully thought out syllabus which would ensure that all aspects of cartographic studies receive adequate treatment—all important branches of surveying, office compilation and drawing and map production as well as map use and interpretation. In suggesting improvements for the geographer, the possibility of building up, on this foundation, courses which will cater for the needs of the specialist cartographer should not be overlooked. Before the War no advanced course of cartographical studies could be taken in any British university. At Cambridge, instruction in advanced topographic and geodetic surveying was available in Part II of the Geographical Tripos; but this course was largely designed for intending entrants into the Colonial Survey Service, and as such was not concerned with the preparation and production of maps

and diagrams recording all the elements in man's environment and his activities in economic, social and political affairs.

The incidence of war has created an increased demand for the specialist cartographer. Government departments have had serious difficulties in satisfying their requirements, and on occasions it has proved impossible to find people adequately trained for cartographic posts. A demand for the services of trained cartographers exists not only in the older Government departments producing maps and charts from fundamental surveys, but also in the newer ministries now largely concerned with the work of planning and reconstruction. The oldest department is the Ordnance Survey (dating back to 1791), and this is charged with the responsibility of the national survey, from cadastral maps to general-purpose sheets on smaller scales. The staff is partly civil and partly military, the latter filling the higher posts and being trained at Royal Engineers schools such as Woolwich and Chatham.

Of a somewhat similar vintage is the Hydrographic Department, founded in 1795, which is responsible for the preparation of charts for the Royal Navy and merchant fleet. Here again service and civilian personnel are to be found, but there is a more rigid demarcation of duties: office and production work is largely a civil matter, the hydrographic survey being undertaken by naval personnel of the surveying service.

The comparable unit in the War Office is the Directorate of Military Survey and Geographical Section General Staff, which dates from 1855. Originally the section had an imperial function, as it was largely responsible for the preparation and production of maps of the Colonies and other poorly surveyed parts of the world in which Great Britain had a special interest. This work has diminished, however, as each Colony and Dominion has taken over its own survey, and now the organization is chiefly concerned with the compilation and supply of maps to the Army; it has recently acquired the responsibility for the preparation and supply of aeronautical maps to the Royal Air Force. Like the Ordnance Survey, its staff is partly civil and partly military, the latter being drawn from the Royal Engineers.

The newer departments, the development of which has demanded, or might demand, cartographic staff, include the Ministries of Home Affairs and Home Security, Information, Town and Country Planning, Transport, Health, and Agriculture and Fisheries, and the Board of Trade.

In the war-time expansion of activity, the Service departments have looked to the universities for suitably trained 'specialists'; but not having recruited personnel from them hitherto, there were no specialist courses, and apart from those teaching cartography in the schools of geography few were found. The situation in the universities of Great Britain is now generally worse than before the War; but one advantage at least has accrued, in that a close knowledge of the needs of these departments has been gained by the university teachers absorbed into them.

Two broad conclusions emerge. In the first place, there are undoubted grounds for an improvement in quality of the cartographical training made available for geographers. Secondly, in view of the probable continued post-war need for specialist cartographers—personnel best recruited from geographers with a good mathematical training—it seems likely that the Government departments will look to the universities of Great Britain when making such professional appointments. It is therefore not too early to consider an investigation into the probable needs of these departments and the possibility of meeting such needs, not only by the desirable general raising of the standard of cartographical teaching, but also by the creation of advanced courses at selected universities.

A SHORTER HISTORY OF SCIENCE

A Shorter History of Science

By Sir William Cecil Dampier. Pp. x+190+9 plates. (Cambridge: At the University Press, 1944.) 7s. 6d. net.

SIR WILLIAM DAMPIER has now published a shorter and easier version of his very successful "History of Science". In the preface he says that the readers he has in mind are, first, that rather elusive creature the 'general reader', and second, those more definable readers who occupy the higher forms of schools. They will either be science students whose science can be broadened, or students of the humanities who need an idea of the place of science in human life. The book should fulfil these requirements very well indeed.

The new volume is less than a third of the length of the earlier one. Thanks to narrow margins, no references in footnotes and thin paper, it can be put into one's pocket. In spite of this, the print is clear and not crowded, and room has been found for nine plates. Six of these are portraits of men of science—Archimedes, Leonardo da Vinci, Galileo, Newton, Darwin and Rutherford. The first portrait is perhaps not very authentic. The last is authentic enough, but is a photograph with that strained expression often seen on passports and not at all characteristic of Rutherford.

The process of compression has been carefully done. By omitting minor lines of investigation and the work of minor contributors, the account has on the whole been made more readable, without any great loss for a book that is not meant to be a work of reference and that supplies a good select bibliography. There is less philosophical discussion but enough to give an outline of that aspect of scientific thought. Parts have been rewritten and some definitely improved, but of course a good deal of the compression has been a matter of scissors and paste. The earlier chapters up to the end of the eighteenth century are highly successful. If the later ones are not quite so good, that is because the immense mass of detail to be considered raises much harder problems. In a few cases compression has gone to the length of obscurity, as in the solitary mention of the work of Langmuir and Adam on surface films (p. 135). The statement about von Baer, the embryologist, at the end of p. 114, has become misleading by the

omission of statements that explain and qualify it in the larger book. The probability curves shown on pp. 96 and 124 without adequate explanation in the text or under the figure are likely to mystify the innocent reader. This is specially to be regretted, as these curves come into a host of modern problems. Still, these are minor blemishes and there do not seem to be many of them.

For the majority of readers, who are not going to be scientific specialists, but who want a conspectus of the development of scientific thought and practice, the book seems admirably fitted. For those young people who are going to devote themselves to scientific investigation it has one defect, though one it shares with almost anything they are likely to read about the progress of science. That is, that this progress is made to look like an unbroken series of triumphs. Before long these people will discover that the experimental method consists in doing fifty things wrong before doing one right. It might be a help to them (to mention one case only) to hear how it happened that "the incomparable Mr. Newton" himself made one serious mistake and devoted years to chemical experiments which yielded no results. There is no need to go to the other extreme of the cynic who said that "science consists of theories, which nobody believes except the man who first thought of them, and facts, which everybody believes except the man who has last investigated them". Nevertheless, the young do tend to take a rose-coloured view of things, and it is part of the duty of their elders to disabuse them.

A. D. RITCHIE.

BIBLIOTHECA CUSHINGIANA

The Harvey Cushing Collection of Books and Manuscripts

(Publication No. 1. Historical Library, Yale Medical Library.) Pp. xvi+207. (New York: Schuman's, 1943.) 8.50 dollars.

WHEN Prof. Cushing bequeathed his remarkable library to his old University of Yale, he set aside a fund to be used in cataloguing portions of the collection. The advisory board of the historical library, however, decided to employ this fund in preparing a short-title list of the *entire* collection. Whether it was advisable to do this, instead of concentrating on a list of only the rarer and more important items, *with full collations*, was doubtless considered. Cushing's bio-bibliography of Andreas Vesalius, published posthumously, does indeed include such collations of the relevant Vesaliana, and this to some extent favours the decision of the members of the advisory board, who were not in a position to ignore considerations of expense, or to indulge in duplication. Prof. J. F. Fulton, who is devoted to the memory of Cushing, and is himself a learned and experienced bibliographer, favoured the solution adopted, and it will be wise to respect his judgment, although a volume comparable in plan with the Bibliotheca Osleriana would have been most welcome.

The library includes 77 early manuscripts, 168 *incunabula*, and some 7,500 books, pamphlets and separates. It is therefore not a large collection, but on the other hand it is relatively very rich in the rarest and most desirable works. To assemble such a library, in times when it was possible, postulated the possession of ample means, of knowing what to

buy and how to find it, and above all of a dogged pertinacity almost superhuman. All three conditions were abundantly exemplified in Cushing and his friend Osler, and the result was the formation of two of the most notable private scientific libraries of modern times. A few of Cushing's rarities, apart from his unique collection of Vesaliana, are: Aselli on the lacteals, 1627; Berengarius' *Isagoge*, 1522; Caius on dogs, 1570; Canano on the muscles, 1541; Coiter's comparative anatomy, 1573-75; Dryander's anatomy, 1536-37; Estienne's anatomy, 1545; Harvey on the circulation, 1628; Mondinus' anatomy, 1538; Rabelais' *Pantagruel*, 1546; Redi on insects, 1668; Vicary's anatomy, 1587; and Wolff's *Inaugural Dissertation*, 1759. There are, of course, notable gaps, some of which are surprising, since they could have been readily filled. Such are Haller's "*Bibliotheca Anatomica*" and "*Elementa Physiologiae*", both of which Cushing must have frequently consulted. Havers on the bones, Tyson's chimpanzee, Willis on the soul of brutes and the "*Acta Medica Hafniensia*" are also wanting.

The volume has been very well printed on good paper and is suitably bound.

F. J. COLE.

WEST INDIAN ARCHÆOLOGY

Yale University Publications in Anthropology,
Nos. 25 and 26

The Ciboney Culture of Cayo Redondo, Cuba, by Cornelius Osgood; Archeology of the Maniabon Hills, Cuba, by Irving Rouse. Pp. 252+14 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1942.) 23s. 6d. net.

THE two areas of excavation under review lie to the west and east of Cuba respectively. Cayo Redondo is a swamp island close to the sea at the head of Guadiana Bay; the Maniabon hills have yielded a number of kitchen midden sites and a cave habitation. Everything earlier than the coming of the Spaniards is, of course, prehistoric, and the early story of Cuba has still to be written in detail. But the generalized outline is known and much suggestive information can be obtained from the volume under review.

It would seem that at some unknown date—perhaps during the first millennium of our era—a people from North America filtered into the "islands" and occupied Cuba. They have been called the Ciboney. Very similar to them in all main characteristics were the so-called Guayabo Blanco folk. The Ciboney introduced a very primitive culture and practised neither agriculture nor manufactured pottery. Any manifestation of art, too, is absent. Their material culture seems to have consisted mainly of objects made from shell and rough stones. Ochre, however, has been discovered, so they may have painted themselves. Their burial ceremonies are unknown though they may have deposited their dead in caves.

At a somewhat later date tribes of the Arawak group, perhaps impelled by the Caribs, penetrated up from South America and occupied most of Cuba, leaving little but small, unhealthy areas on the western coast to the earlier Ciboney. The Maniabon Hills' sites, while yielding a little Ciboney material, have mostly yielded objects left by the newcomers, and the Ciboney probably had to quit. The

invaders fall into two groups chronologically, named respectively the Sub-Taino culture and the Taino culture. They practised agriculture and made pottery. This at first was beautifully decorated, but later became poorer in quality and plain. The Caribs arrived just before the Spaniards, and would doubtless have overrun both the earlier Ciboney and the Taino groups if the Europeans had not arrived in time to mop up everything themselves. Anyone interested in the "pre-conquest" Indian cultures of the West Indies should peruse this work. It is well illustrated.

M. C. BURKITT.

A STUDY OF FREEDOM

The Machiavellians

Defenders of Freedom. By James Burnham. Pp. v+202. (London: Putnam & Co., Ltd., 1943.) 7s. 6d. net.

MR. BURNHAM is well known as the author of "*The Managerial Revolution*". He remarks, with a certain bitterness, of the present book that its circulation is not likely to be large. I am not sure whether Montaigne, who held himself detached from the civil wars of his day, may not have had a richer wisdom than Machiavelli; but Mr. Burnham feels that the Florentine, and his successors of the too little known Italian school, Pareto, Michels and Mosca, require this volume of homage. For Mr. Burnham's attempt to develop still further an authentic political science, following in the way of the Chicago school and its derivative, Bertrand Russell, too high praise can scarcely be given.

The thesis, of course, that the appetite for power rather than the economic appetite provides not only the major but also the master key to the interpretation of political action is, as this writer can testify, not new and will to-day be found even in the writings of Russian Marxists. An eminent Left Wing weekly journal recently, in reviewing Mr. Burnham's book, commented sub-acidulously that it made no contribution to scholarship. We may reasonably suspect that we have here a psychological defence reaction, for which doubtless Pareto would find a technical name. The fact is that the Marxists, under pressure of the results of recent psychological and anthropological research, are in full strategic retreat from their earlier material dogmatism, and the franker among them are prepared to admit that new light is possible since Marx. Our major risk is to be told that Marx invented Burnham's power theory as well as all the rest.

Mr. Burnham, in elaborating the predominance of the quest for power over the specific quest for control of the means of production as social determinant, supports his case by a historical survey from Machiavelli to Mosca. Recent American attention, not least under the guidance of Prof. Henderson, to the modern Italian school is noteworthy. In his "*Managerial Revolution*" Mr. Burnham gave reason to doubt whether the world is moving in the direction of "a free, classless, international society", and many events (not least in the U.S.S.R.) which have taken place since he wrote serve to bear him out. Like most pioneers, he perhaps overstressed his argument and minimized the difference caused not only by the rise to power of new families in that country, but also by the liquidation of old families compared with the managerial situation (at least at present) in western Europe and America. That is, the Communist

Revolution (like the French *bourgeois* Revolution) may be not only more real but also more distinctive, compared with the National Socialist, than he supposes. It does not, of course, follow that it is more equalitarian in its present structure, although even here the traditional Russian ideology is ambivalent (Leninist and Tsarist).

Similarly in his present brief and readable book Mr. Burnham (who, incidentally, is lecturer in philosophy in New York University) tends to overplay his argument. "Despotism is more nearly than freedom in accord with human nature" is but a half-truth. History, indeed, shows political individual freedom (usually destroyed, Aristotle observed, by popular movements in favour of majority will, leading towards tyranny) to be rarer than political authoritarianism of a pronounced type. But Pavlov's thesis that freedom is a conditional reflex or instinct remains undestroyed. All that happens is that, when men come to put first social security, the impulse for freedom—as distinct from the bellicose desire for tribal anarchy—takes other than civil forms, and leads men into the desert solitudes. Mr. Burnham's phrase involves a false antithesis and, taken precisely, will not stand up to criticism. When Mr. Burnham says that there is a universal "trend to Bonapartism", in part precipitated by the coming of war, nationalism and democratic economic needs, but not to be removed by the end of war, he is on safer ground and I agree with him. Certainly every sociologist and politician (including Mr. Cordell Hull) will be benefited by reading this highly stimulating and hard-hitting book, even if in conclusion he says, as did Mr. Hughes of Clemenceau's statement that Hughes was once a cannibal, "the report has been greatly exaggerated". Let us avoid cant. Certainly, if democracy is not to end in popular personal dictatorship (as it now shows signs of doing, not unexpectedly, in France) let us avoid cant, including the cant (of which Dr. Eric Fromm, in the "Fear of Freedom", warns us) which will not admit that many men dislike all liberty save their own.

GEORGE CATLIN.

FRESHWATER FISHES OF CHINA

The Fresh-Water Fishes of China

By John Treadwell Nichols. (Central Asiatic Expeditions: Natural History of Central Asia, Vol. 9.) Pp. xxxvi+322+10 plates. (New York: American Museum of Natural History, 1943.) 9 dollars.

THE Asiatic Expeditions of the American Museum of Natural History have brought together general collections of freshwater fishes from representative localities in China, and this monograph by Dr. Treadwell Nichols, curator of recent fishes, reports on these collections. The scope of this most useful work is, however, much greater than this. Its aim is a comprehensive review of the freshwater fishes of China proper, and it should serve as a handbook to the subject. Outlying territories such as Manchuria and Mongolia are not included. China proper is more or less of a unit faunal area which may be divided into smaller areas and sub-areas. The freshwater fishes are separated into north-central and southern sub-faunas having a standard climatic zonal basis.

Carp-like fishes dominate the Chinese fauna. In

a list drawn up by Nichols in 1928, 263 of the 374 species recognized (70 per cent) were carps and loaches (with one sucker) and 11 per cent of the remainder were cat-fishes, so that only 19 per cent belonged to non-ostariophysine groups. Carps are fundamentally non-predacious, feeding on small animals and even on vegetable matter, and are without teeth in the mouth. They have, however, well-developed, variously specialized teeth on the pharyngeal bones (of the throat). In the suckers the pharyngeal teeth are more numerous and arranged in a comb-like series.

The suckers are usually held to be more primitive than, and more or less ancestral to, the carps. One true sucker only is left in China (*Myxocyprinus*). According to the author one may suppose that the suckers have run their course in China, leaving this peculiar representative behind, and that they have been superseded by the present-day gudgeons, a division of the true carps. The suckers are now almost exclusively North American. This view would make of China a recent centre of differentiation and distribution for carp-like fishes. The true carps are here not only very abundant but also more varied than elsewhere and more advanced in evolution or radial differentiation. Breams, with a single primitive genus in North America and a couple allied to it in Europe, and gudgeons, which seem not to have reached Africa or America but are represented by a few species in Europe, form two sub-families with many genera and species.

Carp-like fishes are the dominant freshwater fishes of the northern hemisphere. Their present distribution is recent, from the north from an Asiatic centre, probably China. The distribution of loaches parallels that of carps. They are probably a secondary offshoot of the true carps. The peculiar Chinese fish *Gobiobola* combines characters of a loach and of a gudgeon. Catfishes and characins are both older than the carps and probably have invaded their present ranges (South and Middle America and Africa), from the north, where both have been more or less superseded by the carps.

The cultivation of freshwater fishes in China is extensive. Pond-fish culture apparently originated there about 2000 B.C. This doubtless complicates the range of various species and sometimes causes confusion between artificial forms and natural races. The present-day methods are much the same as those in use hundreds of years ago. The fish commonly cultivated are *Cyprinus carpio*, *Labeo jordonii* and species of *Hypophthalmichthys*. Almost every freshwater fish, large or small, is utilized for food by the Chinese.

In listing the freshwater fishes of China, brief descriptions have been given of the genera and species, with keys to the species when several occur in a genus. Here and there are interesting field notes and descriptions of fishing methods.

There are numerous text-figures, and the nine coloured plates drawn in the field by Mr. Wang Hao-T'ing are admirable.

The well-known Hilsa is the only Clupeoid included in the work. These fishes are marine, occurring along the coasts, but they ascend the rivers to spawn and may penetrate to waters a thousand miles or farther from the sea. An anchovy *Coilia brachygnathus* plays an important part economically, being caught in vast numbers in special nets at Tiengting, Lake Hunan. Of the numerous carps, *Cyprinus carpio* L. is perhaps of the greatest economic importance.

AGE AND ORIGIN OF THE 'BRECKLAND' HEATHS OF EAST ANGLIA

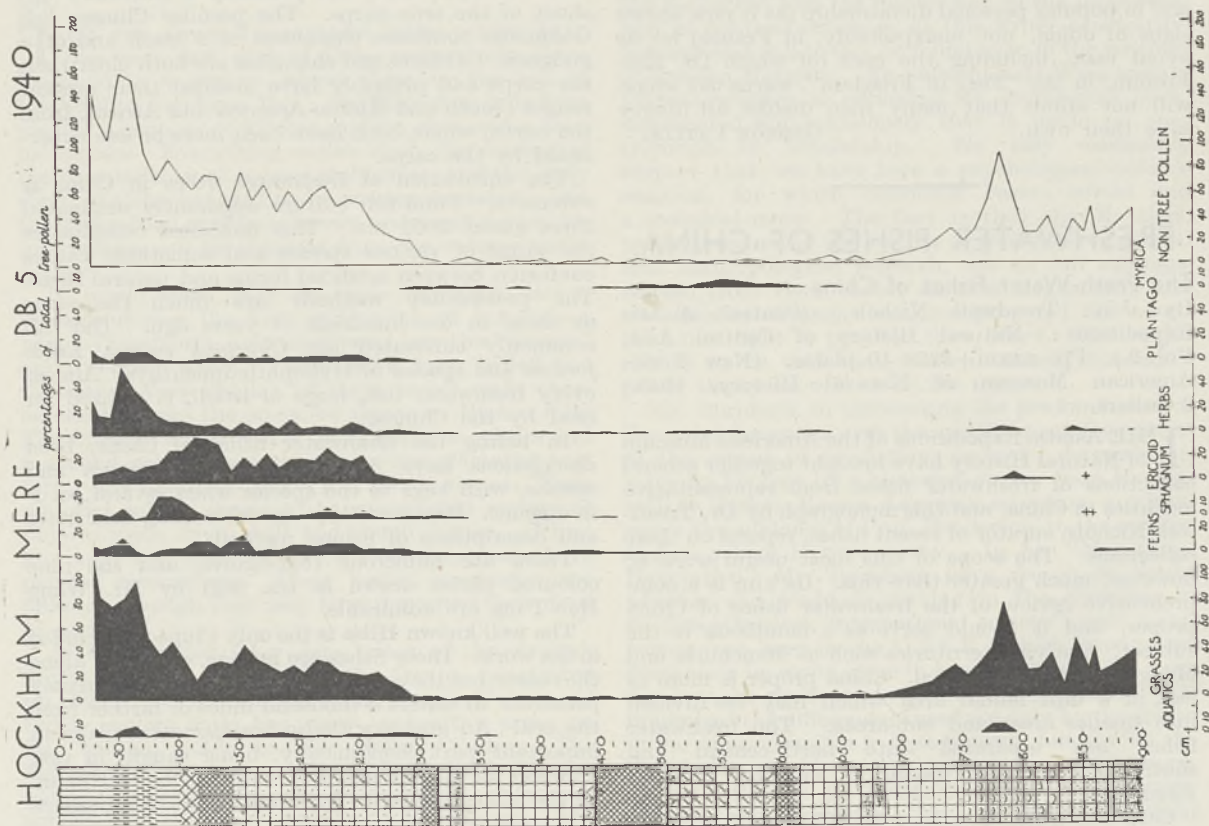
By DR. H. GODWIN
Botany School, Cambridge

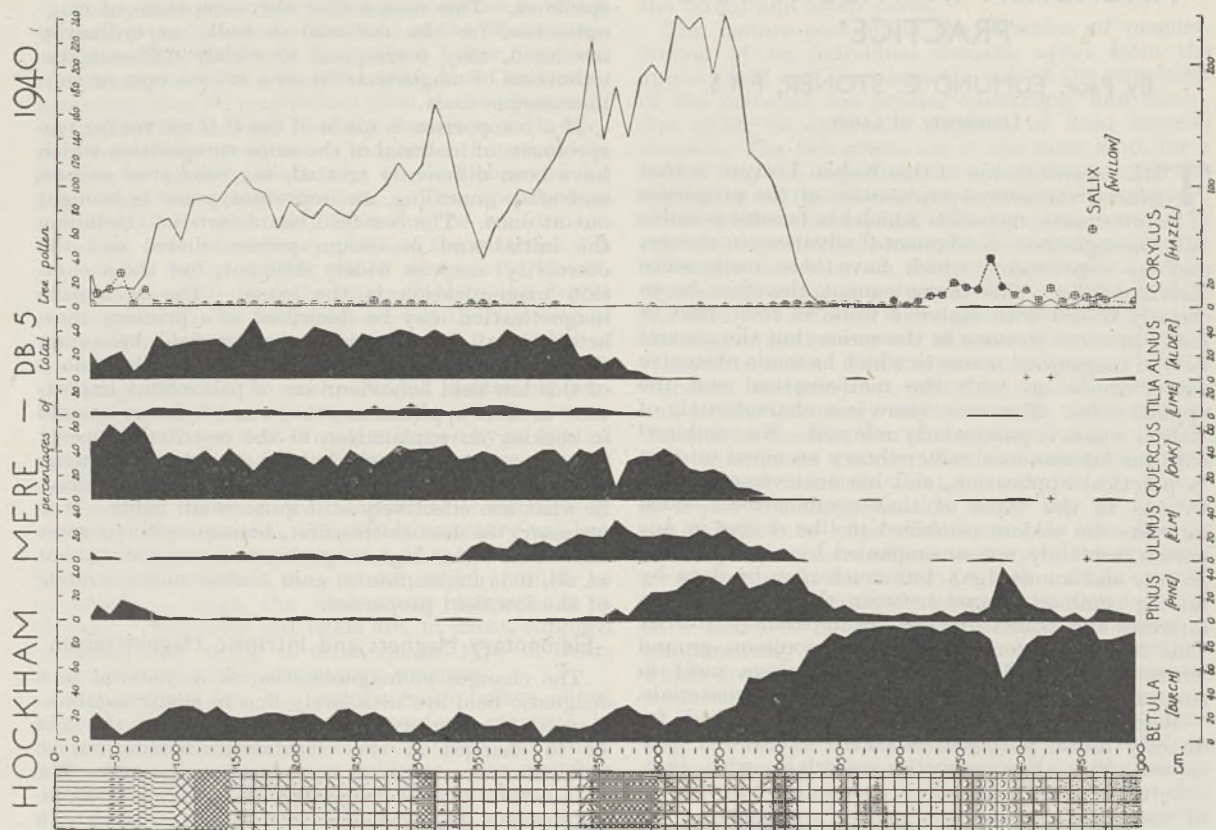
IN a recent issue of *Nature*¹ it was pointed out that Iversson had produced evidence from pollen-analysis of lake-muds that, in parts of Denmark colonized by Neolithic man, the continuity and composition of the natural mixed oak forest cover had been much altered by the human introduction of forest clearance by fire. It now seems appropriate to give results which point in a similar direction for the great heath-land area of East Anglia known as the 'Breckland'. The ecological status of the varied plant-communities of grass-heath, sand-sedge, bracken, ling, and sparse woodland has long been in dispute, especially as regards their relation to the factors of climatic, biotic and edaphic (soil) control. It has sometimes been suggested that the rainfall and porous soil may in themselves prevent the development of natural woodland; but others have regarded the heavy grazing, formerly by sheep and now by rabbits, as the only factor preventing recolonization of the heaths by woodland. The basal question has remained unanswered, whether this heathland is determined as such by natural factors, or whether it represents the effect of human interference upon native woodland.

Towards the northern edge of the Breckland is the

site of Hockham Mere, which was drained at some unknown post-Tudor date, and the quaking surface of which is now overgrown by wet fen-wood. Borings show that the centre of the lake-basin contains organic lake-muds (nekron-mud or gyttja) to a depth of at least 9 m.: only near the surface are these replaced by the sedge-peats which represent the latest stages of the lake's infilling. Though at the sides the lake-deposits were interrupted, in the lake-centre nekron-mud formed continuously: it is a translucent or rather chalky green jelly with conchoidal fracture, and very rich in pollen. Since such muds form slowly and collect pollen from a wide neighbourhood, it is clear that in the Hockham lake-muds we may expect to find recorded, through the pollen-content, the vegetational history of the northern Breckland throughout a very long period. Moreover, the pollen investigation itself here fulfils a double function. On one hand, the drift of the tree-pollen curves establishes the course of post-glacial forest history, and so allows us to date each stage of the mud accumulation by the correlations already made in Britain between stages of forest-history and archaeological, climatic and geological horizons. On the other hand, both tree and non-tree pollen will be direct indexes of the kind of vegetation covering the Breckland hereabouts at each stage of its history.

Events have fortunately realized these possibilities. The tree pollen curves indicate that the oldest muds were formed in a period of birch predominance, where the abundant willow pollen and the high ratio of non-tree to tree pollen indicate the stage of open birch woodland typical of the late-





glacial period. Then follows a relative diminution of the non-tree pollen, and the extension, first of pine and hazel, secondly of elm and oak, and thirdly of lime and alder. The alder-mixed oak forest replaces the birch and pine at a very clear horizon, just as everywhere else in Britain. From this time onwards the tree-pollen curves pursue an uneventful course to the top of the lake deposits, except that we can recognize at 3.3 m. a subsidiary horizon especially indicated by diminution of the elm. This horizon in the Fenland of East Anglia and in the Somerset Levels seems to fall at the opening of the Neolithic period of human culture, and it has been shown to have this correlation also in Denmark and southern Sweden. This correlation is of great importance in the Hockham pollen diagrams, for below this horizon the non-tree pollen of all kinds is negligible; above it there is a sharp increase, and high values of grass-pollen, fern-spores, sphagnum moss spores, ericoid pollen and miscellaneous herb-pollen prevail up to the surface. The nekron-muds continue well above the Early Neolithic horizon, and the stratigraphy makes it clear that this rise in non-tree pollen cannot be due to local changes in the vegetation fringing or filling the lake.

There seems every reason for regarding these high values of non-tree pollens as witness of origin of the Breckland heaths from a pre-existing vegetation of closed mixed oak forest. The high grass-pollen values speak for themselves; the ericoid pollen is indicative of the Calluneta; the fern-spores may or may not have come from bracken com-

munities, for they no longer have their episporous by which fern genera and species can be recognized. The presence of abundant Sphagnum spores is more surprising, but Sphagna persist abundantly in some parts of the Breckland still, and may formerly have been more prevalent. We have not attempted the separate estimation of sedge pollen.

There is no direct evidence of the mechanism by which the vegetational change to heath was brought about; but in view of the conclusions reached by Iversson the correlation of this change with the Neolithic period must be noted, for of course at this time the important flint mines at Grime's Graves were operating, and there is reason to think that there was considerable colonization of Breckland at this time. The suggestion that in a general way the heaths had their origin in Neolithic forest clearance is supported by the recognition that in the Hockham profile, as in Denmark, at the Neolithic level there appears a continuous curve of the pollen of the ribwort plantain (*Plantago lanceolata*), a species one can only associate with low and relatively open vegetation, and certainly not with woodland cover. It seems likely that with careful diagnosis other equally characteristic species may be identified.

It is pleasing to be able to add in conclusion that Dr. A. S. Watt, speaking from his very extensive knowledge of the ecology of Breckland, sees nothing in this hypothesis of the origin of the Breckland heaths which is not in accord with his own views and experience.

¹ *Nature*, 153, 511 (1944).

MAGNETISM IN THEORY AND PRACTICE*

By PROF. EDMUND C. STONER, F.R.S.

University of Leeds

THE central theme of this Kelvin Lecture is that general theoretical explanation of the properties of ferromagnetic materials which has become possible only through those fundamental advances in theory, and by experiment, which have been made since Kelvin's time. This theme cannot, therefore, be so directly linked with Kelvin's work as could that of many previous lectures in the series; but the general field of magnetism is one to which he made extensive contributions on both the mathematical and the applied sides. Moreover, there is a characteristic of Kelvin which is particularly relevant. He combined with his interest in abstract theory an equal interest in practical application, and his achievement bears witness to the value of that combination. Such interests are seldom combined in like degree in one person, certainly not accompanied by corresponding powers and knowledge; but much may be done by finding common ground between those whose main interests and points of view are apparently diverse. This lecture is concerned with a common ground where theory and practice in magnetism meet in connexion with the magnetic properties of materials.

Magnetism in practice, that is as applied for directly useful purposes, is almost exclusively concerned with ferromagnetic materials—with iron, cobalt and nickel, with alloys containing one or more of these metals, and with a few compounds. By theory in connexion with magnetism should be understood that general scheme of ideas and principles, built up from and constantly checked by experiment, in terms of which an explanation is sought of even such complicated observable facts as the properties of ferromagnetics. The aim of theory is to explain. To reach even partial understanding may be a not unworthy end in itself. In addition to this, however, theory may serve as a guide to practice. New theoretical knowledge may not immediately benefit old trades; but a stage is always reached, with the development of theoretical understanding, at which the practical man who despises theory is left far behind the wiser but no less practical man who is alive to the possible bearing of theoretical ideas on his own particular problems. This stage is one which is now perhaps being reached in connexion with magnetic materials.

Magnetization Curves

The most convenient, though not the most logical, approach to ferromagnetism is through the well-known magnetization curves (B, H or I, H curves) for typical ferromagnetic materials. It is sufficient to recall here, first, that a saturation value of the magnetization is closely approached in moderate fields (seldom more than a few hundred oersteds, and often very much less) and, secondly, that in lower fields the magnetic response to a change of field by a given ferromagnetic depends not only on its state of magnetization, or even on the magnetization and the field, but also on how that state has been reached,

that is, on the previous magnetic history of the specimen. This means that the same state of magnetization for the material in bulk, as ordinarily measured, may correspond to widely different distributions of magnetization on a microscopic or sub-microscopic scale.

If a comparison is made of the B, H curves for two specimens of material of the same composition which have been differently treated, say mild steel as cast and after annealing, an important point is brought out at once. The low-field characteristics (including the initial and maximum permeabilities, and the coercivity) may be widely different, but the saturation magnetization is the same. The saturation magnetization may be described as a primary characteristic of the material; the low-field behaviour depends on secondary effects. Although the details of this low-field behaviour are of paramount importance in most applications, they can be almost ignored in seeking an explanation of the essential property of a ferromagnetic, which is that it becomes magnetized to a high value, characteristic of the material, in what are effectively still quite small fields. It is necessary to discuss this first, because without some idea of how this high magnetization can come about at all, it is impossible to gain a clear understanding of the low-field properties.

Elementary Magnets and Intrinsic Magnetization

The changes in magnetization of a material in a magnetic field are ultimately due to slight modifications in the motion of electrons induced by the field or to changes in the orientation distribution of elementary carriers of a magnetic moment. The first effect can be neglected in para- and ferromagnetics. The magnetic moment of a carrier is a resultant of the moments due to the orbital motion and to the spin of electrons forming part of the carrier. In most materials containing elementary carriers of a magnetic moment (such as the metallic ions in a paramagnetic salt) the degree of alignment of the elementary magnets, and hence the magnetization, produced by ordinary fields at ordinary temperatures is very small. In fields of, say, 10 oersteds, the magnetization of a paramagnetic is usually less than that of a ferromagnetic by a factor of the order of 10^6 . From the susceptibility of paramagnetics, the magnetic moment of the elementary carriers can easily be calculated, using the results of a simple statistical treatment. The form of the magnetization curves for ferromagnetics suggests, correctly, that the carriers are aligned nearly parallel in relatively small fields. The magnetic moments per atom of the ferromagnetic metals are, however, of the same order of magnitude as those of the ions of paramagnetic salts.

The attainment of a high degree of magnetization in relatively weak fields by ferromagnetics can only mean that there are, in effect, strong forces tending to align the elementary magnets other than those due to the applied magnetic field. If there were no such forces, fields of the order of several million oersteds would be required to produce the observed magnetization. The forces are not simply magnetic forces between the atomic magnets, which are hundreds of times too small. It was suggested by Weiss, in 1907, that there were forces giving rise to what he called a 'molecular field', proportional to the intensity of magnetization. The development of the consequences of this simple formal assumption led to a remarkable co-ordination of a wide range of ferromagnetic pro-

* Abridgement of the thirty-fifth Kelvin Lecture, delivered before the Institution of Electrical Engineers on April 27.

erties; but no explanation could be given then of how such a field could arise.

It may easily be shown that a substance in which there is a positive molecular field in the Weiss sense would be spontaneously magnetized below a critical temperature (to be identified with the Curie temperature), that is, magnetized even in the absence of an applied field; and that the variation with temperature of the spontaneous magnetization would be similar, at least qualitatively, to that observed for the saturation magnetization. The spontaneous magnetization need not, however, be uniform in direction over an ordinary piece of the material. A piece of a ferromagnetic which appears to be unmagnetized must be fully magnetized to the degree appropriate to the temperature; but the direction of magnetization may vary from one part to another of even a single crystal grain. The regions over which the magnetization is unidirectional, containing perhaps many millions of atoms, are usually known as 'domains'. The process of magnetization by an applied field consists essentially in lining up the directions of magnetization of the individual domains, rather than in changing the numerical magnitude of the already existing magnetization. The fields necessary to align the directions of magnetization of the domains are very much smaller than those which would be required to align the elementary magnets in a domain; but these last fields are, in effect, supplied automatically owing to some special type of interaction between the elementary magnets.

Experiments on the gyromagnetic effect show, almost directly, that the elementary magnets in ferromagnetic metals are electron spins, for which there is ample confirmatory evidence. The electrons involved, which belong to specifiable groups in the free atoms, may be regarded as shared in the metal formed by the aggregation of the atoms. The first step in explaining the molecular field effects is due to Heisenberg, who showed, in 1927, that they could arise from quantum mechanical interchange interaction of the same type as is involved in the explanation of the formation of homopolar molecules of the hydrogen type; but whereas in hydrogen the electron spins point in opposite directions and balance each other magnetically, in a ferromagnetic the spins tend to become aligned parallel to each other. It is clear now why the interaction effect should work this way round for only a limited number of metals; and with sufficient strength to produce ferromagnetism in elements—probably only in iron, cobalt and nickel and in some of the rare earth metals. In detail, however, the theory is still far from being quantitatively worked out.

The Process of Magnetization

Any piece of a ferromagnetic material must be regarded as made up of domains which are themselves magnetized to the saturation value at the particular temperature. The magnetization as ordinarily measured is a resultant, depending on the orientation distribution of the directions of magnetization of the domains, and on their sizes. There are essentially two types of elementary process by which the magnetization can change: first, by a change in the orientation of the direction of magnetization of a domain (without change of size), and secondly, by a 'growth' of a domain at the expense of others with different directions of magnetization (involving a cumulative re-orientation of electron spins at the moving boundary of the domain).

Usually the first type of process predominates on the upper part of a magnetization curve, the second on the initial and steep parts.

The factors controlling the direction of magnetization of an individual domain, apart from the applied field and the magnetization of the remainder of the material, are crystal anisotropy, and strain, due either to externally applied, or local internal stresses. The two effects are of the same kind, for a strain may be regarded as a modification of the symmetry of the atomic arrangement characteristic of the undistorted crystal. The extensive complex of relevant experimental material on the magnetization of single crystals, on magnetostriction of single crystal and ordinary polycrystalline material, and on the effects of external stress (particularly tension) on the magnetization curves, has now been successfully reduced to order. For the present purpose it will be sufficient to state that owing to crystal anisotropy and strain, the energy associated with magnetization depends on the direction of magnetization in a definite and determinate manner. For an unstrained crystal of iron (body centred cubic), for example, the energy is lowest for magnetization along any of the six equivalent cube edge directions. As the field is increased from zero with a polycrystalline specimen (or along an arbitrary direction with a single crystal) the domain directions of magnetization first take up, as a result of boundary displacement processes in comparatively small fields, the cube edge directions which are nearest to the field. Further increase of magnetization then occurs more slowly with increase of field, the magnetization 'rotating' from the cube edge towards the field direction; in this process the magneto-crystalline energy increases and the energy in the field decreases, and for each value of the field an equilibrium direction is taken up. If an applied or local stress is sufficiently large, the strain anisotropy may become more important than the natural crystal anisotropy. Under sufficient tension, for example, a material of negative magnetostriction (such as nickel) acquires an 'easy' direction of magnetization at right angles to the direction of tension, one of positive magnetostriction along that direction, and the forms of the magnetization curves are correspondingly modified. In general, in the demagnetized state, each of the domains of a ferromagnetic is magnetized along one of the easy directions determined by the local crystal orientation and the local strain.

Usually a considerable fraction of the total change of magnetization from zero to saturation occurs by boundary movements (equivalent, in effect, to a partial or complete change of orientation of the domain magnetization by a large angle, such as 90° or 180° , from one easy direction to another) in fields smaller than those required to produce appreciable changes by the reversible rotation process. Domain boundaries may be set up where there are local fluctuations of strain favouring different directions of magnetization in contiguous regions. With an applied field increasing from zero a boundary moves in a direction corresponding to an increase in volume of the domain magnetized with the greatest resultant intensity in the field direction. The movement is at first reversible, the boundary taking up an equilibrium position corresponding to minimum energy for each value of the field. Even with a smooth variation with boundary position of the magneto-elastic energy, at a critical value of the field an unstable position may be reached from which a further

finite movement of the boundary takes place spontaneously (that is, without further increase of field) to a new position of equilibrium.

It is owing to these finite spontaneous boundary movements (corresponding to successive reversals, or finite changes of orientation, as the boundary moves, of electron spins over the greater part of the volume of individual domains) that bulk magnetization may change discontinuously, at least on a microscopic scale, as the field changes continuously. This discontinuous character of magnetization is manifested in the Barkhausen effect. A search coil is placed round a ferromagnetic wire, and connected through an amplifier to headphones. On varying the field continuously (say by bringing up a magnet) a rustling is heard. This rustling is effectively a succession of clicks, each click being due to a sudden change of induction over a finite volume of the material, associated with the change of orientation of electron spins. By an elaboration of the experimental arrangements the size of these volumes (effectively domains) may be determined.

The work of Bozorth and others indicates that most of the change of magnetization on the steep parts of the magnetization curve is due to reversals of groups of electron spins over volumes containing not less than 10^{10} atoms. The average size of these volumes varies over the hysteresis loop, the maximum for different materials ranging from about 10^{-9} to 5×10^{-8} cm.³ (roughly 10^{15} atoms) for different materials. Owing to this and other work, domains are no longer to be regarded as vague hypothetical entities, but as having accurately determinable physical characteristics.

The peculiar microscopic distribution of magnetization in ferromagnetics arises from the complex interplay of a number of factors. The interchange interaction, or molecular field effect, very powerful over short distances, tends to align the electron spins parallel to each other. The long-range ordinary magnetic forces tend to produce a state of the ferromagnetic specimen in which there are no free poles, a demagnetized state. The compromise is an arrangement in which there is parallel alignment within each domain, and in which the increase of interaction energy due to the non-parallel alignment in the transition zones, or boundaries, is balanced by the decrease in the purely magnetic energy. The details of the arrangement, such as the precise size of the domains and the width of the boundaries, depend very largely on the magnitude and distribution of the internal strains, that is, on a secondary structure which is not peculiar to ferromagnetics.

The details of the internal stress distribution are dependent not only on mechanical and thermal treatment but also on the presence of atoms or groups of atoms which do not fit smoothly into the main lattice, or in other words do not form a solid solution. These may be impurity atoms which it is difficult to remove, and even in minute amounts their effect in decreasing permeability and increasing coercivity and hysteresis loss may be considerable owing to the local strains introduced. Effects which are disadvantageous if the object is the production of material of high permeability may, however, be aimed at deliberately in the production of alloys of high coercivity suitable for permanent magnets.

Quantitative theoretical expressions have been derived for the initial permeability and the coercivity for a variety of assumed distributions of the internal stress. These all indicate that the initial permeability

will vary as the square of the saturation magnetization, I_0 , and inversely as the product of the saturation magnetostriction, λ , and the mean amplitude, Z_i , of the internal stress variations. The numerical factors are different, but of the same order of magnitude, in different special cases. The coercivity varies directly as the product λZ_i and inversely as I_0 , but the numerical factor varies over a wide range for different types of stress distribution.

For a full account of the theoretical treatment which has been outlined, and to which many have contributed, reference may be made to the book by Becker and Döring published just before the War. The theoretical ideas not only provide a satisfactory qualitative interpretation of, and guide to, the behaviour of ferromagnetics in low fields, but also, as quantitatively developed, have been experimentally verified in a large number of cases in which the conditions are sufficiently simple and well defined. It should be made clear, however, that as yet it is seldom possible to give a fully quantitative interpretation of the details of the behaviour of particular ferromagnetic materials, the internal structure of which may be extremely complex.

Magnetic Materials

The suitability of magnetic materials for practical application depends on their mechanical and electrical properties, and on their cost, as well as on their purely magnetic properties. It is obviously not possible to consider here even the more extensively used commercial materials in detail. The bearing of the general discussion may, however, be indicated. The materials used fall into three main types: electrical sheet steels, used for large transformers, and rotating machines; alloys having a high permeability in very low fields, used for loading cables, for transformers and for electrical instruments; and permanent magnet materials.

The requirements of high induction in fields of a few oersteds, low magnetic hysteresis, and low eddy current loss for electrical sheet are to a large extent met by the commercial iron silicon alloys with up to about 5 per cent silicon. The theoretical arguments indicate that magnetic hysteresis loss is largely dependent on internal strains. Various factors contribute to the possibility of minimizing these in the silicon steels. The alloys are single phase; the silicon by a chemical action renders oxygen and carbon impurities less harmful; and material of relatively large grain size may be produced, with a reduction in the strains associated with grain boundaries. The electrical resistivity increases rapidly with silicon content, being about four times that of iron for the 4 per cent alloy, while the reduction in the saturation magnetization for this same alloy is only about 10 per cent. Single crystals of the alloy show the same type of anisotropy as pure iron, having easy directions of magnetization along the cube edges; and for some purposes the properties of the polycrystalline sheet material may be improved by a combination of rolling and heat treatment which produces a preferential orientation of the grains.

Most of the commercial high permeability alloys contain iron and nickel as the main components. In the prototype binary alloys in the iron-nickel series the highest initial permeability is developed, by suitable heat treatment, in the alloy with 78.5 per cent nickel. The theoretical treatment indicates that high initial permeability should be attainable with materials of low magnetostriction. It is a striking

fact that the highest value is found near the composition at which the magnetostriction changes through zero from positive to negative, though factors other than low magnetostriction are undoubtedly involved in the full explanation of the facts. Owing to the low maximum induction of the 78.5 permalloy, alloys of higher iron content are sometimes advantageous. There is a wide series of commercial alloys in which other elements are added to the basic iron-nickel alloy, giving improvements, for certain purposes, in mechanical and electrical and also magnetic properties.

In permanent magnet materials a high remanence is required combined with high coercivity, the best single number criterion of the suitability of the material being the maximum value of the product of B and H on the descending part of the hysteresis curve. Of the innumerable materials which might be used for permanent magnets—there were well over seven hundred patent specifications by 1935—reference will be made only to the recent alloys of which the prototype is a ternary iron-nickel-aluminium alloy of approximate composition represented by Fe_2NiAl . With alloys of the general class, values of $(BH)_{\text{max}}$ from three to fifteen times as great as for tungsten steel have been obtained. These alloys exist in a single-phase state at high temperatures, but if slowly cooled they form a heterogeneous mixture of two phases (one of which is usually strongly ferromagnetic compared with the other) at low temperatures. If the cooling is very rapid the single-phase state persists and the coercivity is low. It is also low with very slow cooling when there is a complete segregation of the two phases. For intermediate rates—cooling in air is suitable for some of these alloys—only incipient precipitation occurs. It is then that the high coercivity properties are developed.

In a qualitative way this is in agreement with the theoretical treatment of the dependence of coercivity on the distribution of internal strains. But it would be misleading to give the impression that a complete quantitative explanation of the magnetic properties of these alloys has been given in terms of strains. Moreover, the remarkable improvement in the characteristics of some of these permanent magnet materials by a treatment which includes cooling in a magnetic field is not yet satisfactorily explained. It would perhaps be just a little disappointing if even now all the peculiarities of permanent magnet materials could too easily be completely explained when, for those curious in such matters, the per-

manent magnet has for so long presented an outstanding problem.

Conclusion

In the last twenty years immense progress has been made in the understanding of the properties of ferromagnetic materials, largely as a consequence of advances in fields apparently remote from useful practical application—in the investigation of the fine structure of spectral lines, for example, and in the development of quantum mechanics. Some of the outstanding, or incompletely solved problems are inevitably of specialized interest, but others are very wide in their bearing. The question, "How is it that some metals are ferromagnetic?", is a general question about the metallic state. The investigation of the markedly structure-sensitive low-field magnetic properties may throw light on structure-sensitive properties generally, hardness, plasticity and the like, which are little understood but of central importance in the technology of metals and alloys.

It is proper that users and makers of magnetic materials should know something of what is happening inside a ferromagnetic when it is magnetized, something of the interpretative scheme in which wider theoretical ideas are brought to bear on the characteristics of particular materials. The answer to eminently practical questions about the core losses of transformers may involve reference to electron spins and quantum mechanical interchange interaction. For dealing with the general situation which is exemplified, it is often suggested that there should be much closer collaboration between those concerned with practical problems in industry, and those concerned with theoretical ones in universities. This is indeed most desirable, and the possibility of such collaboration would be welcomed from the academic side; but unfortunately the number of those in universities whose normal duties leave them opportunity for really effective collaboration is minute.

Even if the obvious needs of universities in respect of staffing are met in the future, it would seem desirable that many more young men with the necessary ability and interest for approaching particular problems from a wider theoretical point of view should be given opportunity and encouragement for dealing with them in this way in industry, while keeping in close touch with practical needs. In the field which has been surveyed, a wider permeation of practice by theory would undoubtedly be to the advantage of both.

NEWS and VIEWS

University of Liverpool: Prof. P. M. Roxby

FROM Bromsgrove School, Prof. P. M. Roxby entered Christchurch, Oxford, took the History Schools, studied geography under Herbertson, and, in 1906, began his life-work at the University of Liverpool which then inaugurated a Department of Geography. The value of his work for civic and international goodwill was recognized by the endowment, for him, of the Rankine chair of geography at Liverpool. He has therefore served the University of Liverpool for thirty-eight years, for twenty-seven of which he has held the chair so devotedly that no offer could move him away, until now, on

the eve of his retirement, he has felt the call to a new and arduous task. He has made the promotion of international understanding the main aim of his work, has exerted a lasting influence on the teaching of geography to this end in the universities and schools of England, Egypt and China, in all of which countries his old students carry on his work.

An Albert Kahn fellowship took Prof. Roxby in 1912 around the world, and he began his studies of Chinese life and problems, which he has broadened by subsequent visits that have made him an acknowledged and most sympathetic interpreter of China to the West. Endless societies, summer schools, conferences and committees for the promotion of international

goodwill have had his generous help with counsel and speech regardless of time or trouble. Students from foreign lands, especially perhaps China and Egypt, have been drawn to his school of geography and have found in him, as have all his students, not only a teacher but also a friend. Now Prof. Roxby is to go to Chungking at the invitation of the British Council to be a chief cultural link between China and Britain. He thus crowns a life's work at the University of Liverpool with a high adventure of goodwill.

Royal Institute of Chemistry :

Retirement of Mr. R. B. Pilcher, O.B.E.

THE recent announcement of the approaching retirement of Mr. R. B. Pilcher from the office of registrar and secretary of the Royal Institute of Chemistry will have been received with much regret by all members and friends of the Institute. Mr. Pilcher joined the staff of the Institute as clerk in 1892, was appointed secretary in 1895 and registrar and secretary in 1900, and will thus, on his retirement next year, have completed fifty years service as secretary. To all members Mr. Pilcher's name is inseparable from that of the Institute, and it is to his loyalty, devotion and care that the success of the Institute is largely due. In Mr. Pilcher a sense of the human values is highly developed and his administration of the affairs of the Institute bears the impress of his character and personality. To many chemists he has been a very present help in trouble. As registrar and secretary of the Institute, Mr. Pilcher has become acquainted with, and has gained the esteem of, most of the leading British chemists of the past half-century, and he has, by his gracious manner and personality, established and maintained cordial relations with Government departments and other authorities. Mr. Pilcher has shown much interest in the earlier history of chemistry and has made a large and valuable collection of engravings of alchemists and alchemical apparatus. His lectures on "Alchemists in Art and Literature" and on "A Century of Chemistry : From Boyle to Priestley", published by the Institute, have given pleasure to many. Mr. Pilcher's literary gifts are shown not only in these lectures but also in his book, "The Profession of Chemistry", and in the more important "History of the Institute : 1877-1914". When the time comes, the good wishes of his friends, and they are many, will go with Mr. Pilcher into his retirement.

Committees on Agricultural Education

THE Minister of Agriculture and Fisheries and the President of the Board of Education have jointly appointed a committee to advise them on all aspects of agricultural education to be provided by local education authorities, and particularly on the educational policy and methods of training to be adopted at farm institutes. The committee, which will be a permanent body, is constituted as follows : Dr. Thomas Loveday, vice-chancellor of the University of Bristol (*chairman*) ; Mr. F. Barraclough, secretary to the North Riding of Yorkshire Education Committee ; Dr. J. Ewing, H.M. inspector of schools ; Mrs. F. C. Jenkins, assistant director, Women's Land Army ; Mr. C. Bryner Jones, formerly Welsh secretary of the Ministry of Agriculture ; Mr. L. R. Missen, director of education for East Suffolk ; Mr. A. E. Monks, an organizer of the National Union of Agricultural Workers now serving as labour liaison officer to the Minister ; Mr. W. A. Stewart, county

agricultural organizer and principal of the Northamptonshire Institute of Agriculture ; Dr. G. K. Sutherland, H.M. inspector of schools ; Mr. R. A. Ward, chairman of the Development and Education Committee of the National Farmers' Union ; Prof. J. A. Scott Watson, Sibthorpean professor of agriculture in the University of Oxford.

The Minister of Agriculture has also appointed a committee to consider the character and extent of the need for higher agricultural education in England and Wales and to make recommendations as to the facilities which should be provided to meet the need. This committee will deal with agricultural education provided by agricultural colleges and university departments of agriculture, and will take over the functions of the Ministry's war-time Committee on Higher Agricultural Education. The committee consists of Dr. Thomas Loveday (*chairman*) ; Mr. R. Beloe, chief education officer for Surrey ; Mr. D. G. Brown, farmer and member of the war-time Committee on Higher Agricultural Education, member of the Agricultural Improvement Council ; Mr. George Brown, an agricultural organizer of the Transport and General Workers' Union and member of the Hertfordshire War Agricultural Executive Committee ; Dr. Charles Crowther, principal of Harper Adams Agricultural College and acting director of the National Institute of Poultry Husbandry ; Sir Frank Engledow, professor of agriculture in the University of Cambridge, member of the Agricultural Research Council ; Mr. C. Bryner Jones (also a member of the Joint Committee) ; Mr. T. Neame, horticulturist, governor of Wye College, member of Kent Agricultural Education Committee ; Prof. E. J. Salisbury, director of the Royal Botanic Gardens, Kew, member of the Agricultural Research Council and of the University Grants Committee ; Dr. G. K. Sutherland (also a member of the Joint Committee) ; Miss D. S. Tomkinson, member of the Worcestershire County Council and chairman of the Agricultural Sub-Committee of the National Federation of Women's Institutes ; Mr. L. G. Troup, county agricultural organizer for Hampshire and executive officer of the County War Agricultural Executive Committee ; Mr. J. Turner, vice-president of the National Farmers' Union.

The secretary of both Committees is Mr. F. L. Wormald, Ministry of Agriculture and Fisheries, Block 4, Bickenhall Mansions, Baker Street, W.1.

Artificial Insemination of Cattle

THE Minister of Agriculture and Fisheries has recently arranged for a review of the principles on which the development of artificial insemination centres in England and Wales should be planned and controlled. Discussions have taken place with the National Cattle Breeders' Association, the National Farmers' Union and the Milk Marketing Board. It is considered that artificial insemination centres should be controlled and developed as a national service on behalf of the livestock industry and that, with the exception of centres established for experimental purposes, licences for such centres should be granted in future only to organizations controlled and financed by producers, such as the Milk Marketing Board, farmers' co-operative societies and the cattle breed societies. It would be a condition of the licence that the centre would be available to all producers of cattle within the area of operation. A Central Advisory Committee is being appointed to advise the Minister upon the economic aspects of the control

and development of centres and to consider applications for licences to set up such centres. The chairman and eight members are being appointed by the Minister, and four members each by the Milk Marketing Board, the National Farmers' Union, and collectively by the cattle breed societies.

Therapeutic Trials Committee

VOL. 2, Nos. 3 and 4 of the *British Medical Bulletin* is devoted to certain drugs and their modes of action. Dr. F. H. K. Green, of the administrative staff of the Medical Research Council, describes the work of that Council's Therapeutic Trials Committee. In response to representations by the Association of Chemical Manufacturers, the Medical Research Council organized in 1931 a scheme for the clinical testing of new remedies, and the Therapeutic Trials Committee was set up as a disinterested intermediary between the manufacturers and the medical profession, some medical men having been reluctant to carry out tests at the request of commercial firms. It was agreed that foreign as well as British remedies should be tried out and also the products of academic as well as of commercial laboratories. Manufacturers desiring trials by the Medical Research Council must agree to certain conditions. The composition and nature of the substance to be tested must be fully revealed to the Council; manufacturers must not, without the Council's permission, arrange for other independent trials, and the Council is interested only in new substances which have not been therapeutically tested.

When a substance is to be tested, arrangements are made with clinicians of high standing to make tests, usually at more than one hospital, and the Council reserves the right to decide whether the results, favourable or not, shall be published or revealed only to the manufacturer. If a clinician's results are published, they are published under the clinician's name as a report to the Therapeutic Trials Committee. Since the scheme was organized in 1931, more than forty new substances have been tested clinically. Outstanding examples are the classical papers embodying the results of clinical trials of 'prontosil rubrum', which established the therapeutic possibilities in man of the first sulphonamide drug, which had been discovered in Germany; some of the earliest controlled clinical tests of sulphanilamide; trials of stilboestrol and other synthetic oestrogenic agents. During the War clinical tests of penicillin have been organized and are still going on, and British-made equivalents of important foreign pharmaceutical products are being tested. The control of infections of wounds and burns is also being studied. Ultimately, says Dr. Green, it is at the bedside that the clinical value of any new remedy is decided; but it is evident that the manufacturer, the medical man and the patient all stand to gain by the excellent work of the Therapeutic Trials Committee.

The Ray Society

THE Ray Society was constituted at a meeting held on February 2, 1844. The report of the Council for the year 1943, which has just been circulated, states that it had been hoped to mark the centenary year by publishing a record of the Society's history; but the preparation of this had to be postponed until libraries are more accessible and times more favourable. It is regretted that it has not been possible to

issue any publications during the year, the lamented death of Prof. W. M. Tattersall having prevented the completion of his volume on the British Mysidacea, which, however, is now being prepared for printing by Mrs. Tattersall. A work by Dr. F. E. Zeuner on "The Pleistocene Period, its Chronology, Climate and Faunal Successions" is now in the hands of the printers. The Society has not hitherto published any works dealing primarily with geology, but the Council considers that the subject-matter of Dr. Zeuner's book is so intimately connected with questions relating to the origin and distribution of the existing fauna and flora that it will be of great interest to many members of the Society. Reference is made to the loss suffered by the Society in the death of Sir David Prain, who had rendered important and long-continued service as a member of Council, as treasurer (1932-37), as a vice-president and as a trustee for the Society's investments. The annual general meeting for the current year having been omitted with the consent of the members, the present officers and Council will continue in office.

Sensitivity of the Human Eye

DR. SELIG HECHT, professor of biophysics at Columbia University, has recently made a tour of American colleges and universities, during which he has lectured to fifteen different Chapters of the Society of the Sigma Xi. His lecture gave some interesting data, arising from his own researches, on the sensitivity of the eye. Under the most favourable conditions, the smallest amount of light which the human eye can detect is 58-148 quanta, representing an energy of $2-6 \times 10^{-10}$ ergs. This 58-148 quanta is the amount of light falling on the cornea, but only about 10 per cent (5-14 quanta) of this is actually absorbed by the retina; the rest is lost by corneal reflexion (4 per cent), absorption by ocular media (50 per cent) and passing on beyond the retina (36 per cent). In the particular experiments described, this 5-14 quanta were absorbed by an area of retina which contained about five hundred receptor cells (rods). It seems reasonable to suppose, therefore, that each quantum was absorbed by a separate receptor cell. Chemical studies have shown that one quantum of light changes (bleaches) one molecule of visual purple. The conclusion reached is that we can see a light when the energy from it is sufficient to bleach one molecule of visual purple in each of 5-14 separate receptor cells.

Wood Preservatives and Termite Attacks

IN a recent pamphlet entitled "Effectiveness of Wood Preservatives in Preventing Attack by Termites" (U.S. Dept. of Agriculture. Circ. 683. By T. E. Snyder and J. Zetek. Washington: Gov. Printing Office. 10 cents) the opening paragraphs have a familiar ring to those acquainted with some of the more domestic troubles of early British rule in India and elsewhere in the tropics. "Wood has been classified," says the writer, "in the present global war as a critical structural material. Much of the wood to be utilized for the construction of the large number of necessary barracks and storage depots must be installed in the Tropics. Even in the event of a short War, past experience has shown that structures built to last for only short periods of service must be continued to be used long after the War is over. For the protection of wood from attack considerable research and investigation work

has been carried out for some years by several research organisations in the United States, e.g., Forest Products Laboratory of the U.S. Dept. of Agric.; Chemical Warfare Service of the War Dept.; California Termite Investigations Committee; the Western Union Telegraph Company and others." Various wood preservatives have been experimented with, and the writer of the pamphlet deals with them under three heads. Preservative oils, such as creosotes and combinations in petroleum or tar—especially adapted for penetration of timber to be used in contact with the ground. Water-soluble salts, such as zinc chloride, chromated zinc chloride and several proprietary preservatives, are for use as 'white' or clean pretreatments; they are ordinarily used above ground and the wood can be finished or painted after treatment. Certain toxic chemicals which are nearly colourless, dissolved in light petroleum oils, are adapted for the non-pressure immersion treatment of finished articles. The wood does not swell or shrink, dries rapidly, and is left clean, and after treatment it can be finished or painted. Many methods have now been devised for preserving wood, some simple non-pressure processes, others pressure processes requiring expensive equipment.

American Philosophical Society

THE American Philosophical Society Year Book 1942 covers the year January 1, 1942, to December 31, 1942, and, in addition to the minutes of the meetings and of the executive sessions, includes the reports of standing committees, the report of the Special Committee on Zoology in the Library of the Society, awards of prizes and a list of members. The report of the Committee on the Library refers to the study, in furtherance of the policy of selecting the history of American science and culture as one of the two or three major fields in which the Library should develop its holdings, by a committee of Dr. Conklin, Dr. Moore and the Librarian, of the possibility of building up a really great collection on the history of evolution. The report of the Committee on Research details the general principles adopted in regard to grants, requests for which have been fewer than previously because of the participation of many scientific men in research connected with the war effort. Increased demands are anticipated after the War, and the Committee has recommended accordingly that there should be no reduction in the amount assigned for 1943, but that any unexpended balances in the three funds for 1942 and 1943 should be carried over to be disposed of by the Committee after the War. Lists of grants from the Penrose Fund, the Johnson Fund and the Dorland Fund are included with brief reports from recipients of grants on their work. Obituary notices of members include some which will be of interest to British readers.

University of Leeds Library

THE report of the librarian of the University of Leeds for the session 1942-43 refers to the rapid growth of the Library as shown by the addition of 5,244 volumes during the year, 4,965 of which were added to the Brotherton Library, as well as 2,182 pamphlets and 8,051 periodicals (parts). The total holding of the Library is now 245,839 volumes and 11,007 pamphlets. In the Brotherton Library, 17,476 slips were added to the author catalogue and 2,800 cards to the subject catalogue during the year,

figures which are, in all, higher than any previously recorded. Although the inter-lending scheme was originally adopted by the Library Committee with reluctance, it is now generally agreed that the scheme has become of great national importance, and instances are quoted in the report of the lending of publications which proved of inestimable value. No further increase can be coped with in this respect if the staff continues to be depleted without efficient replacement. A thorough overhaul of the medical library has been commenced and extensive purchases made; but the problem of accommodation is more acute than ever. The use of the Holden Library also continues to increase, and when the rare books and series that have been removed from Leeds are returned there will be no more vacant shelf space. In spite of the fact that the rare books and manuscripts of the Brotherton Collection remain in places of safety away from the University, inquiries from outside have increased.

Repeaters in Submarine Cable Telephony

A PAPER read in London on May 11 before the Institution of Electrical Engineers by Mr. R. J. Halsay considers the problem of multi-channel carrier telephone working on submarine cables, to the permissible limits of attenuation, in relation to present-day practice, and examines the difficulties thereof. While it will be possible to obtain some small increase in the utilization efficiency of such cables by increasing the transmitted power, reduction of the permissible receiving level below the present limit of about -110 db. appears to be impracticable. Development has now reached a stage where the availability of submerged repeaters is essential to further substantial progress, and the design of such repeaters is engaging attention both in Great Britain and in the United States of America. Details of a repeater, laid by the British Post Office in the Irish Sea on June 24, 1943, are given in the paper, and it is believed this repeater is the first to be incorporated in a working cable system. It is suitable for depths down to about 200 fathoms, though at present it is laid in only 35 fathoms. By its use the number of circuits operable over the single cable has been increased from 24 to 48. The further development of repeaters for shallow- and deep-water operation is discussed, the ultimate objective being the provision of considerable numbers of inter-continental telephone circuits over submarine cables.

Institute of Industrial Administration

THE report of the October 1943 conference of the Institute of Industrial Administration has now been issued under the title "Management in Action". It includes papers by W. C. Puckey on "Organising for Production", by E. F. L. Brech on "The Personnel Function", by C. E. Holmstrom on "Marketing the Product", and by A. L. C. Chalk on "Financial Administration", together with Sir Cecil Weir's address "Industry After the War" and the presidential address by Viscount Davidson, and also reports of the discussions. The report emphasizes that the idea underlying all the papers is that management must be, first and last, an instrument of service to the community, and indicates that the Institute is facing the problem of the integration of industry and society as one of the first we must solve if we are to build a post-war social and industrial structure which gives full play to individuality and human values.

College of the Pharmaceutical Society

THE College of the Pharmaceutical Society of Great Britain has continued in its temporary accommodation in Cardiff, being distributed between University College and the Medical Unit of the Royal Infirmary, with the Pharmacological Laboratories and Department of Nutrition under the direction of Dr. K. H. Coward at the National Institute of Research in Dairying, Reading. The chair of pharmacology, left vacant by the appointment of Prof. J. H. Gaddum to Edinburgh, has not yet been filled. Although the College has lost many of its research workers, who left for some form of national service during 1942-43, it is gratifying to see that a large output of research work is still being maintained, as judged by the "Annual Report of Research Work" covering the period January 1942-June 1943, which has recently been issued.

Two Czech Chemists

THE Association of Czechoslovak Scientists and Technicians and the Czechoslovak Research Institute, London, have issued a pamphlet with the above title, by Dr. G. Druce (New Europe Publishing Co., 29 St. James's Street, London, S.W.1. Pp. 67. 3s. 6d.). It describes the life and contributions to science of Prof. Bohuslav Brauner (1855-1935) and the less known Frantisek Wald (1861-1930). An adequate account is given of Brauner's work in inorganic chemistry, which centred around the Periodic Law; and the theoretical views of Wald on stoichiometry and the theory of phases (which were highly rated by Ostwald) are explained in an intelligible way. The work, which has useful bibliographies, is a significant and interesting contribution to the history of chemistry.

Lady Tata Memorial Trust Awards

THE Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee, they have agreed, if circumstances permit, to make the following awards for research in blood diseases, with special reference to leukaemia, in the academic year beginning on October 1, 1944: grants for research expenses to Prof. L. Doljanski (Jerusalem), Dr. J. Furth (New York), Dr. P. A. Gorer (London), Dr. A. H. T. Robb-Smith (Oxford); part-time personal grant and grant for research expenses to Dr. W. Jacobson (Cambridge).

University of London

PROF. FRANK HORTON has been re-elected vice-chancellor of the University of London. Recent appointments in the University include the following: Dr. H. B. Acton, lecturer in philosophy at Bedford College, to the University chair of philosophy tenable at Bedford College. Dr. H. T. Flint, reader in physics at King's College, to the Hildred Carlile chair of physics tenable at Bedford College. Dr. W. N. Bailey, lecturer in mathematics in the University of Manchester, to the University chair of mathematics tenable at Bedford College. The title of reader in zoology in the University has been conferred on Mr. G. P. Wells in respect of the post held by him at University College. The degree of D.Sc. has been conferred on E. J. Irons (Queen Mary College), A. G. Quarrell (Imperial College), R. W. Powell and R. H. Common.

The following, among others, have been appointed fellows of King's College: Dr. T. Loveday, vice-chancellor of the University of Bristol; Dr. R. E. Priestley, principal and vice-chancellor of the University of Birmingham; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; and Dr. J. Henderson, sub-dean of the Faculty of Science of the College.

Summer School in Health Education

IN response to requests from the Ministry of Health and the Board of Education, and in order to reduce the strain on the country's transport system, the Central Council for Health Education has decided not to proceed with its Durham School, and to limit attendance at the London School (August 9-19) to students from London and the Home Counties. Details of the London School may be obtained from the Medical Adviser and Secretary, Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1.

Announcements

DR. H. G. SANDERS, lecturer in agriculture in the University of Cambridge, has been appointed professor of agriculture in the University of Reading, in succession to Prof. R. Rae.

LORD HAILEY has been elected president of the Research Defence Society.

By authorization of the University Court, the Department of Chemistry in relation to Medicine in the University of Edinburgh, the head of which is Prof. G. F. Marrian, will in future be known as the Department of Biochemistry.

DR. C. J. SMITHELLS has been appointed director of research of the British Aluminium Co., Ltd., and will take up his duties in August next. Dr. Smithells was an original member of the research staff of the General Electric Co., Ltd., which he left in 1938 to become general manager of Lodge Plugs, Ltd. He is the author of several books on metallurgical subjects. Dr. A. G. C. Gwyer, the scientific manager of the British Aluminium Co., will reach the retiring age in October 1945, after thirty-three years' service with the Company. During the intervening period he will remain in a consultative capacity in order to assist Dr. Smithells to become conversant with the many problems arising in the Company's research activities.

THE exhibition "Chemicals in War and Reconstruction" organized by the Association of Scientific Workers, will be on view in the Art Gallery, Huddersfield, during the week July 7-14 between 10 a.m. and 7.30 p.m. It will be opened at 6 p.m. on July 6 by Mr. G. B. Jones, chairman of the Yorkshire Section of the Society of Chemical Industry.

IN connexion with the article "Freedom from Want of Food" in *Nature* of June 17, p. 750, Sir Jack Drummond writes: "I did not say that far more milk is being produced to-day than before the War; I directed attention to the rise in consumption of liquid milk that has occurred since 1939. As shown in a recent Ministry of Food publication: 'Food Consumption Levels in the United States, Canada and the United Kingdom', H.M. Stationery Office, 1944, the consumption of milk products in the United Kingdom, excluding butter, in 1943 was 28 per cent greater than in the years immediately before the war".

LETTERS TO THE EDITORS

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

A Virus Attacking Lettuce and Dandelion

DURING the last three years lettuces have been seen in different parts of Britain suffering from a severe disease, the symptoms suggesting infection with a virus. The cause has now been found to be a virus that is also responsible for the chlorotic rings and spots so commonly seen in dandelion (*Taraxacum officinale*).

Symptoms in lettuce appear 1-2 weeks after infection; the young leaves become bronzed as a result of fine brown necroses that form along the veins and in the interveinal areas. In the glasshouse, this is usually only a primary symptom and is followed by chlorosis, with dwarfing and malformation of the whole plants. In the open, necrosis is the major symptom; whole leaves become black and shrivelled and the plants are worthless. The disease is more severe than the common lettuce mosaic and is readily distinguished from it.

The virus is only transmitted by inoculation if some abrasive, such as carborundum, is incorporated in the inoculum. It has been transmitted by the aphides *Myzus ornatus* Laing and *Myzus pseudosolani* Theob., but not by *Myzus persicae* Sulz., the vector of lettuce mosaic virus. The behaviour of the insect vectors seems to differ from any previously described. No infections are obtained unless aphides feed for at least three hours on the source of infection, and the number of aphides that become infective increases with increased feeding time. This is characteristic of the viruses called persistent by Watson and Roberts¹, but even after feeding for as long as three days on the source of infection the vectors cease to be infective within an hour.

As the perennial host is likely to be the source of infection for the lettuce crop, the name dandelion yellow mosaic virus is suggested.

B. KASSANIS.

Rothamsted Experimental Station,
Harpenden, Herts.
June 20.

¹ *Proc. Roy. Soc., B.*, 127, 543 (1939).

Activation of Pyrethrins by Sesame Oil

IN an article on "Activation of Pyrethrins in Fly-Sprays", David and Bracey¹ state that the test insect used in their work was the mosquito, *Aedes aegypti*, and point out that their findings may not hold for other insects. Nevertheless, the use of the term "fly-sprays" in the title is perhaps unfortunate, for we have found that many of their conclusions drawn from work on *Aedes* do not hold when the house-fly, *Musca domestica*, is the test insect. As shown below, the substitution of lubricating oil, etc., for sesame oil in fly sprays, or in dual-purpose sprays intended for fly and mosquito control, would be unjustified, since such substances do not increase the toxicity of pyrethrins to flies.

Tests on the house-fly are carried out at the Pest Infestation Laboratory in a glass-fronted wooden chamber of 18 cub. ft. capacity. The insecticide is atomized into the chamber by means of an Aero-graph artist's brush Type AE supplied with air at 50 cm. free mercury pressure. The flies are reared at 27.5° C. and 55-60 per cent relative humidity, and are kept under these conditions before, during and after test. The flies, four-six days old, are liberated into the chamber before spraying and are exposed to the insecticidal mist for 10 min., after which they are returned to their cage for observation of the percentage kill 24 hr. later. The percentage knock-down is counted during and at the end of the 10-min. exposure period.

Earlier work with seventeen samples of sesame oil of various origins showed that the oils caused markedly different degrees of activation of pyrethrins. One oil (sample TA.3) caused a slight reduction in both knock-down and kill when incorporated with pyrethrins. This oil was tested again with three other substances of low volatility with the following results. (All percentage kills are corrected for control deaths.)

Pyrethrins (% w./v.)	Adjuvant (v./v.)	Av. kill (per cent)
0.05	—	41.5
0.05	5% sesame oil TA.3	35.2
0.05	5% oleic acid	48.2
0.05	5% med. paraffin	30.6
0.05	5% lubricating oil	36.2

It was concluded that adjuvants of low volatility do not as a general rule increase the toxicity of pyrethrins to house-flies, and that those tested have little or no inherent toxic effect when used at 5 per cent. This experiment gave no significant information upon the rate of knock-down of the flies, so several sprays were tested at a reduced dosage.

Pyrethrins (% w./v.)	Adjuvant (v./v.)	Av. per cent knock-down at			
		2 min.	4 min.	6 min.	10 min.
0.05	—	54.7	83.2	93.8	96.7
0.05	5% sesame oil TA.3	29.6	62.8	74.4	86.6
0.05	5% sesame oil TA.4	59.1	86.1	95.0	99.2
0.05	5% med. paraffin	42.5	77.4	86.2	91.6
0.05	0.05% w./v. sesamin	60.5	87.2	95.6	99.3

Sesame oil TA.3 and medicinal paraffin reduced the rate of knock-down. Sesame oil TA.4, which in several earlier tests has been shown to cause a marked increase in kill of flies by pyrethrins, produced a small increase in the rate of knock-down, as also did sesamin incorporated at a concentration approximately equivalent to that contained in 5 per cent of TA.4. With our method of test using flies, therefore, activation for kill is not dependent upon reduction of the rate of knock-down.

The effect of sesamin on kill is shown by the data below.

Expt. No.	Pyrethrins (% w./v.)	Adjuvant (v./v.)	Av. kill (per cent)
72	0.05	5% sesame oil TA.43	72.9
72	0.05	5% TA.43 desesaminized	53.6
74	0.05	—	22.8
74	0.05	5% sesame oil TA.44	48.0
74	0.05	5% TA.44 desesaminized	29.7
73	0.05	—	36.6
73	0.05	0.05% w./v. sesamin	72.8

At the time of these experiments the flies were passing through a period of fluctuating resistance. Nevertheless, the following conclusions are valid because the flies for each experiment were obtained from batches of puparia drawn from randomized popula-

tions. Exp. 72 showed that sesame oil T.A.43 lost markedly in activating power on removal of the sesamin. The mortality with the desesaminized oil was, however, higher than expected of an oil with no activating power. This result was confirmed in expt. 74, in which 0.05 per cent pyrethrins was included for comparison. Exp. 73 demonstrated clearly the activating effect of sesamin.

Five per cent w./v. of sesame oil T.A.4 used alone in kerosene has been shown to be insufficiently toxic to flies to account for the increase in kill by pyrethrins observed when T.A.4 was incorporated in the spray.

From chamber tests on house-flies by the method in use at this laboratory, activation by sesame oil of the toxicity of pyrethrins appears, therefore, to be dependent mainly upon the sesamin content of the oil, and increase in kill is accompanied by a small increase in the rate of knock-down. Medicinal paraffin and sesame oil T.A.3 reduced both the rate of knock-down and the kill by pyrethrins. With *Musca*, oleic acid and lubricating oil when mixed with pyrethrins caused little or no increase in kill, in contrast to the data recorded by David and Bracey in their tests on *Aedes*.

The inactive sample of sesame oil T.A.3 gave a positive colour reaction for sesamin, and optical measurements indicated a sesamin content of about 0.3 per cent w./v. as against the normal 1 per cent (approx.). We now have, therefore, an oil containing a little sesamin, which reduces slightly the toxicity of pyrethrins to the house-fly, and two samples of desesaminized oils, which give a negative colour reaction for sesamin yet cause a slight increase in the toxicity of pyrethrins. There is no reason to doubt that the constituent of sesame oil chiefly responsible for activation of pyrethrins is sesamin; but it seems that there may also be present a complex of secondary factors which, according to its composition, may increase or decrease the effect of the pyrethrins and/or sesamin in a fly spray.

We wish to acknowledge the co-operation of Mr. B. A. Ellis, Government Laboratory, in this investigation, especially for the provision of samples of sesamin and desesaminized oils.

This note, which is based on work being carried out for the Pest Infestation Research Committee, is published by permission of the Department of Scientific and Industrial Research.

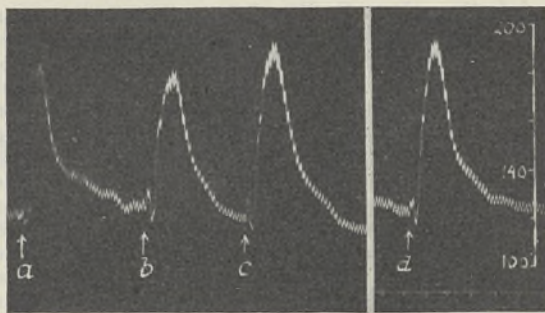
E. A. PARKIN.
A. A. GREEN.

Pest Infestation Laboratory,
Slough, Bucks.
May 22.

¹ *Nature*, 153, 594 (1944).

Identification of a Urine Base with Nicotine-like Action

In a previous communication, the isolation from urine of a volatile base with nicotine-like action has been announced¹. The active substance was obtained from normal fresh cow's urine by means of continuous fluid extraction with ether, and isolated as picrate. On the assumption that the active base formed picrate and hydrochloride with one equivalent of acid, the molecular weight was estimated to be 80-90. The active compound showed the reactions of a secondary amine. Microanalysis of the crystalline



BLOOD-PRESSURE, CAT, CHLORALOSE. HALF AN HOUR PREVIOUSLY THE ANIMAL HAD RECEIVED 0.1 MG. ERGOTAMINE TARTRATE PER KG. *i.v.*

(a) 0.05 mgm. nicotine; (b) 1 mgm. piperidine hydrochloride; (c) 1.5 mgm. of same; (d) 1.5 mgm. of urine base hydrochloride.

picrate yielded results which would correspond to the formula $C_5H_{11}N$ for the base.

The nicotine-like effect, which in strength was about $\frac{1}{15} - \frac{1}{20}$ of that of nicotine, and the chemical data obtained, made it probable that the substance was closely related to piperidine. The picrate and hydrochloride of piperidine were accordingly prepared and their action compared with those of the picrate and the hydrochloride of the urine base on the blood-pressure of the cat before and after atropine, on the rabbit's isolated intestine, on the isolated uterus of the cat and on the unanesthetized frog. In all instances the biological actions of the two sets of substances were, weight for weight, identical. The illustration shows the effect on the blood-pressure of the cat.

The picrate of the urine base melted at 142°, the piperidine picrate at 145° and a mixture of both at 142-143°.

The evidence thus obtained, chemical and physiological, seems to justify the conclusion that the active base is piperidine.

As to the origin of piperidine in urine (up to 10 mgm. per litre) no statements can be made at present. Tentatively, its formation from lysine and pentamethylene diamine should be considered.

U. S. v. EULER.

Physiology Department,
Karolinska Institutet,
Stockholm.
April 8.

¹ Euler, U. S. v., *Acta Physiol. Scand.*, in the Press.

² Moore, B., and Row, R., *J. Physiol.*, 22, 273 (1897-98).

Effect of Unsaturated Fatty Acids upon the Growth of *Lactobacillus helveticus* and other Gram-positive Bacteria

THE findings of Bauernfeind *et al.*¹ and of Strong and Carpenter² suggest that the accuracy of microbiological assays for riboflavin, with *Lactobacillus helveticus* as the test organism, may be seriously affected by the presence of fatty acids in the extracts under investigation. We have studied the conditions under which such interference may occur using a medium freed from lipids by chloroform extraction. Our results will be reported in detail elsewhere³.

We find that the growth of an American strain of

L. helveticus (from Snell and Strong's original strain No. 7469 and kindly supplied by Dr. Barton-Wright) is almost normal on a medium similar to those of Snell and Strong^{4,5} and of Barton-Wright *et al.*⁶ but twice extracted with chloroform. Growth has been estimated with varying amounts of riboflavin ranging from 0.05 to 0.5 $\mu\text{gm.}$ per 10 ml. of medium, and with a standardized inoculum and test procedure. The addition of 160 $\mu\text{gm.}$ of caproic or caprylic acid per 10 ml. of extracted medium does not interfere with growth, but similar amounts of palmitic or stearic acid augment it. Oleic acid, however, suppresses growth completely over a period of twenty-four hours, but not for longer. Linoleic and linolenic acids are much more active than oleic acid, inhibiting growth completely for seventy-two hours (the test period we adopt as a routine) and indeed for some days. Half the quantity of linoleic and linolenic acids, that is, 80 $\mu\text{gm.}$ per 10 ml. will almost completely inhibit the growth of our standard inoculum (about 400 million bacteria) for forty-eight hours (linolenic acid more than linoleic acid), and will inhibit the growth of an inoculum of 200 million bacteria for the full seventy-two hours. Sodium salts of these unsaturated fatty acids are equally effective, but their methyl esters are inactive.

The inhibiting action of linoleic acid in a chloroform-extracted medium is reversed in a striking manner by a number of compounds, some of which, like linoleic acid, are surface-active. Thus, in a concentration of 160 $\mu\text{gm.}$ per 10 ml., cholesterol, lecithin, lumisterol, calciferol (but not ergosterol), α -tocopherol, and α -tocopherol acetate completely reverse the action of a similar quantity of linoleic acid. A wide range of other compounds, including fatty acids, vitamins, hormones and carcinogens, does not show any reversing action, but stearic acid, oestrone, sodium fumarate, oxaloacetic acid, maleic acid and dihydroxymaleic acid are weakly active in this respect. The reversing action of cholesterol and of lecithin is found to be equally potent even when the cultures have been inhibited for 48 hours by linoleic acid.

The effects of linoleic acid, so far as we have been able to observe, are reproducible in the case of other Gram-positive bacteria, namely, *Streptococcus agalactiae*, *Staphylococcus albus*, *Bacillus anthracis*, *Listeria monocytogenes* and *Erysipelothrix rhusiopathiae*, but not in the case of the Gram-negative *Bacterium coli* and *Proteus vulgaris*. The inhibitory action is marked not only in chloroform-extracted medium, but also in unextracted assay medium and in glucose-broth.

Although a dietary essential, linoleic acid appears to be highly toxic when injected parenterally into mice.

E. KODICEK.

Dunn Nutritional Laboratory,
University of Cambridge, and
Medical Research Council.

ALASTAIR N. WORDEN.

Institute of Animal Pathology,
University of Cambridge.
May 31.

¹ Bauernfeind, J. C., Sotier, A. L., and Boruff, C. S., *Indust. Eng. Chem., Anal. Ed.*, **14**, 666 (1942).

² Strong, F. M., and Carpenter, L. E., *ibid.*, **14**, 909 (1942).

³ Kodicek, E., and Worden, A. N., *Biochem. J.* (in the Press).

⁴ Snell, E. E., and Strong, F. M., *Indust. Eng. Chem., Anal. Ed.*, **11**, 346 (1939).

⁵ Snell, E. E., and Strong, F. M., Univ. Texas Publication No. 4137 (1941).

⁶ Barton-Wright, E. C., and Booth, R. G., *Biochem. J.*, **37**, 25 (1943).

Specificity and Mode of Action of Histamine

WHEN human skin is injured, a substance is released into the tissue spaces which brings about the so-called triple response: a local dilatation of the skin vessels, an increase in their permeability leading to wheal formation, and around this an area of further vasodilatation without notable change in permeability, mediated through a nerve axon reflex. Lewis has shown¹ that when a needle is pricked into the skin through a drop of a dilute solution of a histamine salt, this same triple response occurs, and he therefore suggests that the natural excitant substance (*H*-substance) may also be histamine. We have investigated the chemical specificity of the response in detail by Lewis's simple technique, comparing all results with the negligible effects of control pricks through 0.9 per cent saline.

TABLE 1.

Imidazole-ethylamine (histamine) dihydrochloride <i>M</i> /10,000 . . . positive		Group B. Other Amines	
Group A. Other Imidazoles		Cadaverine hydrochloride	
4 (5) Methyl imidazole hydrochloride	<i>M</i> /4	Putrescine hydrochloride	<i>M</i> /2
4,5 Hydroxy methyl imidazole	<i>M</i> /10	Agmatine sulphate	<i>M</i> /16
Pilocarpine hydrochloride	<i>M</i> /2	Tyramine hydrochloride	<i>M</i> /21
Imidazole hydrochloride	<i>M</i> /3	Arginine hydrochloride	<i>M</i> /5
Group C. Substances of Biochemical Interest		Group D. Injurious substances	
Thiamin hydrochloride	<i>M</i> /50	Sodium dodecyl sulphate	<i>M</i> /10
Adenylic acid	<i>M</i> /100	Neutral formaldehyde	<i>M</i> /5
Adenyl pyrophosphate	<i>M</i> /26		
Manganese sulphate	<i>M</i> /2		
Hypoxanthine	<i>M</i> /100		

Table 1 shows that whereas histamine dihydrochloride itself even in *M*/10,000 concentration produces a definite response, the compounds of groups *A*, *B*, and *C* are all inactive, though in much higher concentration. Those of group *D* gave weak positive responses in the concentrations stated, presumably by liberating *H*-substance. In other words, the skin reaction appears to be highly specific, in a way similar to the action of histamine on other tissues², and this may be taken as additional evidence in favour of the view that histamine and the natural *H*-substance are identical.

Current pharmacological theory³ holds that many drugs may exert their highly specific effects through the action on specific enzymes in the cell interfering with normal metabolic processes. We have, therefore, tested the effect of histamine on the oxygen uptake and aerobic and anaerobic glycolysis of fresh baker's yeast, which is said to contain no histaminase⁴, and which resembles muscle and other mammalian tissues in some of its enzyme systems.

From Table 2 it is seen that histamine acid phos-

TABLE 2. ACTIVE FRESH BAKER'S YEAST, 5 MG./ML. IN 2 PER CENT GLUCOSE PHOSPHATE BUFFER pH 6.5, IN BARCROFT DIFFERENTIAL MANOMETERS CONTAINING 3.3 ML. TOTAL SOLUTION AT 39°C. ANAEROBIC GLYCOLYSIS OBTAINED BY ADDITION OF 0.02 *M* CYANIDE TO FLASKS, AND SUBTRACTION OF AEROBIC VALUES. EQUILIBRATION FOR 12 MIN. CO₂ ABSORBED BY 10 PER CENT KOH PAPERS IN CENTRE TUBES.

Min.				Plus <i>M</i> /20 histamine		
	Oxygen used	Aerobic CO ₂	Anaerobic CO ₂	Oxygen used	Aerobic CO ₂	Anaerobic CO ₂
15	70	nil	82	70	10	100
30	120	nil	165	120	20	200
45	200	nil	227	202	40	290

All values expressed in c. mm. of gas.



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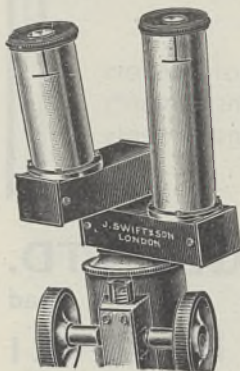
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It may therefore be concluded that histamine inhibits neither cytochrome oxidase, succinic dehydrogenase, nor any enzyme active in the glucose phosphorylation cycle of anaerobic baker's yeast, and the biochemical mechanism of its specific action remains obscure.

J. L. CRAMMER.
M. P. HELE.

Department of Clinical Research,
University College Hospital Medical School,
London.
and Molteno Institute,
University of Cambridge.

¹ Lewis, T., "The Blood Vessels of the Human Skin and their Responses" (Shaw, 1927).

² Guggenheim, M., "Die biogenen Amine" (Basle: Karger, 1940).

³ McIlwain, H., *Nature*, **151**, 270 (1943).

⁴ Zeller, E. A., "Advances in Enzymology", **2**, 106 (1942).

An Androstenetriol in Normal Human Urine

TEN years ago, while working at the University of Toronto, I isolated from human pregnancy urine a new solid alcohol which melted at about 263°. Afterwards, in collaboration with Dr. G. C. Butler, the same substance was isolated in an average yield of about 0.1 mgm. per litre from urine specimens from non-pregnant normal women and normal men, and the following derivatives prepared: an acetate (m.p. 189–191°), a chloracetate (m.p. 161–163°), a hydrogenation product (m.p. 257.5–259°), an acetate and a chloracetate of the latter (m.p. 174–176° and 180–182° respectively), and a lead tetra-acetate oxidation product (m.p. 199–201°). At the time, analyses of these derivatives could not be reconciled with any of the formulae which the analysis of the parent substance seemed to indicate, and consequently the findings were not published.

More recently, Hirschmann¹ has isolated from the urine of a boy with an adenocarcinoma of the adrenal cortex large amounts of a steroid (m.p. 265–270°) identified as a Δ^5 -androstene-3(β),16,17-triol. For the following reasons it is believed that this substance is identical with the one isolated by Dr. Butler and me from normal human urine:

(1) The analyses of the above-mentioned derivatives (but not of the parent substances) are in close agreement with those required by theory; (2) the melting points of the androstenetriol triacetate (187–188.5°), the androstanetriol (256–260°), and the androstanetriol triacetate (175.5–176.5°) as reported by Hirschmann agree closely with those of the corresponding derivatives of the compound from normal urine; and (3) the melting points of the acetate and of the acetate of the hydrogenation product were not depressed by admixture with androstenetriol triacetate and androstanetriol triacetate, specimens of which were very kindly supplied by Dr. Hirschmann.

The original difficulty in reconciling the analyses of the derivatives with those of the parent compound can probably be ascribed to the presence in the latter of solvent of crystallization, since certain of Hirschmann's preparations of the androstenetriol gave analytical figures indicating the presence of half a molecule of methanol of crystallization.

Hirschmann has raised the interesting possibility that this androstenetriol may be produced from dehydroisoandrosterone by a metabolic process similar to that involved in the conversion of œstrone to œstriol. The finding of this androstenetriol in normal human urine is of considerable interest, since it shows that the metabolic process by which it is formed is a normal one.

G. F. MARRIAN.

Department of Biochemistry,
University of Edinburgh.
May 29.

¹ Hirschmann, H., *J. Biol. Chem.*, **150**, 363 (1943).

Identification of Trypanosomes by Chromosomes

FOLLOWING a suggestion by Dr. H. Fairbairn, sleeping sickness officer, Tanganyika Territory, namely, that it might be possible to distinguish *Trypanosoma brucei*, *gambiense* and *rhodesiense* by the appearance, or the number, of chromosomes in each, the majority of the recognized chromosome-staining techniques were explored. Two methods gave good results, either using dried blood films from rats with very heavy infections, or probes of infective tsetse. The latter is a new method devised by Dr. E. Burt, entomologist, at the Trypanosomiasis Research Station, Tinde, Tanganyika, in which the fly is caused to salivate upon a glass slide; I have modified the original method, in order to facilitate the handling of large numbers of tsetse. (a) The films are fixed with acetic alcohol¹ and stained with Giemsa or hæmatoxylin. (b) The films are hydrolysed for 4–6 minutes in normal hydrochloric acid at 60° C. and then stained with Giemsa for 1–2 hours.

It has only been possible so far to examine *Trypanosoma rhodesiense* (Tinde strain) and *T. congolense* (Shinyanga strain). Mitosis occurs in both these species, as has been previously noted by several authors, quoted by Wenyon². The present observations show that *T. rhodesiense* has two types of individuals, one homoploid, with two paired and two unpaired chromosomes ($N = 6$) and the other heteroploid with two paired and one unpaired chromosomes ($N = 5$). *T. congolense* has also been observed to have two types of individuals, one with three paired chromosomes and the other with three paired and one unpaired chromosomes.

It appears, although this is not yet confirmed, that meiosis may also take place, the unpaired chromosomes acting like the sex chromosomes of other animals, and that gametes are thrown out by the meiotic trypanosome. The latter are presumed to unite with the reduced nucleus of another trypanosome, but this has not yet been observed. Fry³ observed and recorded objects he considered were gametes being extruded from a trypanosome. I have observed similar flagellated objects near the trypanosomes, and others that appear to be in the process of being extruded, in a stained (acetic-alcohol-Giemsa) slide of *T. congolense* from a probe of a laboratory-infected *G. morsitans*.

Work on these lines is being continued, and it is hoped to publish a fuller account elsewhere later.

F. L. VANDERPLANK.

Tsetse Research Department,
Old Shinyanga,
Tanganyika Territory.
May 10.

¹ Darlington, C. D., and La Cour, L. F., "The Handling of Chromosomes" (London, 1942).

² Wenyon, C. M., "Protozoology", 1 (London, 1926).

³ Fry, W. B., Reports of the Sleeping Sickness Commission of the Royal Society No. XII, p. 25 (1912).

Electro-magnetic Wave Crystals

At the conclusion of her very interesting lecture on "Diamonds, Natural and Artificial"¹, recently given at the Royal Institution, Dr. Kathleen Lonsdale mentioned past attempts at producing artificial diamonds by dissolving graphite in a molten metal at a very high temperature and letting the solution solidify under very high pressure. There is, in her judgment, strong evidence that some of the recorded attempts were successful.

I would suggest the possibility of another method of producing artificial diamonds which appears to me worth investigating, particularly in view of the much wider field which it may open.

The essence of this method consists in causing crystallization to proceed in a space filled with stationary electro-magnetic waves with the nodal points corresponding to the positions of the atoms in the crystal. It seems that in this way any feasible atom lattice can be realized, for it can be shown, on the lines which I used for determining stable positions of a rotating electron beam², that these nodal points will also be the points of maximum stability of corpuscles. Such an electro-magnetic wave pattern can be called an 'electro-magnetic wave crystal'.

The simplest electro-magnetic wave crystal corresponding to the diamond will be formed by three intersecting sets of plane stationary waves with the nodal planes determined by the sets of directional

cosines $100, \frac{\sqrt{3}}{3} \frac{\sqrt{3}}{3} \frac{\sqrt{3}}{3}$, and $\frac{\sqrt{3}}{3} \frac{\sqrt{3}}{3} - \frac{\sqrt{3}}{3}$, and

the wave-lengths of travelling waves, propagating in opposite senses and thus forming stationary waves, 1.78 Å., 2.06 Å. and 2.06 Å. respectively. It seems that a diamond could be obtained by solidification of carbon vapour in such an electro-magnetic wave crystal. It may be that this was actually the way in which the natural diamonds were formed, and that their rarity is due to the small probability of spontaneous formation of the corresponding electro-magnetic wave crystals.

It should be possible to extend this method to controlling the formation of any chemical compound by causing an appropriate chemical reaction to take place in an electro-magnetic wave crystal corresponding to the lattice structure formed by the atoms of the compound. For this purpose it would probably not be necessary to form a complete electro-magnetic wave crystal, in which every single atom of the compound should find its corresponding place; it might be sufficient if the crystal were to accommodate the unstable atoms of the molecule and a sufficient number of atoms of the stable part of the molecule to determine the position of the molecule. There are various possible biochemical and even therapeutic implications of this train of ideas.

The stationary electro-magnetic waves forming such crystals can be produced by interference of monochromatic beams of X-rays or by using electron diffraction. The technical difficulties involved in the construction of an apparatus for this purpose do not appear to be unsurmountable.

It is doubtful, however, whether the work of a single investigator could yield sufficient results, within a reasonable time, to provide the requisite stimulus for further progress along these general lines. I do not expect to be able to undertake anything of the kind myself in the near future, and publish the suggestion in the hope that some who have the opportunities and equipment may be inclined to follow it up.

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April 17.

¹ *Nature*, 153, 669 (1944).

² *Sci. J. Roy. Coll. Sci.*, 121 (1931).

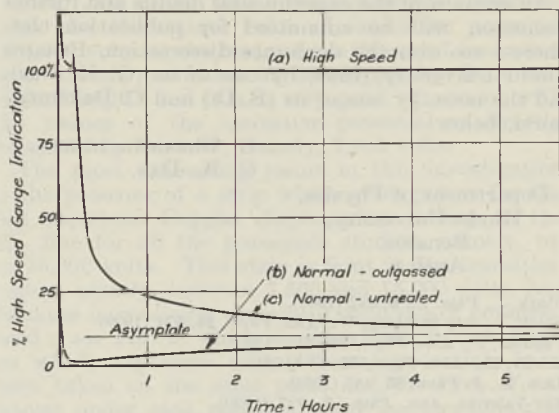
Use of the Ionization Gauge on Systems Evacuated by Oil Diffusion Pumps

THE ionization gauge is in almost universal use for the measurement of extremely low pressures, and whereas much careful work, for example, Dushman's classical experiments¹, has established its accuracy for permanent gases, very little work which throws any light on the possible sources of error when the gauge is used on systems evacuated by organic vapour pumps has been published.

Some experiments recently carried out in this laboratory have shown that, unless certain precautions are taken, the observed ionization current may be as small as one hundredth of that corresponding to the vapour pressure of the pump fluid. This result was discovered during experiments to determine the errors which would occur if a specially designed ionization gauge were used without degassing, the following procedure being adopted.

Two gauges having identical electrode structures, but with tubulation speeds of 0.7 litres/sec. and 80 litres/sec. respectively, were connected to the same vessel. The vessel, which had a volume of 10 litres and an internal surface area of 5 sq. ft., was evacuated by a standard commercial oil diffusion pump of speed 23 litres/sec. After running this pump for several hours, during which the first (or normal) gauge was opened and bombarded to remove occluded gases, no treatment whatever being applied to the second (or high-speed) gauge, the two gauges were switched on simultaneously. Readings of the positive ion currents were then taken for a period of six to seven hours. The results of this test are shown by the curves *a* and *b* in the accompanying figure.

It will be seen that the pressure indicated by the high-speed gauge fell to a value within a few per cent of its final value within about five minutes. This is in marked contrast to the very considerable variations shown by the normal gauge, the indication of which first fell to a value just greater than 1 per cent of that for the high-speed gauge, finally increasing asymptotically to about 10 per cent of this value. It would appear logical to ascribe the high indication of the high-speed gauge to the fact that it had not been outgassed, but that this was not the case was



RELATIVE INDICATIONS OF NORMAL AND HIGH-SPEED IONIZATION GAUGES.

easily demonstrated, first by degassing it, when no appreciable change in its final indication was observed; secondly, by running the normal gauge without degassing, its final indication in this case approaching the same asymptote as in the first experiment, in the manner shown by curve c.

An alternative and more tenable explanation of the difference between the indications of the two gauges can be based on the statement of Gaede² that the ionization gauge itself acts as a pump and consumes the gas which diffuses into it. For this, among other reasons, Gaede dismissed the ionization gauge as being unsuitable for low-pressure measurements, but there appear to be few references to work where the possibility that gas consumption may vitiate the results has been considered.

Experiments so far carried out here indicate that the consumption of elementary gases and of some of the lighter organic gases such as methane and propane is negligibly small, but that the vapours of some diffusion pump fluids are consumed to a marked extent. Consumption appears to be due to two effects: (a) adsorption or condensation, which is very pronounced when the glasswork is newly outgassed, but which decreases as the concentration of condensate of the surface increases; (b) a consumption effect which does not change as time proceeds, and is probably caused by breakdown of the heavy oil molecules by the hot filament. The former effect, which has also been observed by Hickman³, accounts for the very low pressure shown early in curve b and for the gradual increase of pressure up to the asymptote. The latter phenomenon was observed by M. R. Andrews⁴ in her studies on the reaction between tungsten and naphthalene; but its effect on the accuracy of the ionization gauge has not previously been considered. It accounts for the fact that the asymptotic value of the ionization current for the normal gauge is only 10 per cent of that of the high-speed gauge, irrespective of the time the gauges have been running.

The main conclusion of this communication is that in cases where the vapour of the pump fluid forms a major constituent of the total pressure in a system, special care in the interpretation of ionization gauge measurements is required, and that wherever authors have been unaware of the fact of vapour consumption, the pressures they quote will be proportional not only to the vapour pressure and the ionization constant of the particular pump fluid, but also to the conductance of the tube connecting the gauge to the

vacuum system. On the other hand, it will be apparent that by using a gauge which offers no resistance to the entry of gas or vapour from the system, the pressure drop in the connecting tube caused by gas consumption will be reduced to zero, and the third of these variables will thus be eliminated. At the same time, such a gauge (an approximation to which is given by the high-speed gauge used in these experiments) could be used without initial degassing and would be in equilibrium with its surroundings immediately on switching on.

Thanks are due to Dr. A. P. M. Fleming, director and manager of Research and Education Departments, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish this note.

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¹ Dushman, S., *Phys. Rev.*, **17**, 7 (1921); **23**, 734 (1924).

² Gaede, W., *Z. tech. Phys.*, **12**, 664 (1934).

³ Hickman, K. C. D., *J. Frank. Inst.*, **221**, 215 (1936); **221**, 383 (1936).

⁴ Andrews, M. R., *J. Phys. Chem.*, **27**, 270 (1923).

Doppler Effect in Positive Rays of Hydrogen

THE Balmer lines in the spectra of the positive rays of hydrogen show Doppler displacement $d\lambda$ given by the relation

$$\frac{d\lambda}{\lambda} = \frac{v}{c} \cos \theta,$$

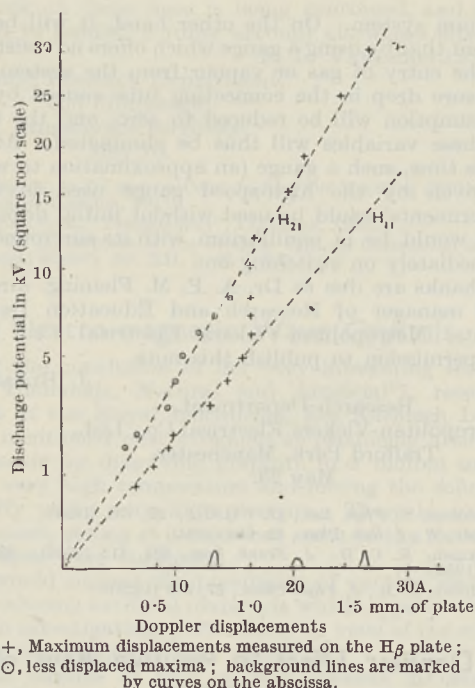
where λ is the wave-length of the light emitted by a neutral atom of the positive ray beam, moving with a velocity v , the direction of motion of the atom making an angle θ with the direction of observation; c is the velocity of light.

J. Stark¹, and J. Stark and Steubing² showed that whereas the Doppler displacement is not a line but a strip of finite width, the maximum displacement gave a value for v which fell far short of the value to be expected from the relation

$$\frac{1}{2} mv^2 = eV,$$

where e , m and v are the charge, mass and velocity of the atom respectively, and V is the difference of potential across the electrodes in the discharge tube in which the positive rays were produced. Paschen³ found that for V varying from 525 volts up to 24,000 volts the maximum Doppler displacement did not show any appreciable increment at higher voltages with increase of voltage. The maximum obtained corresponded to a voltage equal to 5,000. H. Kreff⁴ and K. Lion⁵ found that the maximum displacement did not remain constant but increased continuously up to 70 kV. and 130 kV. respectively. The values fell short of what is to be expected theoretically. Ney-Valerius⁶, who worked at voltages of about 1,000, found values agreeing with the theoretical values.

We have made a systematic investigation, taking special care to see that the maximum values of the Doppler displacement as measured are really the maximum obtainable, and that they are not falsified or minimized for want of adequate exposures on the photographic plates. This has been made possible by taking spectra with varying times of exposures. The maximum so obtained for any one voltage was



found to be constant within wide ranges of the times of exposure.

In the accompanying graph the maximum Doppler displacement actually measured for H_{β} has been plotted against \sqrt{V} . Theoretically, all the points should fall on the dotted straight line H_{11} . Actually, however, it is seen that the points lie on this line only up to a voltage of 5,500. Between 5,500 and 11,000 volts there is no change in the displacements. The points lie on the straight line H_{21} from 11,000 up to the highest voltage used, namely, 30,000. This line, H_{21} , has been drawn theoretically like the line H_{11} with m replaced by $2m$. It follows, therefore, that above 11,000 volts the atom responsible for the maximum Doppler displacement has been derived by dissociation of a molecule of hydrogen accelerated in the discharge tube as a singly charged ion; the dissociation is supposed to take place after leaving the field. Ionized molecules are known to be present from the electromagnetic analysis. The potential 5,500, which corresponds to the value of the maximum Doppler displacement measured in the region of transition from the H_{11} line to the H_{21} line may be regarded as a transition potential.

A relation similar to that with H_{β} has been found by us to hold good for H_{α} also, between the same limits of voltages. The transition potential for this line, however, is lower, namely, 3,500 volts. The value of the transition potential for H_{α} may be expected to be higher than that for H_{β} . It may, by extrapolation, be taken as about 7,000 volts. On the basis of the theory of ionization by atomic impacts developed by G. Joos and H. Kulenkampff⁷, the value of the ionization potential is 6,200 volts. It appears, therefore, as likely that the ionization potential determines the transition potential.

An account of the experimental details and further discussion will be submitted for publication elsewhere; see also the doctorate dissertation, Benares Hindu University, 1938, by one of us (G. K. Das), and the note, by one of us (B. D.) and C. Dakshinamurti, below.

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¹ Stark, J., *Phys. Z.*, **6**, 892 (1905).

² Stark, J., and Steubing, W., *Ann. Phys.*, **28**, 974 (1909).

³ Paschen, F., *Ann. Phys.*, **23**, 247 (1907).

⁴ Kreffit, H., *Ann. Phys.*, **75**, 75 (1924).

⁵ Lion, K., *Z. Phys.*, **33**, 442 (1933).

⁶ Ney-Valerius, *Ann. Phys.*, **6**, 727 (1930).

⁷ Joos, G., and Kulenkampff, H., *Phys. Z.*, **25**, 1 (1924).

Ionization Potential and Doppler Effect in Hydrogen Positive Rays

In the note above by G. K. Das and one of us (B. D.), it has been pointed out that the transition potential as defined therein with positive rays of hydrogen for the H_{α} line should be about 7,000 volts. We have carried out a systematic investigation with this line, the current being kept constant at all potentials with times of exposure varied within wide limits. The results are shown in Fig. 1.

It may be seen that the transition potential comes

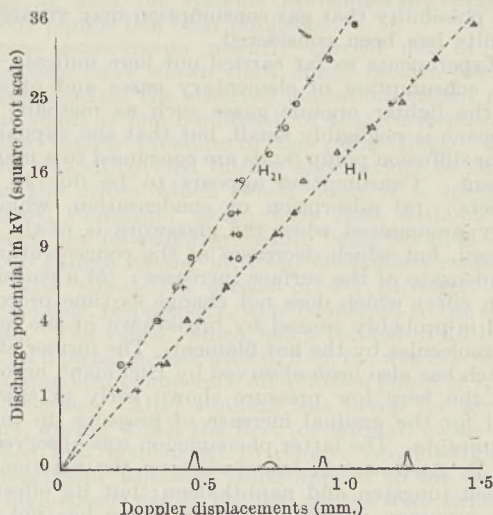


Fig. 1. MAXIMUM DOPPLER DISPLACEMENTS IN THE H_{α} LINE. DISPERSION, 33.8 Å. PER MM.

\Delta, maximum Doppler displacements } graded exposures.
o, less displaced maxima }
+, exposures of 2 hr. each on a single plate.

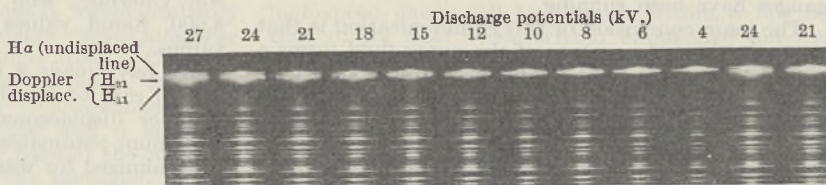


Fig. 2. VARIATION OF DOPPLER DISPLACEMENTS WITH VOLTAGE. NOTE THE INCREASING INTENSITY OF THE H_{11} STRIP AT HIGHER VOLTAGES; TIMES OF EXPOSURE ARE CONSTANT, 2 HR.

out as 7,500 volts. This voltage is in fair agreement with the theoretical value of ionization potential of 6,200 volts on the basis of the theory of ionization with atomic collisions as developed by Joos and Kulenkampff¹, and it is in very good agreement with the values of the ionization potential as directly measured by Bartels², namely, 7,000 volts.

The most interesting result in this investigation is the presence of a strip which gives points for the full maximum Doppler displacement falling on the H_{11} line for all the potentials studied, namely, up to 35,000 volts. This strip is faint in the transition region, namely, between 7,500 and 15,000 volts, but becomes increasingly prominent with rise of potential used; see Fig. 2, which is reproduced from a plate on which exposures with different potentials have been taken on the same plate and the time of exposure under each potential used was two hours, in order to be able to estimate the relative intensities independent of time and development. To check that the conditions of experiment have not altered, the first two exposures on the plate were repeated at the end.

Previous investigators were not able to establish agreement between the experimental and theoretical maximum Doppler displacements for potentials above 5,500 volts.

We have carefully investigated the maximum Doppler displacements for the H_{β} , H_{γ} , H_{δ} and H_{ϵ} lines also, in order to be able to understand the outstanding behaviour of H_{α} . A discussion of the same, particularly with reference to measurements carried out by Anna I. Mepheron with homogeneous beams of positive rays which were made for H_{β} and H_{γ} only, will be reserved for consideration elsewhere; see also doctorate dissertation by one of us (C. D.), Benares Hindu University.

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¹ Joos, G., and Kulenkampff, *Phys. Z.*, **25**, 1 (1924).

² Bartels, H., *Ann. Phys.*, **13**, 373 (1932).

³ Mepheron, Anna I., *Phys. Rev.*, **45**, 485 (1934).

Roozeboom's Solid Solution Diagram, Type II

PROF. A. N. CAMPBELL, of the University of Manitoba, has suggested¹ that this type of diagram should no longer be mentioned in treatises dealing with the phase rule. A similar opinion is also held by Prof. Jaenecke. I find this conclusion inadmissible for the following reasons.

(1) Roozeboom, in his classical study on the equilibrium of solidification with formation of mixed crystals, asserts this from a purely thermodynamic point of view without reference to the stoichiometric interpretation of the phenomena; consequently, so long as a single example of such a type of equilibrium is known, it is not legitimate to omit a description of it when enumerating possible cases.

(2) Prof. Campbell seems to believe that examples of this type are known only in the case of two pairs of optical antipodes. This is an obvious error. The following examples may be cited: (a) Other mixtures of enantiomorphs of which the melting-point curve shows a maximum: secondary butyl hydrogen

phthalate²; α bromocamphor³. (b) Other mixtures: 1.2.4.6.tribromtoluene plus 1.2.3.5.tribromtoluene⁴; phenol plus cyclohexanol⁵; bismuth plus thallium⁶; lead plus thallium⁷. None of the maxima in (b) corresponds to a simple stoichiometric relationship. (c) Finally, if one takes into account the analogous equilibrium between mixed crystals and solvents, Clendinnen and Rivett⁸ have described a series of mixed crystals formed by $2\text{NH}_4\text{Cl} \cdot \text{MnCl}_2 \cdot 2\text{H}_2\text{O}$ with $\text{MnCl}_2 \cdot \text{H}_2\text{O}$ on one hand and NH_4Cl on the other, passing through a minimum of isothermal solubility corresponding to a maximum melting point.

The number of these examples alone shows the necessity of retaining Bakhuis Roozeboom's exposition in its entirety.

(3) Van Laar's demonstration, which Profs. Campbell and Jaenecke mention, does not appear to me to be so very convincing, because van Laar's calculations are based on the introduction of van der Waals' equation (contrary to what Prof. Campbell affirms); in fact, the values of α are calculated with the aid of the terms a and b of the van der Waals' equation as van Laar states expressly on p. 218 of his text.

(4) In order to decide which stoichiometric interpretation to give to such a maximum in the solidification curves, Prof. Jaenecke's considerations do not strike me either as being convincing, though I consider his conclusion as probable. As shown above, the maximum does not always correspond to simple stoichiometric proportions; this fact is almost fatal, as is proved by the outline of the solidification curves themselves, of which the maximum is flattened; consequently, the addition compound existing in the solid phase partially dissociates on melting; and it is quite possible that the addition of one of the products of dissociation to the compound will raise its melting point and thus displace laterally the maximum.

In order to decide in such a case whether one is dealing with a definite compound or a simple hylotropic solution⁹, the safest way would be to study the equilibrium of melting under various pressures; if it is a hylotropic solution, the concentration at the observed point will vary continually with pressure, whereas it will remain fixed in the case of a definite compound; this experiment is analogous to the one by which Roscoe and Dittmar proved that the azeotropic mixture $\text{H}_2\text{O} + \text{HNO}_3$ is not a definite compound. But in the present case, in consequence of the slight influence of pressure on the melting point, it is essential to work under pressures varying between limits of several hundred or thousand atmospheres, using, for example, the method of 'piezometric' analysis as perfected by my collaborator L. Deffet and myself¹⁰. This experiment has not yet been made, but Clendinnen has carried out a similar one by studying the variations of the positions of the minimum of the curve of isothermal solubility at different temperatures, and has proved that in his case it was a hylotropic solution and not a compound.

(5) But in the case of a mixture of optical antipodes such as that discussed by Campbell and Jaenecke, this test fails because the diagram is perfectly symmetrical, from 50 to 0 per cent and from 50 to 100 per cent, owing to the identity of the thermodynamic properties of the two antipodes. It is therefore impossible, strictly speaking, to prove precisely in this particular instance whether the maximum melting point arises from the existence of a definite compound or whether it is a simple hyl-

tropic solution in a diagram perfectly symmetrical at all pressures. But I agree from other considerations that the maximum corresponds there to a definite compound.

Conclusions: In a communication which I recently made to the Second Education Conference held by the Association of University Professors and Lecturers of the Allied Countries in Great Britain on April 15, I complained of the fact that in the Anglo-Saxon countries too little use was made of original publications by scientific men on the Continent, with the exception of those from Germany, which appear to be widely read. I should like to emphasize that the foregoing discussion is an excellent case in point.

In my treatise "Les Solutions Concentrées", published in Paris in 1936, in which I gathered together all the known examples of mixtures of two organic components, will be found most of the systems mentioned above. The arguments developed in paragraphs 4 and 5 on the interpretation of the maximum melting point of mixtures of optical antipodes may be found at length in Chapter 4 of another work of mine published in Paris in 1927 and of which an English translation was made by my colleague, Prof. R. E. Oesper of Cincinnati University. This appeared in London and New York in 1940 under the title of "Chemical Species" (see Chapter 4, pp. 18-24).

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¹ *Nature*, 154, 530 (1944).

² Lombaera, *Bull. Soc. Chem. Belg.*, 33, 232 (1924).

³ Padoa and Rotondi, *Gaz. Chem. Ital.*, 45, 1, 51 (1915).

⁴ Jaeger, *Z. Kryst.*, 38, 583 (1904).

⁵ Mascarelli and Pestalozza, *Gaz. Chem. Ital.*, 39, 218 (1909).

⁶ Kurnakow, *Z. anorg. Chem.*, 88, 109 (1914).

⁷ Guertler and Schulze, *Z. phys. Chem.*, 104, 269 (1923).

⁸ *J. Chem. Soc.*, 119, 1329 (1921).

⁹ See Ostwald, *Trans. Chem. Soc.*, 84, 106 (1904).

¹⁰ *Bull. Soc. Chem. Belg.*, 44, 44 (1935).

'Soil' Mechanics

THE objections raised¹ to the name 'soil mechanics' are timely and cogent, but the difficulty is too deep-rooted to be disposed of by a mere change of the title of the science. The main trouble would appear to be the continued use by engineers of the term 'soil' for material which is not soil in the generally accepted sense, but comprises all soft and loose deposits, namely, gravels, sands, silts, clays and peats. Some workers in soil mechanics also adopt with altered significance other expressions (for example, soil profile) which were first used and are now well established in pedology (soil science).

With the two sciences of soil mechanics and pedology both in a stage of early and rapid development, it is a matter of urgent necessity that steps should be taken to prevent the clashing of terms.

Soil mechanics was christened at the International Congress of Soil Mechanics and Foundation Engineering at Havard in 1936, and appears to have received considerable impetus in Britain after the James Forrest Lecture at the Institution of Civil Engineers by Terzaghi in 1939. Examples could be given from several soil mechanics text-books in which the difficulties of trying to retain a dual usage of the word 'soil' are apparent. In fact, acquaintance with the literature leaves one in no doubt that the adoption of 'soil' to refer to unconsolidated deposits in

general has resulted in considerable ambiguity and confusion.

The word 'earth' was in common use in early engineering literature in Great Britain and it is used by some writers on soil mechanics to explain what they mean by 'soil'. It would appear, therefore, to be a more appropriate term and, although not without some objections, it is well established in engineering parlance (for example, earthwork, earth dam, earth pressure). There seem to be few objections to 'earth mechanics' or 'earth statics', provided 'earth' is defined as meaning unconsolidated deposits and excavated material. It is questionable whether engineers would readily accept 'geostatics', and, to the geologist, the prefix suggests something more profound than the surface layers encountered in engineering structures. However, as already stated, the name of the science is not the major issue, which is the misuse of the word 'soil'.

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¹ *Nature*, 153, 716 (1944).

The Concept of Force

A FINGER pressed against a table has sensations of contact and muscular sensations of resistance. Prof. H. H. Price, in his presidential address to the Aristotelian Society on February 11, analytically supposes the finger to have the muscular sensations only. The owner would have a notion of *force* through these muscular sensations, but no notion of matter because he has no sensations of contact. Thus a being who experiences muscular sensations and never experiences sensations of contact would be "aware of pure force, disembodied force as it were".

When a motor-car turns sharply round a corner the passenger feels as if he were shoved, but not as if a thing shoved him. This centrifugal experience, Price notes, gives the normal human being an experience of "pure force". Also, the supposititious being who has this experience only, because no contact sensations assure him of material things, would fully appreciate the "fields of force" of physics.

The contents of sensory experience are presumably embodied in concepts of *force*, and, however unreflective the embodiment may be, analysis can legitimately expect to disclose it. The talks in the "Hermetica", which were probably finally collected in the third century A.D., are pervaded by a sense of pervasive forces. The talks collect ideas rather than systematize them, and the items in this Greco-Egypto concept of force can be again collected from them into a précis. The forces are efficacious, immortal, imperceptible, unextended, radiative and, though incorporeal, only work in bodies. This concept of force is well compounded; the "radiative", for example, has probably an analogue in solar rays, but the *incorporeal* corresponds to the revelation of "disembodied force" by muscular sensations, and the "only work in bodies" corresponds to the normal connexion between force and material bodies through sensations of contact.

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RESEARCH ITEMS

Causes of Death in Fishes in Captivity

A REPORT on the causes of mortality of fishes exhibited in the New York Aquarium at Battery Park, New York City (now closed), is given by Ross F. Nigrelli (*Zoologica*. Scientific Contributions of the New York Zoological Society, 28, Part 4, No. 22; 1943). Careful attention and research have reduced the mortality very considerably in the last few years and all diseases and epidemics are well under control. There are many factors, however, which may cause death besides parasites and disease. Overcrowding is important, sudden change in temperature, the wrong adjustment of light, range and degree of pH, density, amount of oxygen, chlorine and nitrogen in the water, metabolic waste products and diet—all cause mortality; also too much handling and too frequent removal from one tank to another. It is established that the fishes themselves contribute largely to their own well-being in fitting themselves to their environment. There is a definite population density of fishes for a given volume of water and the fishes will kill one another off to maintain equilibrium when all other ecological factors are equal. They can, and do, control to a certain degree the chemical contents of their environment. This paper is full of valuable information and should be studied by all who are interested in aquaria.

Chondrocranium and Visceral Arches of *Ascaphus*

H. K. PUSEY (*Quart. J. Micro. Sci.*, 84; 1943) has provided an account of the chondrocranium and visceral arches of the frog *Ascaphus truei*, illustrated by seven text-figures and nine plates and containing a comparison with the conditions obtaining in the Urodela and other Anura. G. K. Noble, in a recent classification of the Anura, places *Ascaphus* with a New Zealand genus *Liopelina* in a separate family and regards it as the most primitive family of the Anura. The author of the present paper, as the result of his detailed studies, agrees with this, and hence a knowledge of the chondrocranium in this family is essential for an appreciation of the relationships of the higher Anura and of these to the other Amphibia. *Ascaphus* has more characters in common with the Urodela than the larva of any frog hitherto described, and is in some respects even more primitive than any living Urodela or indeed other living Tetrapod. The most nearly related family of the Anura appears to be the Discoglossidae. It is not possible within the limits imposed to enumerate all the points brought out, but the consideration of the cartilages and muscles in this form do permit of criticisms of previously proposed interpretations regarding them in Anura and also Stegocephalia. As is only to be expected, *Ascaphus* possesses certain individual specializations which are clearly indicated.

Taxonomy of Onchidiidae

THE family Onchidiidae has frequently been placed in the Pulmonata, although it has been generally recognized that it has affinities with the Nudibranchs. It has also been regarded as belonging to the Opisthobranchs by other authorities. The recent work of Vera Fretter on *Onchidella celtica* (*J. Mar. Biol. Assoc.*; 1943) has finally provided a solution to this problem and shown that the family is to be regarded as an early offshoot of the Opisthobranchs. In structure the veliger of *Onchidella* resembles that of the

monotocardian prosobranchs, but it lacks a ctenidium and an osphradium. It has a cavity on the right side and, although at this early stage there is no genital aperture, this is to be regarded as a true mantle cavity. During metamorphosis detorsion takes place, and this cavity moves round to the posterior end, carrying with it the anus and kidney opening. At the same time the cavity closes up to become a narrow tubular space and its aperture contracts to a pore. The result of this is that a bilateral symmetry is once again established and the pore at the hinder end of the mollusc, until now regarded as the anus, is, in fact, the opening into the reduced mantle cavity. The metamorphosis is accompanied by a reduction of the visceral hump and the loss of the shell.

Genes and Cytoplasm

SEVERAL papers recently have reported unsuspected relations between genes and cytoplasm in the production of a phenotypic character. T. M. Sonneborn (*Proc. U.S. Nat. Acad. Sci.*, 29, 329; 1943) describes a remarkable case in *Paramecium aurelia* where a pair of characters, 'killer' and 'sensitive', exhibit this phenomenon. *P. aurelia* individuals carrying 'sensitive' are killed by fluid in which 'killer' individuals have lived. An F_1 between killer and sensitive shows that vegetative 'killers' all derive their cytoplasm from 'killer' and 'sensitive' cytoplasm from 'sensitive' parents. Further, a gene *K* in cytoplasm of race 51 gives 'killer' but not in cytoplasm of race 32. However, if the sensitive gene *k* is carried in race 51, this race does not develop killer when *K* is again introduced. Experiments show that the cytoplasm develops a definite substance in the uninterrupted presence of *K*, but *K* alone cannot produce this killer reaction. Thus 'killer' depends on a gene *K* and a cytoplasmic substance. This substance is kept in production by *K*, but *K* alone cannot initiate its production. Sonneborn points out the resemblance of this peculiar behaviour with that in other organisms. For example, cytoplasmic inheritance in plants is closely parallel to results in *P. aurelia*. In this species, however, race 32 contains *k*, which is allelomorphous to *K*. In its presence the cytoplasm ceases to exert its previous influence on the killer character. The antigenic complex of *Pneumococcus* may also be compared with *P. aurelia*. Here antigenic types may be transformed into one another by suitable alterations in the environment. It is suggested that a gene of *Pneumococcus* will induce the cytoplasm to continue the production of an antigen when the basic substance is already present, but that it cannot initiate this substance. Adaptations may also be of this type, sometimes as in the acquired ability of *Propionibacterium pentasaccarrum* to synthesize vitamin B₁ after being supplied with this substance. Mutations may not only be genic or chromosomal in type, but also sometimes may be of this cytoplasmic reaction form.

Fungus Diseases of Fruit Trees

THREE recent short papers (*J. Pom. and Hort. Sci.*, 20, Nos. 3 and 4; Oct. 1943) describe new diseases of tree fruits. Dr. H. Wormald has isolated the fungus *Cylindrocladium scoparium* from shoots of plum and cherry varieties raised for rootstocks, and has proved its pathogenicity. Fructifications are rarely found on wilted shoots, though microsclerotia are common. Control methods which are suggested

include the dipping of infected stool shoots in Bordeaux mixture. The same author also describes the appearance of papery-bark canker on trees recently top-grafted. The fungus *Stereum purpureum* was isolated from several grafts, but one of them yielded *Polystictus versicolor*. A disease of apple fruits, known as dry eye rot, has been investigated by E. H. Wilkinson. *Botrytis cinerea* is the causal fungus; it attacks through an injured calyx, forms an initial eye rot, remains quiescent for a period, and later involves a complete rot of the whole fruit. Change from a high humidity to drier conditions prevents the progress of the disease to a complete rot.

Diamonds in the Bolivian Andes

A RECENT discovery of diamonds in the river gravels of the Caupolican district of north-east Bolivia is reported by V. Oppenheim (*Econ. Geol.*, 38; 1943). The diamonds are associated with gravels derived from Permian tillites. The latter are made up of rocks which are not found in the region but have evidently been transported by Permian ice from the basement metamorphic and igneous rocks of the Brazilian Shield, far to the east. In 1936 the author described the diamond-bearing tillites of the Parana Basin in south-eastern Brazil and showed that the diamonds occurred in acid intrusive rocks such as are thought to be the source-rocks of the diamonds of eastern Brazil. It is suggested that the Bolivian diamonds have probably been derived from a similar source in the Shield, whence they have been transported by ice and concentrated by rivers. Closer investigation is proceeding with the view of ascertaining the possible economic importance of the placer deposits.

Atmospheric Ozone Determination

E. Glückauf, H. G. Heal, G. R. Martin and F. A. Paneth have described (*J. Chem. Soc.*, 1; 1944) a semi-portable apparatus for the continuous recording of the local concentration of atmospheric ozone. Iodine is liberated by the ozone from sprayed buffered potassium iodide solution and is electrometrically titrated at short intervals with very dilute sodium thiosulphate solution. The small current resulting from the depolarization of a pair of platinum electrodes by the iodine is amplified by a two-stage valve amplifier, and made to actuate an automatic burette containing the thiosulphate solution when the iodine concentration reaches a given value. The whole apparatus is actuated by the a.c. mains.

Ascorbic Acid as a Photographic Developer

ASCORBIC and *iso*-ascorbic acids have been known as photographic developers since 1934, and formulae for such developers have been published. Their oxidation products do not interfere with the development process. In presence of a suitable amount of bromide, the two acids yield good image development with only slight fog formation; they show no unusual properties and in general resemble hydroquinone, apart from the lack of activity of the oxidation products. T. H. James (*J. Amer. Chem. Soc.*, 66, 91; 1944), who has established these results, also finds that the *iso*-acid reacts at a somewhat greater rate. At $pH = 10$ the active developer consists almost entirely of the bivalent ion, which is adsorbed prior to reaction with the silver bromide. In caustic alkali solution, diffusion rates determine the measured development rate. The rate increases with nature and concentration of salts present, the effect being

caused by a depression of the double-layer zeta-potential of the silver bromide; this permits a greater penetration of bivalent ascorbic acid ions through the double-layer region to the surface of the grain.

A New Electron-Optical Voltmeter

IN a paper read recently in London before the Institution of Electrical Engineers, Dr. L. Jacob described an electronic instrument for measuring a.c. or d.c. peak voltages in the range of 2–20 kV. to an accuracy of 3 per cent. The voltmeter has a low capacitance (9 cm.) and can be used in some circuits up to frequencies of 1 Mc./s. or more. Its action is based on the proportionality theorem for a triode electron-optical system, in that the angle of the beam is defined by the ratio of two voltages, the anode voltage and the voltage of the modulator grid. The beam angle remains constant when both terms of this ratio are multiplied by the same factor, the modulator bias voltage being directly proportional to the voltage to be measured when the latter is applied to the anode. A high voltage is thus measured in terms of a low voltage, the instrument constituting an electron-optical potentiometer. The range of measurement can be extended as desired. The same principle can also be applied to the construction of high-voltage tubes so that they act as their own voltage-measuring instruments.

Quantum Mechanics of Fields

THE usual treatment of quantized field theories is not very satisfactory. According to a recent paper by Prof. M. Born and Dr. H. W. Peng (*Proc. Royal Soc. Edin.*, 62, 40; 1944), the difficulties are somewhat similar to those which occurred in Bohr's semi-classical quantum mechanics of particles. These difficulties were overcome by replacing Fourier series by matrices. In the existing field theories we already have matrices, but we also have indices which do not belong to these matrices, and are related to Fourier series. In short, these theories are still partly classical. The remedy proposed by Born and Peng is to build up a new theory in which each field component is wholly represented by a matrix. The advantages of this are that the technique is much simpler and of the same type as that of ordinary quantum mechanics. The new theory can be applied to non-linear field equations without any mathematical complication, as the superposition principle holds for each state of a pure field. It is hoped to extend the work to account for the production of new particles from the primary ones.

Trapezium Stars

Otto Struve and John Titus, of Yerkes Observatory, have studied the four stars forming the trapezium in the Orion nebula, and have found that the lines of these stars are displaced more towards the red than the emission lines of the nebula (*Sky and Telescope*, February). It is surprising to find these stars moving with twice the speed of recession of the Orion nebula, because they have usually been thought to be associated with the nebula. Dr. Struve suggests that the stars may shine brightly and yet be of small size but large masses, and that the Einstein effect is in evidence here, as with the companion of Sirius. If this is so, the excess of red shift may not be due to a higher speed of the stars than of the nebula.

THE ASH TREE

By ALEXANDER L. HOWARD

THE ash stands alone among our forest trees in the peculiar shape and manner of its growth. Sculptors and artists have always been inspired by the grace and beauty of trees and all that the tree bears, so that we have exquisite models of the oak leaf, the acorn, the twisted and gnarled bark of many kinds of trees. The habit and growth of the limbs of the ash being distinctive, the artist has taken it as a model for the arms of the standard and other lights in cathedrals and churches, and the architect for the columns and fair tracery which support the vaulted roof similar to that of the forest glade.

Pliny says :

"There be many trees besides that Nature hath brought forth ; for their wood of timber : and among them the Ash, which of all others, groweth most plentifully in every place . . . much ennobed by the praise and commendation that the Poet Homer giveth it, as also for the speare or lance of Achilles, made thereof. . . .

"The Greeks have made 2 kinds of the Ash : the one runneth up tall and even without a knot : the other is lower, more tough and hard, and withall, of a more brown and darkish colour. . . . Others have put a difference between Ashes, according to the places : for that of the plaine and champion country, hath a more curled and fristed graine than the other of the mountaines, but contrariwise, the wood of this is more compact and harder than the other. The leaves of this tree, according to the Greekes, are hurtfull, venomous, and deadly to horses, mules, and such labouring garrons ; but otherwise to beasts that chew cud they be harmlesse. . . . Moreover, they be excellent good, and nothing so soveraigne can be found against the poison of serpents . . . nay, so forcible is their virtue, that a serpent dare not come neare the shadow of that tree. . . .

"A wonderful goodnesse of dame Nature that the Ash doth bloome and flourish alwaies before that serpents come abroad."

Yet it would be difficult to trace the original cause of the belief in the supposed efficacy of the cure by what was called the shrew-ash. Superstition has always held an overpowering influence over the mind of man. The medicinal qualities of trees and shrubs were far more generally known and practised in earlier times, when qualified medical aid was difficult to procure, and the health of husband and children devolved far more on the housewife. It is probable that cures which had been effected by the use of the leaves, fruit or juices of the ash trees had actually been brought about, but certain it is that up to a hundred years ago, and even to-day, a belief still prevails in the curative powers of the shrew-ash.

The Rev. C. A. Johns says :

"They have also a superstitious custom of boring a hole in an Ash, and fastening in a shrew mouse ; a few strokes with a branch of this tree, is then accounted a soveraign remedy against cramp and lameness in cattle, which are ignorantly supposed to proceed from this harmless animal."

Gilbert White (of Selborne) says :

"In a farm-yard, near the middle of this village, stands at this day a row of pollard-ashes, which, by the seams and long cicatrices down their sides, manifestly show that in former times they have been cleft asunder. These trees when young and flexible, were severed and held open by wedges, while diseased children, stripped naked, were pushed through the apertures, under a persuasion, that by such a process the poor babes would be cured of their infirmity. As soon as the operation was over, the tree in the suffering part was plastered with loam, and carefully swathed up. If the parts coalesced and soldered together, as usually fell out, where the feat was performed with

any adroitness at all, the party was cured ; but where the cleft continued to gape, the operation, it was supposed, would prove ineffectual. . . . We have several persons now living in the village, who in their childhood were supposed to be healed by this superstitious ceremony, derived down, perhaps, from our Saxon ancestors, who practised it before their conversion to Christianity."

Johns was of the opinion that John Evelyn half believed in the efficacy of this practice.

Many of our well-known arboriculturists have given us accounts of remarkable trees, among which Elwes mentions the Queen's Ash at Ashridge Park. He says :

"One of the most perfect examples, from a timber point of view, is a tree growing in a wood called Poultridge, just outside Ashridge Park, which is about 125, perhaps 130 feet high. . . . It had, in 1906, an absolutely straight clean stem, about 75 feet in height by 11 feet 10 inches in girth, and looked as if it would square 27 to 28 inches halfway up, in which case it contains about 400 feet of faultless timber in one length."

The year in which the Conservative Party first occupied the house at Ashridge Park (about 1920) I visited the tree, to find that the measure had increased since Elwes's time. I was informed that an immense price had been offered for it and refused. Alas, within three weeks it was struck by lightning, which revealed that it was almost a hollow shell, with scarcely a sound piece of timber throughout the immense size. It was a strange case, as the tree displayed no sign, appearing perfectly healthy, sound, and clothed with a sound bark throughout. I have repeatedly seen oak trees struck by lightning, ash rarely, elm never ; it would be interesting to discover the reason.

No tree repeats itself so vigorously as the ash tree, which through its winged seed spreads far and wide, producing innumerable young seedlings. No tree planted, or transplanted, will grow so sturdily and establish itself so surely. Every gardener finds self-sown ash trees springing up around his beds and paths in such profusion that they become a nuisance, and in those districts where ash plantations abound, every year a wide area of strong naturally regenerated plants will be found. A wiser control in the past would have protected these areas, so that at the least possible cost a wealth of young forest would have been added to our depleted woodlands. This course has never been pursued, and year by year young trees have been trodden down, ploughed up, or destroyed by animals.

While many of the trees grown in Great Britain have been wanted and from time to time have been realizable at varying prices—sometimes actually negligible—the demand for ash has remained constant, and the price regular. Even in Evelyn's time, nearly three hundred years ago, the great value of the ash was recognized. He says :

"In 40 years from the key (seed), an ash hath been sold for £300. sterling, and I have been credibly informed that one person hath planted so much of this one sort of timber in his life-time as hath been valued worth £50,000. to be brought." (£50,000 in his day would be equal to say £100,000 to-day.) "Every prudent Lord of a Manor should employ one acre of ground to Ash with every 20 acres of other land, since in as many years it would be more worth than the land itself."

There can be little doubt that the future will bring the fortunate owner a reward, as it is doing to-day, on a higher scale than any other tree which he could grow.

Of the innumerable species of ash trees which can be found distributed all round the globe, and in pro-

fusion in the United States, Canada, Europe, China and Japan, three kinds only will be referred to in this article—the common ash, the manna ash, and the weeping ash. The common ash (*Fraxinus excelsior*) was abundant in male and female trees before the War of 1914–18, before which time there had been a steady demand year by year; but there was no cause for alarm. With the wholly unexpected and prodigious requirements of the War, and the advent of the aeroplane, whole areas were entirely denuded of the finest trees. A search for straight, well-grown trees, suitable for aeroplane construction, was relentlessly pursued, and ash trees of sufficient length and of clean hard growth brought the owners prices the highest ever known. In the years following the War the demand continued with unabated vigour, and undesirable and unfortunate as it may be deemed, large consignments of trees were sold to Japan.

Through all ages the wood of ash has been used for a great number of purposes, and because of its character it has served a special purpose for which no other wood has been found equal. The early writers or historians continue to record its merits for service both in war and peace.

Johns says:

“As a timber tree the Ash is exceedingly valuable, not only on account of the quickness of its growth, but for the toughness and elasticity of its wood, in which latter quality it surpasses every European tree. In its younger stages (when it is called *ground-ash*), it is much used for walking sticks, hoops, and hop-poles; and it matures its wood at so early an age, that an Ash-pole, three inches in diameter, is as valuable and durable for any purpose to which it can be applied, as the timber of the largest tree. The use of Ash is (next to that of the Oak itself) one of the most universal: it serves the soldier (Spears were anciently made of Myrtle, Cornel and Hazel, but Pliny prefers the Ash for that purpose)—and heretofore the scholar, who made use of the inner bark to write on, before the invention of paper. The carpenter, wheelwright, and cart-wright find it excellent for plows, axle-trees, wheel-rings, and harrows; it makes good oars, blocks for pulleys, and sheffs, as seamen name them: for drying herrings no wood is like it, and the bark is good for the tanning of nets; and, like the Elm (for the same property of not being apt to split or scale), is excellent for tenons and mortises; also for the cooper, turner and thatcher; nothing is like it for our garden palisade hedges, hop-yards, poles and spars, handles and stocks for tools, spade-trees, etc. In summer the husbandman cannot be without the Ash for his carts, ladders, and other tackling, from the pike, spear, and bow, to the plow; for of Ash were they formerly made, and therefore reckoned amongst those woods which, after long tension, has a natural spring, and recovers its position, so as in peace and war it is a wood in highest request.”

The quality of the wood grown in Great Britain surpasses in its toughness and flexibility that of any other country, although some grown in Canada and some in the Transylvanian Alps approach it very closely. For the purpose for which it is used it would be difficult or even impossible to find a satisfactory substitute. With the advent of the aeroplane, ash became a far more important medium, one indeed on which the whole course of the War of 1914–18 was peculiarly dependent. Ash was used for the longerons, collapsible wheels, internal packing blocks, and for skids and runners for gliders, where length, straightness of grain, absence of imperfections, strength and toughness preserved the lives of flying men. Such was the demand that the whole available existing supply of seasoned wood was exhausted in a few months. Thousands of trees were cut down in Great Britain, and thousands were brought from the

Continent. No less than twelve thousand trees could have been seen at one depot, in separate piles. The imported ash produced a longer length of clean straight growth than that grown in Great Britain, showing the advantage gained by scientific forestry practised abroad as compared with the absence of these methods in Great Britain. The largest drying kilns available were continually employed with day and night shifts, year in year out, without cessation, and wood from growing trees was actually in aeroplanes flying over the enemy's lines within a few months of the felling of the trees. Ash was also used for the keel pieces of the gondolas or boats of the blimps or airships. The length required for this purpose was exceptional, being about 26 ft. long, with a dimension of 1½ in. by 4 in.—a demand which, although drastic, was fulfilled.

The ash tree is attacked by a fungus, the identification of which does not yet appear to have been determined. Everyone will have noticed spreading from the trunk, perhaps at the base, or at any other point to the crown, a collection of overhanging growths, in mushroom form. This is the outward manifestation of the fungus growth in the tree. Sometimes it forms in a part where vigorous young shoots are pushing out, which form what is known as a burr. With the ash tree, however, the fungus mingles with the wood growth, consolidating into one solid mass of apparently woody growth. Such burrs when cut through display the customary bird's-eye surface, but intermingled will be found thin black streaks circling in and out among the bird's-eye marking. Ash burrs, whether pure and white without fungus, or whether as described above, with fungus, have always been highly valued, and for three hundred years used by cabinet-makers in vogue fashion for the making of art furniture. Examples can be found, particularly in the cases of grandfather clocks, especially those made in the reign of Charles I. The fashion would seem to have insensibly fallen away, but has revived again lately.

We must not overlook the weeping ash (*Fraxinus excelsior* var. *pendula*), one of the most decorative forms that any tree bears. This tree appears to have been discovered about one hundred and fifty years ago, and Elwes says:

“Loudon describes several forms of it, and says that the original tree was discovered near Wimpole in Cambridgeshire 150 years or more ago,”

and he refers to another form, “the Cowpen Ash”, which he says has “assumed a very similar habit”; and still another, the Kincairney Ash, which “was distinguished by its alternately pendulous and upright branches”. He reports a weeping ash, by far the finest known, which was grafted about 1848 at Elvaston Castle, near Derby, and was reported as being 98 ft. high, with long weeping branches, and another with a bole 50 ft. by 12½ ft.

Apparently it is necessary to rear this tree only by means of grafting on to the ordinary common stock, a proceeding which has much been neglected, but which if pursued would give additional interest and much pleasure to those who are concerned with arboriculture. No doubt the enterprising nurseryman will have continued to produce the weeping ash for his customers, but its popularity to-day is insignificant in comparison with about one hundred and forty years ago. The beautiful examples then established can be seen in almost every park and garden, in the gardens of country houses, in the public parks, in cities and the surrounding gardens, and in the botanical gardens,

but the youthful tree which should take its place is conspicuous by its absence to-day.

The manna ash (*Fraxinus ornus*) is another beautiful tree, far too little known or appreciated in Great Britain. It is said to have been introduced by Dr. Uvedale in 1710 from southern Europe. Elwes says the tree was common "in Eastern Spain, Corsica, Sardinia, Italy, Servia, Bosnia, Greece, and Asia Minor".

Later he adds:

"Its chief economic importance is due to its being the source of manna. The manna of commerce, according to Hanbury, is exclusively collected in Sicily . . . incisions are made in the bark . . . and the manna exudes as a clear liquid, which solidifies on the stem of the tree or on pieces of straw or wood that are inserted in the incisions. Manna consists mainly of a peculiar sugar called mannite, which is a mild laxative and is employed as an official drug in many countries."

So far as it is possible to ascertain, no use has been made of the manna ash tree for the production of manna in Great Britain, as has been the case in Sicily and southern Europe.

So little is this tree known that the owner of a house had one of them on her lawn, which she highly prized, and which for years was appreciated by those who visited her, but every inquiry she made failed to reveal its identity.

The tree thrives well, and under good conditions will reach a height of 50-60 ft., with a maximum recorded girth of 8 ft. 8 in. A very fine specimen can be seen at Kew, the measurement of which is given by Elwes as 60 ft. high by 7 ft. 6 in. girth. A very fine grove of these trees can be seen near the Castle at Arundel.

A young tree, but already with a beautiful habit, can be seen near the Epstein statue in Hyde Park. This tree, about seven years ago, was heavily loaded with seed, of which I obtained a quantity, and from which I reared three hundred and fifty trees, some of which are now 8 and 9 ft. high. Whether these trees will revert to the original stock or prove to be true manna ash (*F. ornus*) remains to be seen. Generally, if not always, it has been grafted on to a stock of the common ash (*F. excelsior*).

The trunk, with a smooth grey stem, supports the crown, whence branches somewhat drooping bear a rich foliage, not unlike the common ash, but with a more rounded and delicate leaf. Dr. R. Melville says:

"The Manna Ash, . . . exhibits a fair degree of variation in leaf form. There are at least two varieties described of the Manna Ash based upon leaf shape."

The lovely whitish flowers give off a delightful perfume, which permeates the air around the tree.

The wood is of finer grain, but otherwise similar to that of the common ash, but so rarely provided that it is generally unknown to the craftsman.

CHOLESTEROL METABOLISM IN THE ANIMAL BODY

By DR. G. A. D. HASLEWOOD

Guy's Hospital Medical School, University of London

THERE has been a considerable amount of recent work on the unsaponifiable fatty material of several types of animal tissue, and one of the results of this kind of experiment has been to throw some light on the changes which probably take place during

life in the substance cholesterol (I), a ubiquitous constituent of animal cells.

By no means the least interesting aspect of this research is the somewhat unexpected discovery that the changes undergone by cholesterol are so easily brought about that it is often impossible to say with certainty that they might not have occurred during the processes leading to the isolation of the resulting products from the tissue extract. Moreover, Bergström and Wintersteiner¹ have shown that purified cholesterol itself can be transformed under conditions of pH, oxygenation and temperature which must occur *in vivo*. The possibility that enzymic systems might alter the course of cholesterol transformation has not yet been adequately explored, but it seems safe to assume a high degree of probability for the occurrence of at least the following substances in the tissues named, if these are supplied with oxygen at a normal mammalian pH and temperature:

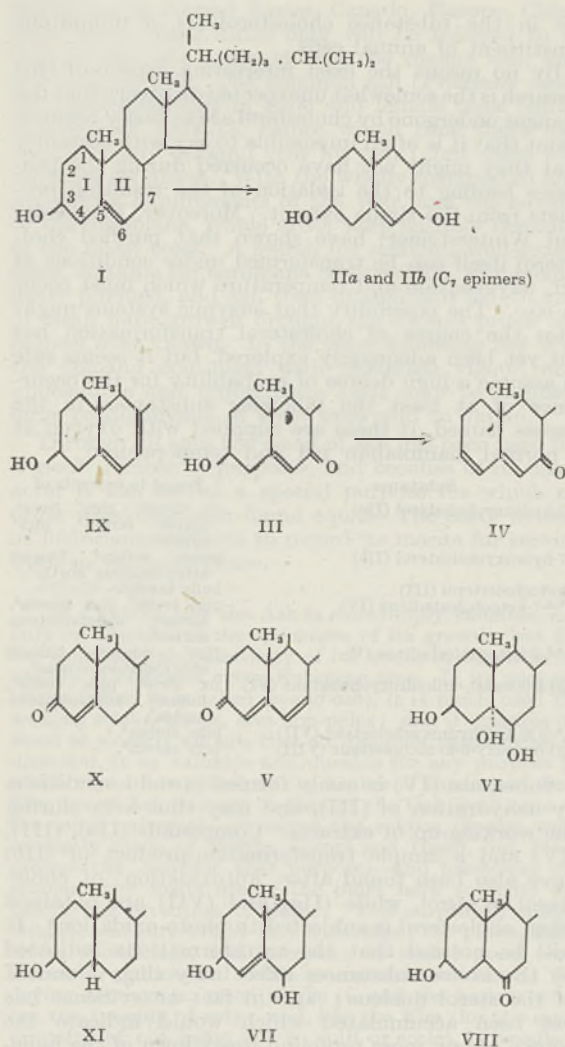
Substance	Found in extracts of
α -7-hydroxycholesterol (IIa)	ox liver ² , pigs' liver ³ , mares' serum ⁴ , pigs' spleen ⁵ .
β -7-hydroxycholesterol (IIb)	mares' serum ⁴ , human atheromatous aorta ⁶ .
7-ketocholesterol (III)	bulls' testis ⁷ .
$\Delta^5,7$ -ketocholestadiene (IV)	pigs' testis ³ , pigs' spleen ⁵ , human atheromatous aortas ⁸ .
$\Delta^{4,8}$ -3-ketocholestadiene (V)	pigs' spleen ⁵ , human atheromatous aortas ⁸ .
3(β),5,6(<i>trans</i>),-trihydroxycholestane (VI)	ox liver ² , pigs' testis ⁷ , human atheromatous aortas ⁸ .
Δ^4 -3(β),6,-dihydroxycholestene (VII)	pigs' spleen ⁵ .
3(β)-hydroxy-6-ketocholestane (VIII)	pigs' spleen ⁵ .

Substance (IV) is easily formed in mild conditions by dehydration of (III), and may thus arise during the working-up of extracts. Compounds (IIa), (III), (IV) and a simple transformation-product of (IIb) have also been found after 'autooxidation' of cholesterol *in vitro*¹, while (IIa) and (VII) are obtained when cholesterol is subjected to photo-oxidation⁹. It will be noticed that the transformations indicated by the above substances affect only rings I and II of the sterol nucleus; and in fact no evidence has yet been accumulated which would indicate the course of any more profound breakdown of the molecule. Apart from indirect experiments, such as those of Bloch and Rittenberg with deuterium¹⁰, definite proof of further chemical changes during cholesterol metabolism is still lacking.

It may also be noted that, in spite of the facile *in vitro* production of 7-dehydrocholesterol (IX, provitamin D₃), from α -7-hydroxycholesterol (IIa), the mechanism of the formation of this important substance in the animal body remains entirely obscure.

Prelog, Ruzicka and Stein⁵ point out that tissues which so far they and their colleagues have examined in great detail differ from adrenal tissues, testis and urine in containing no steroids of the C₂₁ (progesterone, corticosterone, etc.) or C₁₉ (androsterone, testosterone, etc.) types, a fact which, if it is generally confirmed for other tissues, may prove highly significant for studies of steroid metabolism.

Cholestenone (X) has been found in dogs' and rats' faeces¹¹ and in pigs' testis⁵. Rosenheim and Webster¹² continue to believe that it is a precursor of faecal coprosterol (XI), which they think is unlikely to arise, as was formerly believed, by bacterial action in the intestine¹². The same workers have observed a quite remarkable dietary influence on the production of coprosterol by the intact animal¹³; this discovery may be a valuable lead towards the solution of more than one problem. In this connexion,



it is to be hoped that the saturated sterols so frequently stated to be present in tissues will be re-investigated, especially with regard to their complete chemical identification, since it certainly cannot be stated with confidence that coprosterol itself is absent from the body cells.

Since the above substances (II-VIII) are such as may arise in normal cells during life, it would appear reasonable that they should be tested for physiological activity, especially of the kind which may be directly associated with growth processes.

¹ Bergström, S., and Wintersteiner, O., *J. Biol. Chem.*, **141**, 597 (1941); **143**, 503 (1942); **145**, 309, 327 (1942).

² Haslewood, G. A. D., *Biochem. J.*, **33**, 709 (1939).

³ MacPhillamy, H. B., *J. Amer. Chem. Soc.*, **62**, 3518 (1940).

⁴ Wintersteiner, O., and Ritzmann, J. R., *J. Biol. Chem.*, **136**, 697 (1940).

⁵ Prelog, V., Ruzicka, L., and Stein, P., *Helv. chim. Acta*, **26**, 2222 (1943).

⁶ Hardegger, E., Ruzicka, L., and Tagmann, E., *Helv. Chim. Acta*, **26**, 2205 (1943).

⁷ Ruzicka, L., and Prelog, V., *Helv. Chim. Acta*, **26**, 975 (1943).

⁸ Haslewood, G. A. D., *Biochem. J.*, **35**, 708 (1941).

⁹ Windaus, A., Bursian, K., and Riemann, U., *Z. physiol. Chem.*, **271**, 177 (1941).

¹⁰ Bloch, K., and Rittenberg, D., *J. Biol. Chem.*, **145**, 625 (1942); **149**, 505, 511 (1943).

¹¹ Rosenheim, O., and Webster, T. A., *Biochem. J.*, **37**, 513 (1943).

¹² Rosenheim, O., and Webster, T. A., *Biochem. J.*, **37**, 580 (1943).

¹³ Rosenheim, O., and Webster, T. A., *Biochem. J.*, **35**, 920 (1941).

OBJECTIVE CLINICAL METHODS

A NEW and remarkably ingenious example of the objective clinical methods which are constantly being developed in modern medicine and surgery is the phono-electrocardioscope designed by Dr. G. E. Donovan (*The Lancet*, 500, April 15, 1944), which permits simultaneous direct visual recording of the phonocardiogram, electrocardiogram and sphygmogram, with amplified auscultation through a binaural stethoscope; in addition, photographic records can be made. The expense of such instruments and the difficulty of producing them in sufficient numbers will prevent all but a few workers from using them, but it is worth remembering that some of them can be applied to the study of the normal animal as well as to the sick animal for whose relief they were invented. The electrocardiograph and the techniques of radiography, cystoscopy and duodenal intubation are examples of objective clinical techniques which can be, and are being, used by anatomists and biologists for studies which have no connexion with disease. The cystoscope or the ophthalmoscope, for example, need not always be used for the study of the bladder or the eye. The principle on which such instruments are constructed can be applied to other things. If an instrument allows you to look into the bladder of a man, it may be used also for seeking out the death watch beetle underneath a floor, and it is being used in this way by Prof. Bayley Butler in Dublin; and the biologist, the medical man and the veterinarian can all use modern methods of studying the fluids and soft tissues of the body and so demonstrate that they are all students in the same field of inquiry.

There will always be, however, an especially close correlation between the methods of the medical man and the veterinarian, because it is their common object to understand and to treat disease—or better, to prevent its occurrence and to maintain health. The trend of medical thought is, or should be, as Prof. J. A. Ryle and other medical men have pointed out (see *Nature*, **153**, 443; 1944), to teach medical students to rely less upon instruments and laboratory procedures and more upon the art of clinical observation and inference in which their grandfathers were so skilled. There will, however, always be some aspects of disease which require the instrument and the laboratory expert. You may be able to diagnose malaria or amoebic dysentery with adequate accuracy by experienced interpretation of the symptoms only, but a protozoologist can do it much more quickly and with absolute certainty; in certain cases, indeed, his laboratory report may be the only means of doing it or of saving the patient's life. In the same way, radiography or the electrocardiograph may give vital information which could not be got in any other way.

The value of such objective methods of study can perhaps be most clearly demonstrated when they are applied to patients who cannot tell the medical man or the veterinarian what their sufferings are. The deaf and dumb adult, the infant and the young child who cannot speak—or, if he can, cannot make reliable statements about himself—must tax to the full the art of the clinician who has only his own experience to guide him. Very often such patients require the aid of objective studies by means of instruments or laboratory procedures which cannot, so the optimist at any rate believes, tell a lie. The neurotic or hysterical adult may also require this

kind of study; and there are some diseases, such as trichiniasis, which are so protean in their manifestations and simulate so many other diseases that the diagnosis can only be made by the finding of the parasite or by serological methods which depend upon considerable laboratory experience. The veterinarian, of course, is always confronted by this kind of difficulty; his patients may be able to utter cries the quality of which may tell the experienced hearer of the vital things, but they cannot tell the whole story, and the experience necessary to interpret them comes only after years of practice. It comes, moreover, only to those who have the ability to acquire it; and it cannot be communicated to students and others except by a similar long experience based on a similar ability.

In a matter like this, the veterinarian and the medical man must therefore find a wide field of mutual interest. It is a field which deserves energetic co-operation and exploration. If the children's doctor may seem to be most likely to profit from such co-operation, the whole of medicine may learn much from the study of animal illness. Comparative medicine, whether it be practised by the medical man or the veterinarian, must certainly have a direct interest in objective methods of study which can give it reliable information about the conditions of certain organs, or about such cardinal symptoms as the quality, intensity and distribution of pain, about normal and pathological variations in body temperature, about fatigue, the reactions of the autonomic nervous system and so on. Much might be learnt, too, from a comparative study of the reactions to certain cardinal symptoms of disease which are shown by animals so different as the carnivore, the ungulate, the mammal and the bird.

The interpretation of the results of studies such as these will not be easy. They will usually involve behaviour patterns for the study of which the co-operation of a psychologist will be required. Perhaps we could begin with a reconsideration of the whole basis of Pavlov's work, or at least with a critical examination of certain criticisms of it (see *British Medical Journal*, 487, Oct. 16, 1943; *ibid.*, 305, Aug. 14, 1943; and *ibid.*, 573, April 22, 1944), which would seem to merit the serious attention of biologists. At any rate, we should have to begin with carefully thought out basic experiments, planned by a medical man, a veterinarian and a psychologist, which would be designed to provide a basis for further work. Such a plan has, in fact, been formulated by the Institute of Animal Behaviour, a committee of which is designing a programme of work the object of which is to explore the possibility of creating an objective science of clinical study. A similar theme was discussed at a recent meeting of the Section of Comparative Medicine of the Royal Society of Medicine. There exists, of course, a great deal of knowledge based on objective experiment which will help such a project; and both the medical man and the veterinarian can supply a vast store of clinical experience which will, if it can be systematized, be invaluable. Meanwhile the explorers stand upon their peak in Darien. Let us wish success to their campaign on behalf of all those, whether they be human or animal, who suffer but cannot tell their sufferings, or, if they would tell, are prevented by their own constitutions or immaturities from telling the truth or directing attention to the root causes of their troubles.

G. LAPAGE.

THE IMPERIAL CANCER RESEARCH FUND

THE Imperial Cancer Research Fund, which has just issued its forty-first annual report, is still carrying out experimental work and is also improving its financial position. During the past year, more than £20,000 has been added to the capital account, so that the Fund has now almost £430,000 in hand and spends about £15,000 a year in supporting research work in its laboratories at Mill Hill.

With a scientific staff of seven and four visiting workers, the laboratories are working in many fields of cancer research. The visitors include Sir John Ledingham, Dr. L. Dmochowski from Poland and Dr. E. Vasquez-Lopez from Madrid. The report of the director, Dr. W. E. Gye, is divided into sections on carcinogenesis, tissue culture, the mammary tumour inciter, and chemotherapy.

The work on carcinogenesis consists of Mr. H. G. Crabtree's study of the effects on the induction of cancer in mice of substances which inhibit metabolic processes. He has found that organic halogen compounds which react with substances containing sulphur in the body are able to retard the induction of tumours on the skin of mice painted with a carcinogen. The halogen compounds are of two types: those in which the halogen is reactive, as in chloroacetone, and combines directly with sulphhydryl groups, and others, such as bromobenzene, which react with sulphur compounds in the body without loss of halogen. Both types of compound appear to cause a local fall in concentration of glutathione when applied to the skin of mice. A similar effect was looked for with maleic anhydride, as it is known that maleic acid combines with glutathione. Maleic anhydride applied to the skin of mice treated with benzpyrene proved to be a more potent inhibitor of carcinogenesis than is bromobenzene. The work suggests that sulphur compounds are connected with the induction of tumours in some way which is not yet clear.

If connective tissue cells are grown in tissue culture in contact with carcinoma cells, the growth of the former is stimulated. On the other hand, sarcoma cells tend to restrain the growth of connective tissue. Stimulating effects of carcinomata have long been known to operate *in vivo*, as the change of connective tissue cells into malignant cells in the presence of transplanted mammary tumours has often been observed. Dr. R. J. Ludford and Miss H. Barlow have tried to demonstrate such a malignant transformation in connective tissue cells grown *in vitro* in contact with mammary cancer tissue, but so far without success.

The effect of the mammary tumour inciter, discovered in the Roseco B. Jackson Memorial Laboratory in the United States, which is present in the milk of strains of mice with a high incidence of breast cancer, has now been shown to operate in the high-cancer strain RIII and the low-cancer strain S. It is pointed out that the fact that oestrene treatment induces tumours in male mice of susceptible strains indicates that the factor is present in the tissues as well as in the milk of mice in which mammary cancer occurs. The presence of the inciter in spleen tissue has been confirmed.

The difficulties of work on chemotherapy of cancer are discussed. For effective therapy either all the cancer cells must be destroyed, or the stimulus to divide which is present in these cells must be neutral-

ized. Other difficulties are the similarity in properties of normal and cancer cells, and the variation in growth and lethal effects of spontaneous tumours. The advantages of using a tumour which has arisen in a pure line of mice and is transplanted into mice of the same strain are stressed; no reference is made to a tumour of that nature introduced by Dr. E. Boyland some years ago.

RESEARCH WORK FOR 1944 IN THE ACADEMY OF SCIENCES OF U.S.S.R.

By LYDIA BACH

THE Academy of Sciences of the U.S.S.R., as the guiding centre for all scientific activity in the Soviet Union, has planned its work for 1944 in four main divisions. First, the study of scientific problems of various branches of knowledge for the advancement of science in general; secondly, research work in the sphere of improving armaments for the Red Army; thirdly, the mobilization of resources to strengthen the defence of the U.S.S.R.; and, fourthly, scientific problems connected with the rehabilitation of regions liberated from the German invaders and devastated by war, and further development of the national economy as a whole.

Plans for the year's work were drawn up by each institute separately, primarily by laboratories and then for institutes as a whole. A committee from each institute selects from its programme problems which offer the greatest interest for inclusion in the general plan of the Academy. Plans are then approved at a general meeting of members of the Academy, corresponding members, and leading scientific workers of each section of the Academy, which examines the subjects submitted in detail and draws up a plan for each section of the Academy. The Academy has eight sections covering the following branches of knowledge: physics and mathematics, chemistry, geology and geography, biology, technology, history and philosophy, economics and law, language and literature.

The 1944 plan which was approved by the presidium of the Academy on December 21, 1943, shows that the Academy is devoting the greatest amount of attention to big theoretical and practical research tasks, on the assumption that other questions can be better dealt with by institutions which work in special spheres and branches of industry.

In the Section of Physics and Mathematics, cosmic rays and the structure of the atomic nucleus will be studied by Dr. A. Alikhanov and Prof. D. Skobeltsin. Expeditions to the Pamirs and Mount Elbrus are being organized to study cosmic rays at high altitudes. The building of a cyclotron has been planned. Dr. P. Kapitza and his colleagues will continue their investigation on properties of matter at temperatures approaching absolute zero. The problems of the structure of matter are being worked at in the Physico-technical Institute by Joffe, and in the Institute of Crystallography by Prof. A. Shubnikov; at the Institute of Physics, S. Vavilov is working on mechanics, luminosity and the employment of luminescence. At the Institute of Mathematics, I. Vinogradov, S. Sobolev, A. Kolmogorov and S.

Bernstein are working on theoretical mechanics and giving particular attention to methods of employing calculating machines to solve equations arising in mathematical physics.

In chemistry, work will proceed on the development of modern conceptions of chemical bonds in the kinetics and catalysis of chemical reactions (N. Semenov, Prof. S. Roginsky). Frumkin and his school will continue their work on theoretical questions connected with electrode processes and the theory of surface phenomena. Work on the synthesis of carbon compounds of high molecular weight is proceeding. The chemical institute of the Academy of Sciences is devoting considerable attention to scientific and technical assistance to industrial enterprises, employment of new chemical and technical processes and their intensification, and also the rehabilitation economy of devastated regions which have been liberated from enemy occupation.

The programme for geology and geography includes the study of the main questions of stratigraphy and tectonics of the U.S.S.R., the mineralogy and the geochemistry of the formation and distribution of ore deposits. P. Stepanov will continue his work on the theory of coal formations in the world; V. Obruchev and his colleagues will work on the theoretical and practical problems connected with perpetually frozen territories. The work is being extended to the spheres of hydrogeology and the study of lakes and volcanoes. Work on the study of geography in the Soviet Union and foreign countries, and research work on processes taking place in the soil will be continued.

Each biological institute will work on its own special problems, but will handle them from the evolutionary point of view, developing them all as a complex whole in accordance with the basic problem of biology, that of Darwinism. The institute of evolutionary morphology is studying the laws governing that branch of biology. In the institute of palaeontology, Borisyak has established a system of practical phylogenesis for the determination of evolutionary processes in fossils. The institute of physiology (Leon Ordeli) is concerned with the evolutionary processes of various systems of the human organism, muscular, neural, etc. Trofim Lysenko, of the Institute of Genetics, is continuing his work on inheritance.

Work on the humanities includes the study of Russian history, peasantry and working class collectivization, Russian culture, patriotic war, study of Slavonic peoples and the history of international relations. Further volumes, "History, Philosophy", will cover Russian philosophy and the philosophical views of Marx, Engels, Lenin and Stalin.

The mobilization of the country's resources for the needs of defence includes the study of problems connected with the industrialization of Kazakhstan. Work on the oil of new oilfields in Bashkiria continues.

In order to help rehabilitation economy in districts that have been devastated by enemy occupation and by war in general, and to help the general development of national economy, the problem of post-war provision of electrical energy is receiving urgent attention and fundamental principles are being laid down. Research is being done on the restoration of the Donets coal basin and its coalmines; industrial enterprises and transport are being greatly extended. The Academy's institute of economics is working on a very comprehensive publication, "Soviet Economy in the War and Post-War Periods".

EARLY ASTRONOMY

THE third of the series of articles on early astronomy appearing in *Sky and Telescope*, published in the February issue, deals with the Polynesians (see also *Nature*, April 15, p. 459). In this article it is shown that, contrary to earlier views, these people had an intimate knowledge of the constellations and hundreds of stars. They studied the motions of the planets and the phases of the moon, which were used to indicate lapses of time, and they possessed an extraordinary aptitude for making meteorological forecasts.

In navigation the Polynesians displayed remarkable skill; their method of sailing was usually to steer north or south until they reached the latitude of the chosen island, and then to steer east or west. They made use of the "sacred calabash" for determining the latitude. This consisted of a large gourd in which four holes were bored at the same height near the neck. An accurate horizontal plane was provided by the level of the water at these holes, and a sight through a hole over the opposite edge at a bright star gave the angle of its height above the horizon. By placing the holes at the correct distance below the edge to indicate the latitude of their destination, they knew when to turn east or west to reach the island of their quest. Their long sea journeys proved that the earth was round thousands of years ago.

The Polynesians nearly everywhere commenced the new year on December 1, with the first new moon after the first appearance of the Pleiades in the eastern sky in the evening twilight. In the Hawaiian islands twelve lunar months of thirty days each were used, and the religious year was correlated with the sidereal year by introducing five extra days. The months were divided into three periods of ten days each. The origin of the world was explained by various legends, but some of the fundamental ideas were similar, and a primitive egg was the natural beginning. The darkness of the earth was removed by the raising of the sky and letting in the light of dawn.

In the March issue of *Sky and Telescope* there is a brief reference to the astronomy of the Chinese, Indians, Phœnicians, Greeks and Egyptians. Although the inclination of the ecliptic was determined very accurately by Chou Kung in 1100 B.C., yet this eminent mathematician failed completely in his estimate of the sun's distance, as he calculated from the hypothesis of a flat earth. It is remarkable that, though the Phœnicians were expert navigators, yet they have left no other evidence of their astronomical knowledge.

A few of the attainments of the outstanding astronomers and mathematicians of Greece and Egypt are mentioned in this article, and among these we may refer to Aristarchus of Samos, born in 310 B.C., who attempted to measure the relative distances of the moon and sun by a principle theoretically sound, but beset with practical difficulties which rendered it useless. He assumed that at half-moon the angle at the moon between the directions of the sun and the earth was 90° , and if he could measure the angle subtended at the earth by the lines earth-moon and earth-sun, he could solve the triangle of which one angle was a right angle. Unfortunately, a very small error in either of these angles would be responsible for a considerable error in determining the relative distances of the sun and moon, because the ratio of their distances depends on the

small angle at the sun subtended by the earth-moon line, and this angle is very sensitive to errors in either of the other angles. Aristarchus obtained a value of the ratio of the distances of the moon and sun which was about twenty times too great, thus making the sun very close to the earth—about twenty times the moon's distance. Aristarchus had the courage to suggest publicly that the earth was a planet and revolved round the sun like the other planets—a view for which he was charged with impiety.

THE WHITE BUTTERFLY IN NEW ZEALAND

IN the *New Zealand Journal of Science and Technology* of June 1943, J. Muggeridge, of the Department of Scientific and Industrial Research, gives an account of the introduction of parasites of the small cabbage white butterfly (*Pieris rapæ*) into New Zealand. Two species of parasite are taken into consideration, namely, the Braconid *Apanteles glomeratus* and the Chalcid *Pteromalus puparum*. Following the entry of the same species of white butterfly into North America, the Braconid species just mentioned was introduced from Europe in an effort to obtain a measure of control over the pest in question.

There seems little doubt regarding the soundness of this procedure since the insect is considered to be one of the most important agents destroying the caterpillars in North America to-day. This conclusion naturally suggested the possibility that the *Apanteles* would similarly parasitize, and so destroy, the caterpillars of the butterfly in New Zealand. Acting on these foundations, upwards of half a million cocoons of the *Apanteles* were introduced from England into New Zealand during the years 1931–34. Liberations were made in various localities, but in spite of intensive field surveys the creature appears to be no longer present.

During 1938–39 about six thousand American-bred *Apanteles* were introduced, and all the evidence indicates that these have become successfully established. The behaviour of the European *Apanteles glomeratus* contrasts sharply, therefore, with that of the American-bred form. The *Pteromalus* is a parasite of the pupa of the butterfly. Its larva kills the pupa and the adult Chalcid emerges through a small hole made in or near the region of the wing of the future butterfly. The male Chalcids remain near the pupæ from which they have issued and wait there for the appearance of the females with which they mate. This parasite was sent to New Zealand while still within the pupæ of the butterfly and was first introduced during 1932–33 when about five hundred of these chrysalides were shipped. From out of these hosts more than twelve thousand adult parasites emerged and nearly nine thousand were liberated in the field in 1933. From a field survey made at the latter end of the same season it was found that out of 415 collected butterfly pupæ 58 per cent had become parasitized. The species thus became established with remarkable rapidity and is exercising a useful degree of control. As the author remarks, it has spread rapidly from the points where liberations were originally made, even as far as eighty miles in the first season, and it has had a marked influence in reducing the butterfly population and the damage

caused by the caterpillars. It has been found to be extremely efficient under dry conditions, where the bulk of the Cruciferous crop is grown, but in places with a high rainfall the butterfly seems better able to live than the parasite. It is suggested that this seeming failure might be offset by the introduction of some other larval parasite and one better fitted to withstand the conditions in such areas.

FORTHCOMING EVENTS

Saturday, July 1

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (in the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Conference on "Applied Spectroscopy": (Prof. H. Dingle: Introductory Address; Mr. F. Twyman, F.R.S.: "Spectroscopic Instruments"; Mr. D. M. Smith: "Spectrographic Analysis"; Dr. W. A. Roach: "The Determination of Mineral Deficiencies and Excesses in Plants by Spectrographic Analysis"; Dr. R. W. B. Pearse: "Applications of Molecular Spectra").

Monday, July 3

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Dr. I. Broda: "Prominent Austrian Scientists".

Tuesday, July 4

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2 p.m.—Colonel Prof. A. T. Jurasz: "Former and Post-War Health Problems in Poland" (Lloyd Roberts Lecture).

Friday, July 7

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the INTERNATIONAL AFRICAN INSTITUTE) (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. P. P. Howell: "The Installation of the Shilluk King".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Maurice Black: "Limestone Depositions in the Bahamas".

Thursday, July 6—Sunday, July 9

BRITISH RHEOLOGISTS' CLUB (at St. Hilda's College, Oxford).—Conference.

Friday, July 7

10 a.m.—"Rheology of Large Deformations and Plastic Flow", (a) Plasticity of Metals; (b) Polymers; (c) The Liquid State.

2.15 p.m.—"Relations between Shear, Tension and Compression in Complex Bodies (The pi-problem)".

5 p.m.—"Some Rheological Applications to Medical Science".

Saturday, July 8

10 a.m.—"Rheological Nomenclature and Symbols Metallurgical and Non-Metallurgical".

8.30 p.m.—"Future Organisation of Rheology".

APPOINTMENTS VACANT

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

ASSISTANT MASTER (full-time, graduate preferred) to teach mainly MATHEMATICS and SCIENCE in the Junior Building School of the Accrington Technical School—The Director of Education, Broadway Chambers, Accrington (July 4).

CIVIL ENGINEER as Chief of Construction Department with an Oilfield Company in Peru—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1010XA) (July 5).

ELECTRICAL INSPECTOR OF FACTORIES (temporary) in the North-West of England—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.798A) (July 5).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.902A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.903A), by the Sierra Leone Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 5).

EXECUTIVE ENGINEER by the Sierra Leone Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1011A) (July 5).

SPEECH THERAPIST (full-time, temporary)—The Director of Education, Education Offices, 14 Sir Thomas Street, Liverpool (July 7).

TEACHER OF ENGINEERING SCIENCE AND MATHEMATICS, and a TEACHER OF ELECTRICAL ENGINEERING, SCIENCE AND MATHEMATICS in the Bootle Municipal Technical College—The Director of Education, Town Hall, Bootle (July 7).

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (July 8).

SPEECH THERAPIST to the St. Helens and Wigan Education Committees—The Director of Education, Education Office, St. Helens, Lancs. (July 8).

TEACHER (full-time) IN TEXTILES in the Oldham Municipal Technical College—The Director of Education, Education Offices, Oldham (July 8).

TECHNICAL CHEMIST (Reference No. F.2012XA), and a LABORATORY ASSISTANT (Reference No. F.2503XA), by London Paint Manufacturers—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 8).

LECTURER (full-time) IN PHYSICS—The Principal, Royal Technical College, Salford (July 10).

AGRICULTURAL ENGINEER for the Ceylon Government Department of Agriculture—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2189A) (July 10).

ASSISTANT VETERINARY INVESTIGATION OFFICER at the Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (July 14).

PSYCHIATRIST (part-time, man or woman), an EDUCATIONAL PSYCHOLOGIST (woman), and a PSYCHIATRIC SOCIAL WORKER (woman), in the Child Guidance Service in the North Riding—The Secretary, Education Offices, County Hall, Northallerton (July 15).

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham (July 15).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (July 15).

DEMONSTRATOR (man or woman) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

CHEMISTS (temporary) with considerable experience in analysis of metals—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2628A) (July 25).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

ASSISTANT SECRETARY to the Oxford and Cambridge Schools Examination Board—The Chairman of the Oxford Delegacy, St. Catherine's Building, St. Aldate's, Oxford (July 31).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

MISTRESS TO TEACH BIOLOGY and GENERAL SCIENCE in the Day Technical School for Girls and the Day Technical School for Boys, and a TEACHER OF ENGINEERING SUBJECTS, and a MATHEMATICS MASTER—The Principal, Technical Institute, Gravesend.

LECTURER (full-time) IN ENGINEERING SUBJECTS in the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1.

TECHNICAL ASSISTANT (male or female) for abstracting and preparing bibliographies and summaries of technical articles mainly in Electrical Engineering and Applied Physics—British Electrical and Allied Industries Research Association, 15 Savoy Street, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Colonial Development and Welfare Act, 1940. Return of Schemes made under the Colonial Development and Welfare Act, 1940, by the Secretary of State for the Colonies with the concurrence of the Treasury in the Period from 1st April 1943, to 31st March 1944. (Cmd. 6532.) Pp. 16. (London: H.M. Stationery Office.) 3d. net. [86]

Colonial Research Committee. First Annual Report, 1943-44. (Cmd. 6535.) Pp. 12. (London: H.M. Stationery Office.) 2d. net. [86]

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation submitted to the Twenty-third Annual General Meeting on June 6th, 1944. Pp. 16. (London: Empire Cotton Growing Corporation.) [86]

School Certificate Mathematics. Report of a Conference of Representatives of Examining Bodies and Teachers' Associations, with a suggested Alternative Syllabus and Specimen Papers. Pp. 16. (London: Mathematical Association.) [136]

Other Countries

Sixtieth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1942-1943. Pp. 10. (Washington, D.C.: Government Printing Office.) [16]

Annals of the New York Academy of Sciences. Vol. 45, Art. 6: Experimental Modification and Control of Molts and Changes of Coat-Color in Weasels by Controlled Lighting. By Thomas Hume Bissonet and Earl Elmore Bailey. Pp. 221-260 + 7 plates. (New York: New York Academy of Sciences.) [16]

Proceedings of the United States National Museum. Vol. 94, No. 3175: A Revision of the Embioptera, or Web-Spinners, of the New World. By Edward S. Ross. Pp. 401-504 + plates 18-19. (Washington, D.C.: Government Printing Office.) [16]

Educational Wallsheet No. 3: The Louse. 22½ in. × 17½ in. (Cape Town: The African Bookman.) [16]

Bulletin of the American Museum of Natural History. Vol. 82, Art. 6: Comparative External Morphology, Phylogeny, and a Classification of the Bees (Hymenoptera). By Charles Duncan Michener. Pp. 151-326. (New York: American Museum of Natural History.) [56]

Bulletin of the National Research Council. No. 108: The Problem of Changing Food Habits: Report of the Committee on Food Habits, 1941-1943. Pp. 177. (Washington, D.C.: National Academy of Sciences.) [56]