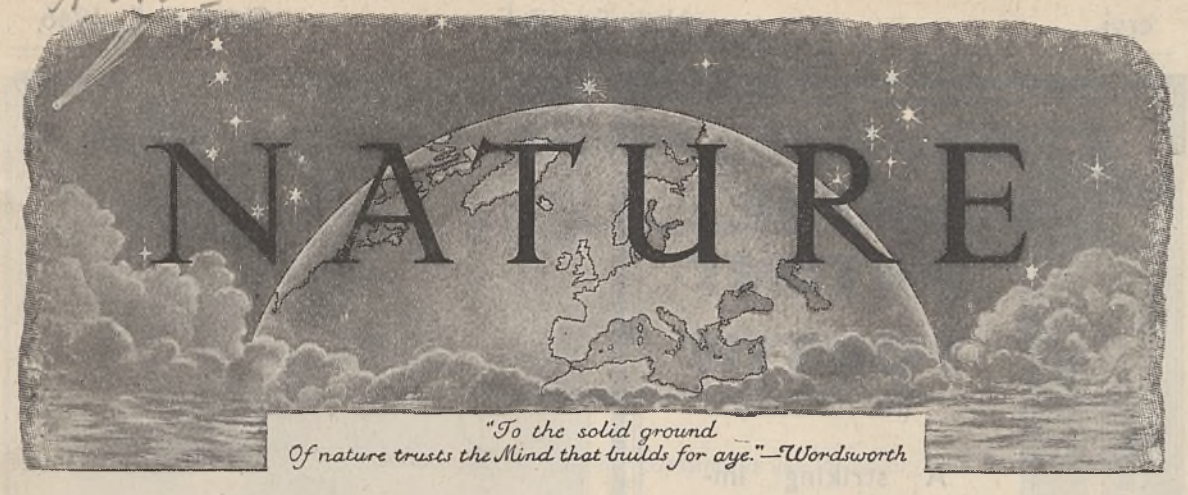

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CONDITIONS OF SURVIVAL: FREEDOM OF THOUGHT AND THE INTERNATIONAL COMMUNITY

THE General Assembly of the International Council of Scientific Unions has formulated clearly the duty of men of science to maintain a spirit of frankness, honesty, integrity and co-operation, and to work for international understanding; to promote the development of science in the way most beneficial to mankind and to exert their influence so far as possible to prevent its misuse; and to serve the community not only by their specialized work but also by assisting so far as they are able in the education of the public in the purposes and achievements of science. To assert that those duties and conditions cannot be realized under communism as we see it in Soviet Russia is not to assert that co-operation is impossible, but rather to clear the way to an understanding which is based on mutual respect. For if it is imperative to maintain uncompromisingly that surrender of national sovereignty is an essential and unescapable condition of the control of atomic energy and avoidance of the evils of atomic, biological or biochemical warfare, it is equally imperative that nothing should be left undone, consistent with that principle, to reassure the U.S.S.R. that they have nothing to fear from the American lead while the super-national authority is being established.

One of the more recent "Looking Forward" pamphlets on reconstruction issued by the Royal Institute of International Affairs helps to clarify thought at this point. Martin Wight concludes his survey of "Power Politics" with a section in which he points out that, though the tradition of an international community with a common standard of obligation and justice has faded, it has not altogether disappeared. It is the main influence that has modified and can yet modify the operations of power politics and can still be discerned in the preamble to the Charter of the United Nations. It must be remembered, too, that morality in international politics is not simply a matter of civilized tradition, but is equally the result of security—a truth that gives us the clue to much of Russia's policy.

Mr. Wight points out that profound as is the common material interest in the planned development of the economics of geographical areas and groups of nations, it does not touch the problem of power. Every Power has an interest greater than welfare, an interest on which it believes that welfare depends and to which welfare must in the last resort be sacrificed—the maintenance of power itself. Nevertheless, the idea of a common moral obligation is probably a more fruitful social doctrine than the idea of a common material interest, and if the greater realism which characterizes the mood of 1946 as against the mood of 1918 means not the abandonment of high ideals but the discarding of foolish expectations and above all of appeasement, the traditions of Europe may not be destined to be put aside.

In this sense the position taken up by men of science generally since the existence of the atomic

bomb was first made known to the world has been consistently realistic. They have never wavered from the position that the advent of atomic energy, apart from any other potential methods of scientific warfare, has made some surrender of national sovereignty the condition of the survival of civilization. They have emphasized, too, that the lines of advance to secure the restoration and reconstruction of much of the cultural life and values of the Western world are exactly those upon which scientific advance itself depends. As Prof. Farrington Daniels has pointed out, the withholding of knowledge handicaps scientific workers even within a single country or field, and, while engendering ill-will, is ineffective except for a brief period. Restoration of full freedom of investigation and of communication, except in a very limited and highly technical field of actual production of weapons of war, is an indispensable condition if creative thought is to be stimulated and the interest and keenness of men of science in the work maintained in the way that will ensure the fullest use of their abilities.

Freedom, in the fullest sense of freedom of exchange of ideas and discussion, the abrogation so far as possible of all controls and restrictions, freedom from pressure, from fear and from want, the provision of the proper atmosphere for intellectual activity is the first and most essential requirement for science, as Dr. L. A. DuBridge pointed out in a speech "Science and National Policy" to the Sigma Xi Society, and without it all is lost. Dr. DuBridge follows this plea for free exchange of scientific information and its corollary that our national programme, and the organisations adopted to execute it, must ensure the maintenance of the freedom of science, with a further plea that science is not a national but an international problem and that science should point the way to world co-operation. He is as emphatic as Prof. Daniels that the fundamental problem is international control and the organisation of the world to prevent war. If the human race is to survive war cannot continue.

The world-wide freedom for the human mind claimed in these addresses involves equally, as Dr. C. E. Merriam has pointed out in an address, "Physics and Politics", to the American Political Science Association on March 29, an analysis of the ways and means of preserving freedom and the consent of the governed in the new age opening before us. The public need of our time is the reconciliation of order with freedom, of planning and personal initiative, and it is exemplified equally in this question of freedom of scientific investigation and communication whether in nuclear energy or in other fields of science, and at the political level in the general relations between Soviet Russia and the United States and Western Europe. At both levels we may have, indeed, to evolve new forms of organisations and even new institutions to serve the needs and purposes of the post-war world.

Deliberate and serious planning through as serious an effort as in war to apply atomic and related energies to peace-time purposes, to increase the gains of civilization while guaranteeing to all men a fair share of these gains, the analysis of the organisation of a world community and a world government and mapping the roads leading thereto—these are projects for systematic study in an era of closer union of physics and politics submitted by Dr. Merriam; and the crisis over the future of Germany, the termination of U.N.R.R.A., and the development of the Food and Agriculture Organisation are sufficient illustration of their soundness. We may not yet know the institutional forms, whether on the national or the international scale, which will best serve our purposes; but in the evolution of these forms we shall need not merely the research activities envisaged by Dr. Merriam but also every bit of help that such institutions as the universities or the religious bodies can give. That help will be required both in the study and thought leading to the evolution of new institutions or the modification of old ones and the education of public opinion as to need for change and the functions and meaning of the new institutions, but even more will be necessary on the spiritual and ethical plane.

The need to draw on the full intellectual, moral and spiritual resources of Western civilization must be remembered above all on the political plane when we approach that problem of the reconciliation of freedom and discipline which lies at the root of the difficulties between Soviet Russia and the United States of America and Great Britain. If order and discipline are regarded by the U.S.S.R. as their primary need and they are disposed in the search for security to sacrifice human personality and freedom, it is right that every effort should be made to reassure them, to eliminate any substantial foundations for fear that the United Nations Organisation or any other international instrument may be directed against them. It is equally imperative that in doing so, in formulating our plans for any international organisation or supernational authority, there should be no surrender of those moral and spiritual values of Western civilization in which the human spirit has found its highest expression and in which alone the conditions of scientific advance and creative achievement are satisfied. The way to understanding and reconciliation of the Western democracies with the U.S.S.R. and with it the solution of the problem of the control of atomic energy will not be found by appeasement, but only when the concepts and the spirit of human rights and human freedom are accepted and cultivated.

No one nation or group of nations can prescribe the methods or even provide the means by which any other nation can realize and maintain its own spiritual ideals; but without co-operation those ideals may be unattainable, and without mutual respect and good faith they can scarcely be maintained. The inadequacy and bankruptcy of brute force and its inability to satisfy even the material needs of mankind is increasingly apparent to-day, and the healing of the nations and the solution of these difficult problems of the control of atomic energy, the relief and rehabilitation of Europe and the Far East, the

raising of standards of health and nutrition, will come nearer as the nations recognize the need for a moral and spiritual basis for the task of reconstruction and co-operation. Some spokesmen of science such as Sir Henry Dale and Prof. Niels Bohr have already rendered great service by their witness to the importance to the preservation of civilization, and with it of scientific effort, of re-establishing the common traditions and ideals of intellectual and spiritual life, including the fullest freedom of intellectual intercourse. They have set an example which statesmen will do well to note, and if the U.S.S.R. or other Powers reject the traditions of civilization and refuse to make the essential surrender of national sovereignty, the way forward does not lie in the surrender by other nations of those traditions and ideals. A better course is to shape national policy and practice upon such ideals and conditions and to build up as far as possible among the nations who share them the organisation and institutions which will serve their common purposes. So far from being directed against those who remain outside, such action will ultimately win the confidence and co-operation of those nations by the way in which such institutions minister to the needs of mankind, encourage the development and equitable distribution of resources and eliminate those disparities which have so often been the root cause of misunderstanding, ill-will and open conflict. If even Britain and the United States, for example, joined with other Powers holding similar ideals, put into practice the safeguards and inspection system recommended by the Lilienthal Commission and demonstrated the feasibility of the sacrifice of national sovereignty therein involved, something well worth while might be achieved which might prove a stepping-stone to a true super-national authority. But any such experiment demands the real and sustained interest of ordinary men and women who fully apprehend the nature of the moral and spiritual struggle involved, not simply for their own physical survival or material comfort but also for the preservation of the great intellectual, cultural and spiritual heritage of civilization.

THE EXPLANTED CELL

Biology of Tissue Cells

Essays. By Albert Fischer. Pp. ix+348+21 plates. (Copenhagen: Gyldendalske Boghandel, Nordisk Forlag; Cambridge: At the University Press; New York: G. E. Stechert and Co., 1946.) 31*s.* 6*d.* net.

TISSUE culture, it has been said, is a technique that has had a brilliant future. The criticism thus implied is one which Dr. Fischer refers to several times in his new volume of essays, and he does his utmost to refute it. But the result of the following imaginary experiment with biological history will make it clear that there is some good ground for our disappointment. Suppose that tissue cultivation had not proved workable, or that every record of its prosecution were to be wholly expunged from the literature. Would biology be so very much the worse off? It is difficult to say 'yes', at least if we exclude from formal tissue culture the embryologist's use of explantation methods to study the organised growth of large tissue fragments over relatively short periods.

The great theoretical achievements of tissue culture were mostly the work of its first ten or fifteen years. Tissue culture made it possible to prove that the cell-lineages of the ordinary somatic cells of the body are indefinite or indeterminate; to put it in the usual loose way, that somatic cells are potentially 'immortal'. More recently it has been shown that the cell types of explanted tissues are cytogenetically fixed: they breed true to histological type, and their de-differentiation is superficial and, under the appropriate conditions, reversible. Again, tissue culture has proved a theorem of real importance for the theory of development, namely, that the rate of growth and state of differentiation of cells vary inversely with one another. No experiments have made this clearer than Fischer's own. Third, it has given evidence of the universal and spectacular *mobility* of cells. Fischer says that biologists have been slow to appreciate the significance of this mobility, which he associates with Vogt's famous demonstration of the movements of cellular sheets in the process of gastrulation. Fischer himself believes that the cells of the intact organism are sessile, and remain so until a commodity which he calls 'life space' is made available to them *in vitro*. Some modern histologists, however, are prepared to believe that the majority of cells and cell processes in the organism are mobile, and that they undergo a sort of slow jostling movement in which the 'life-space' made available to any one moving cell may be that left vacant by another.

A modern view of tissue culture is that it is a technique of distinct but subordinate value which is capable of giving decisive and formally beautiful answers to problems of a rather narrow range. (One calls to mind, for example, the elegant demonstration by Landsteiner and Parker that rabbit cells continue to manufacture compounds serologically specific to the rabbit even after weeks of cultivation in media taken from the hen; and there are equally good examples from the more recent literature.) But only a small proportion of tissue culture work has been of this type. Much of it is cultivation for its own sweet sake, for as Fischer says, the beauty of cultivated tissues has beguiled many research workers into work of the narrowest general significance—to be likened, perhaps, to that of histologists who are for ever inventing new multi-coloured stains. Perhaps (is this heresy?) the formal insistence on the use of 'permanent strains' has something to do with the failure of tissue culture to pull its weight. There are radical and important differences between cultures freshly explanted from embryos of different ages; but as cultivation proceeds, the cells either come to acquire a dull uniformity of behaviour, or a diversity which bears no relationship to the age of the embryo from which they came. Meanwhile, their metabolism changes profoundly. Cultivated cells seem to bear the same relationship to their counterparts *in vivo* as does monastic life to the hurly-burly of everyday affairs—and not merely because monks, like cultures, live in cells.

Another misfortune of tissue culture is that the demand it makes on the practitioner's time and work is very often out of proportion to the value of the results to be achieved. One of Fischer's anecdotes tells how for years he renounced a holiday, in order to maintain and propagate his cultivated strains.

Tissue culture is evidently a jealous mistress : Is it very unkind to suggest she is now a little past her prime ?

Fischer's book does not claim to be a treatise, and it has not the fullness of documentation of a review. It is to be regarded as a series of essays by one of the great masters of tissue-culture technique on the problems most relevant to general biology. Fischer describes the sigmoid growth-curve of the culture, its limiting size, shape-regulation, and power of true reconstitutive regeneration. In these respects it reproduces the properties of the intact organism in miniature and accessible form, for a culture is indeed an organism, and no mere assemblage of individual cells. All biologists should read Chapters 3, 4, 6, 7 and 8, in which the relevance of tissue culture to general biology is made admirably clear. The later chapters are of more technical interest : one gives 'stop-press news' about the nature of 'embryo extract'. The translation, by a Danish colleague, is grammatical but not always idiomatic.

P. B. MEDAWAR

RURAL LIFE IN JAPAN

A Japanese Village : Suye Mura

By John F. Embree. (International Library of Sociology and Social Reconstruction.) Pp. xx+268+32 plates. (London : Kegan Paul and Co., Ltd., 1946.) 18*s*. net.

SOCIAL anthropology seems at present to be entering a state of transition from the study of purely primitive societies to that of the extremely complex societies which make up the civilized world. The technique developed in the study of primitives will clearly need modification if it is to serve the study of civilized communities.

Dr. Embree's "Japanese Village" is an excellent example of the way in which social anthropology is developing to-day. The author has selected a village to suit his purpose, a village that is small enough for him to deal with the whole population, ordinary enough not to differ in any striking particular from the general run of villages, a rice-growing village neither very rich nor very poor. This he has studied in detail. After briefly sketching in the general historical background, the author describes in the three succeeding chapters the organisation and population of the village as a co-operative agricultural unit ; the individual household with its relationships, its daily life and its festivities ; the various forms of co-operative activity undertaken by the village in routine, such as road-making, bridge-building or house-building, in emergency, in co-operative credit societies, or on the more social occasions of festivals and gift exchanges. These chapters are followed by three more dealing with social classes and associations, social sanctions and avoidances, with the life-history of the individual, and with religion and superstition, including a calendar of monthly observances. The last chapter deals with observable change at present taking place. Appendixes are added on the economic basis of village life, and on household expenses, and specimens of talks and lectures given at village meetings are included. There are a bibliography and index and sixteen pages of good photographs, while the text contains the necessary figures and maps.

It will be seen that the life of an inhabitant of Suye Mura is described in most of its aspects ; but particular emphasis is laid on the interaction between the individual components of society and their place in the structure of the social and territorial groups. Much of the material dealt with is more complicated than most rural communities might be expected to show, an instance being that of the *kō* or co-operative credit clubs which combine the function of a co-operative credit bank with that of a lottery. This is no more a feature of a primitive society than Japanese painting or ceramics, and the description of this village community throws a fresh light on Japanese culture. A contrast to it is to be found in the religious observances of the village, the most important part of which seems to consist in a series of ritual observances closely bound up with the phases of the moon, and likewise in the seasonal occupations of the life of an agricultural village.

The author's general method of approach, which is in the most modern style of social anthropology, recalls a remark of Disraeli's somewhere to the effect that ultimately "it is private life that governs the world".

J. H. HUTTON

GAME ANIMALS OF BRITAIN

British Game

By Brian Vesey-Fitzgerald. (The New Naturalist Series.) Pp. xv+240+72 plates. (London and Glasgow : Wm. Collins, Sons and Co., Ltd., 1946.) 16*s*. net.

IN this latest volume of the "New Naturalist" series, Mr. Vesey-Fitzgerald sets forth to tell the general reader about the mammals and birds of the British Isles that are commonly called 'game'. The book is produced in the same handsome style as its predecessors and is illustrated by a number of excellent photographs, also by colour reproductions of old sporting prints, etc. The author's remarks on the history of game preservation in Britain are interesting. First he points out the probability that the Romans reared pheasants in England ; but he also tells us that he cannot find any reference to a gamekeeper earlier than 1814, little more than one hundred and thirty years ago. As a fact, game preservation in the sense of the protection of pheasants, partridges and grouse for sporting purposes is a comparatively recent development in the life of the well-to-do countryman. Game preservation as regards the King's deer and so on was, on the contrary, much to the fore in the Middle Ages, when game laws and penalties were stringent. Game in some sense or other has long been an important factor in the country life of the British Isles.

The author is not content to deal merely with the game birds, those mentioned above and the capercaille, black grouse, ptarmigan, red-legged partridge and quail, but writes entertainingly of wildfowl, that is, swans, geese and ducks, of the waders, including woodcock and snipe. Part 4 deals with "ground game and various", and part 5 with our three species of deer, while part 6 is devoted to the preservation of game. Among the illustrations to the ground game section is a photograph by Mr. G. B. Keary of a mountain hare in its form in the snow, which is a really remarkable snapshot.

It is somewhat ironical that an animal which provides perhaps more sport than any other British creature, namely, the fox, is always classed as vermin,

and therefore in this book is only mentioned in that category, apropos of which the reviewer was surprised to find a remark about foxes killing weakly sheep. That hill foxes commonly take the small lambs of mountain sheep is well known, as it is that the lowland foxes will very occasionally lift a weakly or dead lamb ; but that foxes often tackle sheep, even weakly ones, is definitely another matter. The reviewer, with more than forty years experience of the deeds and misdeeds of foxes, has never come across a case.

The chapter on the enemies of game, which treats of the birds and mammals that are adversaries, also many that are quite harmless, such as the barn owl, contains much that is useful ; but the chapter devoted to the preservation of game is the one that provides most food for thought. Its remarks on the changed and changing balance of Nature, on the effect of shooting, plus game preservation, on British wild life, together with comments on the 'bird crank', the collector, the scientific ornithologist, etc., and the controversies that have arisen between them, are well worth reading and much to be commended, as are the author's liberal views on the preservation of the rarer predators. F. Pitt

ELECTRIC POWER SYSTEM CONTROL

Electric Power System Control

By H. P. Young. (Monographs on Electrical Engineering, Vol. 11.) Second edition, revised and enlarged. Pp. xii+369. (London : Chapman and Hall, Ltd., 1946.) 25*s*. net.

A HOUSEHOLD electricity supply installation exemplifies in the simplest form and on a small scale the power systems, the control of which is described in the book under review. In the case of the household model in Britain there is usually only one source of supply. Its capacity is of the order of 5 kilowatts at 230 volts. It is subdivided at a distribution box from which circuits of about 1 kW. capacity radiate to the different parts of the premises and supply lights, radiators, cookers, power plugs and the like. Each circuit is controlled by a simple hand-operated switch, and provision in the form of fuses is made for automatically disconnecting circuits which become faulty. All apparatus and wiring is well protected against mechanical damage so that faults are infrequent.

In the power systems which supply domestic and industrial consumers, the distribution is at 400/230 volts and each distribution circuit is of about 200 kW. Supplying the distribution system, there is a network of higher voltage cables working at, say, 11,000 volts, each capable of carrying about 4,000 kW. The 11,000 volt systems are in turn supplied by 33,000 volt or 66,000 volt systems, with proportionally higher power-carrying capacities.

All these systems are interconnected by the Grid, which operates at 132,000 volts and which has standard circuits of 90,000 kW. capacity.

The Grid and the correlated systems already mentioned are subjected to hazards from lightning, aircraft, accidents and tempests. It is not economically practicable to preclude the occurrence of faults arising from such causes, so that efficient means for disconnecting faulty sections must be provided. The circuit-breakers and associated relaying systems for the Grid must disconnect almost instantly faults which may reach magnitudes of the order of 2,000,000 kW. During the War, faults of maximum severity occurred very frequently, and the almost perfect continuity of electricity supply during that abnormal period provided final evidence of the value of an interconnected power system to Britain.

In peace, the main objects of power systems are to secure maximum overall economy of production and the best practicable degree of continuity of supply.

It is now well known that the Grid has made an important contribution to the national welfare by reducing the average fuel consumption per kilowatt hour generated by some 15 per cent compared with pre-Grid generation by smaller power systems working independently.

An extremely satisfactory standard of reliability of service has likewise been attained.

The book under review draws largely from Grid practice. It provides technical information regarding the equipment which is used to control individual components in generating stations and interconnected working of power systems. It also provides a clear picture of the underlying principles of parallel operation.

Circuit-breakers, which are probably the most important component in the control of a power system, are admirably dealt with, and the latest forms of oil and air-blast types are adequately described.

Apparatus and methods for control and regulation of voltage, frequency and power flow also receive sufficient attention to satisfy the needs of users of electrical power plant. All of the foregoing components have been evolving for almost fifty years, and they are approaching stability of form and principle. There are, however, items of control equipment which have only been brought into being since the Grid was started in 1927. These are instruments and relays for indicating in a central control room electrical measurements such as power flows. These remote indications, as they are termed in electricity supply circles, are transmitted over telecommunication channels or actual power lines by high-frequency carrier currents. The same principles as are used for indications can be applied to remote control of plant and equipment, and the present trend is towards such control.

Mr. Young gives a good exposition of remote control and indication as at present used on the Grid system. It is probable that there will be great and even revolutionary developments in this branch of power system control, when the possibilities of apparatus used for war purposes become more widely appreciated.

A comprehensive bibliography is provided which will help those desirous of exploring the subject more completely. The diagrams and illustrations, although rather lacking in character, are adequate for their purpose.

The first edition of the book appeared in 1942 and the second in 1946. As only a few thousand people are intimately interested in power system control, this constitutes an excellent testimony to the value of Mr. Young's book. The reviewer considers that the book is an excellent basic treatise on a subject of growing importance, and hopes that further editions will appear as and when technical developments justify them. C. W. Marshall.

ROCKET DEVELOPMENT

By Dr. W. H. WHEELER
Deputy Director of Guided Projectiles, Ministry of Supply

Scope of Rocket Development

ROCKETS were developed and produced on a considerable scale as weapons and thrust units by all four major contestants in the Second World War. There has been since 1940, as there still is, official interchange of information between the Americans and ourselves, and a good deal is known about German developments. Comparatively little has been published by the Russians, but they are familiar with the German work and it may be assumed that they are active in the rocket field.

Pre-war developments. It is as well to admit that in rocket technique the Germans were considerably ahead of all competitors. The reason is simple; namely, they started soonest and applied most effort. So early as 1933 the rocket experimental station in Berlin was a well-established concern, developing a rocket stabilized by one large gyro in the nose; and in 1934, the gyro having now been shifted to the centre, the rocket was successfully launched on a flight of 2,000 metres. By 1938, a projectile similar in shape to the V.2 and about 25 ft. long, with automatic steering and rudders in the gas stream, was launched vertically in the manner eventually adopted for V.2. This projectile had a range of some 18 km.

As a measure of German official interest, the experimental station at Peenemünde, constructed in 1937 and 1938, cost (according to the Germans) 300,000,000 Reichmarks; and it has been stated that a prototype V.2 was the first rocket to be tested at Peenemünde, which indicates the advanced stage reached at this time.

It is of interest to note that so early as 1935, the factory equipment firm of Wilhelm Schmidding of Köln-Niehl had been in touch with Dr. von Braun at Peenemünde and devoted a section of its research department to the development of assisted take-off units and rocket propulsion units. Schmidding's firm was a typical non-armament organisation; no doubt the German armament manufacturers were already considerably implicated.

The scope of contemporary British development may be assessed from the fact that until early 1939, when the 3-in. rocket trials took place in Jamaica, no occasion had arisen justifying a large-scale ballistic trial of any British rocket. In the United States still less official interest was shown in modern rocket development until 1940, when Sir Henry Tizard took there full details of British progress and plans. This in spite of the fact that Goddard and Hickman, at the Smithsonian Institution and elsewhere, had made and fired a number of solid fuel rockets for the U.S. Army about 1919, and later forestalled, in principle at any rate, much of the technique embodied in the German V.2.

War developments. In Germany, during the War, many of the best-known armament and engineering firms were heavily involved in rocket development, and Peenemünde retained direct control of only the liquid-oxygen types. Dr. H. Walter, director of the Walterwerke at Kiel, was given responsibility for the development of hydrogen peroxide motors. Drs. Pietzsch and Adolph at the Elektro-Chemische Werke at Munich, and later at Bad Lauterberg, developed processes and laid down exceedingly large-scale plant for manufacture of concentrated hydrogen peroxide. The Bayerische Motoren-Werke were responsible for the development of nitric acid rocket motor units. Krupps, Rheinmetal Borsig, Dynamit A.G. and many other concerns developed solid fuel rockets, including a multi-stage rocket by Rheinmetal Borsig with an anticipated range of 100 miles; and the Schmidding concern was involved in the development of rocket motors using methyl nitrate and methyl alcohol ('Myrol') as propellant.

In the United States also, particularly towards the end of the War and afterwards, comprehensive development contracts were placed with industrial undertakings (many of which are still current) aimed at the development of long-range and anti-aircraft guided rockets.

In Great Britain the majority of rocket development has been carried on by the Government, started in 1936 and controlled since then by Sir Alwyn Crow in the Ministry of Supply. Some academic and industrial institutions have collaborated, it is true, notably R. P. Fraser at the Imperial College of Science and Technology and I. Lubbock at the Asiatic Petroleum Company, but the total number of extramural research workers regularly employed has scarcely ever exceeded twenty. In all cases, moreover, these collaborators have tackled self-contained sections of the work. One result is that only a few people in Great Britain are familiar with all aspects of rocket work, while others are aware only of specific applications upon which, for one reason or another, they have been enlightened. In this there seems a danger that both the essential virtues and the inherent deficiencies of rocket motors may be imperfectly discerned by the scientific and engineering community as a whole, and British rocket technique may never receive the impetus which derives from informed, widespread discussion and thought.

Technical Progress

It is impossible to overlook the importance of the German V.2 as a landmark in rocket development. So late as 1944 there was a very strong body of technical opinion in Britain, and in the United States, convinced that rockets with ranges of the order of 100–200 miles were impracticable. It was admitted that these ranges might be attained by the employment of multi-stage rockets; but the added complexity introduced by the staging was held to preclude the employment of such rockets as practical weapons. The missile which landed in Sweden on June 13, 1944, provided the first irrefutable evidence that long-range rockets existed, and V.2 rocket components recovered from German trials near Blizna in Poland a few months after this date (and very shortly afterwards in Great Britain!) furnished details establishing the single-stage nature of the rocket. Following, as it did, immediately after an unsatisfying period of somewhat hazardous conjecture, the rapidly accumulated mass of technical detail concerning a real long-range rocket served to fix and crystallize technical thought. Where previously every argument had been diffuse and unconvincing, due to lack of experimental support, it now became possible to catalogue the essential practical requirements in long-range rockets and define present and future possibilities with some conviction. Most important of all there was tangible evidence, for all to see, of progress

already made, and indicative of the potentialities latent in rocket technique.

But this phase introduced a danger, aggravated by restricted knowledge, that the virtues and potentialities of more conventional rocket weapons might be forgotten; and there is still real need for the exercise of an informed analytical approach in assessing the weight and disposition of technical effort to be directed into the various channels of rocket research and development.

In spite of its great complexity in detail, even the V.2 is simple enough in conception, and it would be a tenable conclusion, after consideration of present-day rocket technique, that no revolutionary or fundamental discoveries have been made during the last ten years. It can be argued that the rocket, externally a simple example of the principle of conservation of linear momentum, and internally an embodiment of the principle of conservation of energy, offers comparatively little scope for fundamental discovery. Support is claimed for this argument in the fact that advances during recent years have been made rather in the better understanding of functional details and the application of improved materials in more effective compromise, than in rocket fundamentals.

Two different views are expressed, arising out of these considerations: one, that the time has come to place the development of rockets in the hands of engineers, the function of scientific research being to furnish, on demand, data ancillary to design; the other, that for several years the development of improved rockets must await the fruit of scientific research programmes designed to replenish the worked-out store of basic knowledge upon which the engineers must draw. The weakness of these views lies in the tacit acceptance, in both, that scientific research and engineering design applied to rockets must be treated as separate arts. To a greater extent, possibly, than any other development at the present time, rockets depend on the concerted efforts of men of science, designers and production engineers. Their closest possible integration, much more than a clear differentiation between the responsibilities of the various professional groups, should be the starting assumption.

This is the lesson to be learned from our own experience since 1939 when projectile development was constituted a self-contained establishment; from the German system, employing self-contained teams in industry; and from the Americans, who have followed suit and announced their rejection of the proposal to separate propellant research from complete motor development. Indeed, the American Service staffs have, in several instances, placed requirements *as a whole* with firms and academic institutions. Examples are Johns Hopkins University; California Institute of Technology; Sperry Gyroscope Co.; General Electric Co.; Aerojet Corporation.

Rocket Characteristics

General considerations. The outstanding common characteristic of rocket motors*, whether for projectiles or power units, is the development of thrust for a limited time with minimum mechanical complexity and weight. According to the thrust required and its purpose, and the period of its application, the emphasis shifts between constructional simplicity and minimum weight, qualified by reliability and suitability for production and service. The broad considerations, therefore, which eventually govern the choice of a rocket motor system are as follows: (i) thrust; (ii) duration; (iii) weight; (iv) shape; (v) complexity; (vi) reliability; (vii) suitability for production.

In rocket projectiles, but not in thrust units, ballistic accuracy is often an overriding consideration.

Rocket velocity. In a non-resisting medium, and disregarding for the moment the gravity component, the velocity attained by a rocket at the end of burning is governed by (*a*) the proportionate weight of propellant in the rocket, and (*b*) the efflux velocity of the propellant gases. The relationship can be written:

$$V_r = V_g \log_e \frac{W + w}{w} = V_g \log_e \left(1 + \frac{W}{w}\right),$$

where the suffixes r and g denote 'rocket' and 'gas' velocities respectively, and W and w are the propellant weight and empty weight respectively of the rocket.

It is often convenient to have an approximate ready reckoner for rocket velocities, and by taking the first two terms of the expansion for $\log (1 + x)$ and taking 6,000 ft. per sec. as a good working value of V_g we get:

$$V_r = 6{,}000 \frac{W}{w + W/2}$$

as an approximate but useful formula for all-burnt velocity in rockets where the time of burning is not too long.

Performance index. Reference is frequently made to 'performance index' in rocket motors. It is the same thing as 'specific thrust'—pounds thrust per pound of propellant burned per second—and is directly related to efflux velocity by the momentum equation, so that

$$\text{Performance index } (I) = \frac{V_g}{g}.$$

Proportionate weight of propellant. It has also become customary in many quarters to use the ratio of propellant weight to total weight of a rocket as a criterion, and the ratio is generally written as α,

$$\text{that is, } \alpha = \frac{W}{w + W}.$$

Using these terms, the 'all-burnt' velocity of a rocket *in vacuo* becomes

$$V_r = I\, g \log_e \left(\frac{1}{1 - \alpha}\right),$$

and the vacuum range at 45° becomes

$$R = \frac{V_r^2}{g} = g \left[\log_e \left(\frac{1}{1 - \alpha}\right)\right]^2 I^2.$$

Fig. 1 shows how maximum range varies with I and α, and it is useful in showing the relative effectiveness of improvement in I and α in arriving at increased range for rockets with comparable ballistic coefficient.

One of the most important characteristics of the German V.2 rocket was the high value of α achieved. For an all-up weight of 12½ tons, the rocket carried some eight tons of propellant, representing an overall value of α of 0·64, which is significantly higher than had been believed practicable in preliminary calculations made in Britain. By this means the Germans were able to content themselves with a reasonably low performance index, thereby reducing the problem of sustaining the combustion chamber against excessive heat and pressure.

* 'Rocket motor' is the name adopted to denote the rocket-thrust assembly without warhead or luggage.

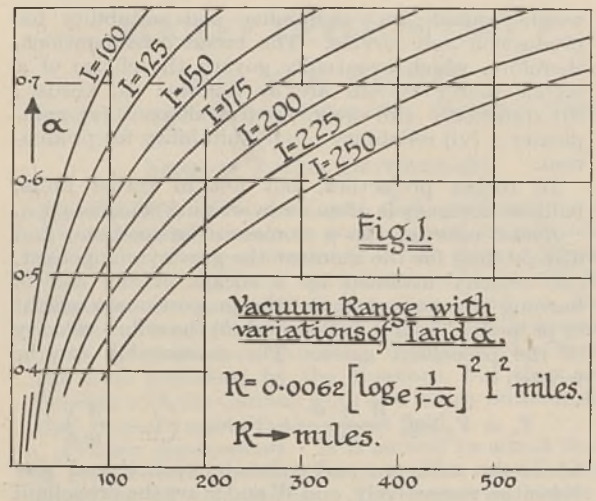


Fig. 1.

Vacuum Range with variations of I and α.

Internal Ballistics

Broadly speaking, the difficulties of achieving high performance in rocket motors are the same for projectiles as for thrust units; the aim is always to reduce to a minimum the weight of metal components comprising fuel containers, nozzle, combustion chamber and ancillary gear, and to secure at the same time the maximum gas velocity. In projectiles, accuracy of flight imposes special difficulties. Unfortunately, high efflux velocity of propellant gases is almost synonymous with high combustion temperature and pressure, both of which tend to require heavy metal components; and in all cases, therefore, it is necessary to seek a compromise which must satisfy the broad practical considerations listed above.

Under ideal conditions where heat and friction losses are neglected, gases are assumed perfect, and all expansion is adiabatic, the equation for the jet velocity can be derived by integrating the following equation from the pressure and temperature in the combustion chamber to the pressure at the nozzle exit:

$$-v\,dp = \frac{V\,dV}{g},$$

where v is volume, p is pressure, V is gas velocity, and g is acceleration due to gravity.

The result can be expressed in the form

$$\text{Efflux velocity, } V_e = \sqrt{2gRT_c\left(\frac{\gamma}{\gamma-1}\right)\left(1-\frac{T_e}{T_c}\right)}$$

or, performance index,

$$I = k\sqrt{\frac{T_c}{M}}\left\{\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{p_e}{p_c}\right)^{\frac{\gamma-1}{\gamma}}\right]\right\}^{\frac{1}{2}},$$

where the suffixes e and c refer to exit and chamber conditions respectively, M is the molecular weight of the gases, R is the gas constant and γ is the ratio of specific heats.

This relation shows that the performance index increases with the expansion ratio p_c/p_e; that is, with an increasing chamber pressure and decreasing exit pressure; and also with increasing combustion temperature and decreasing molecular weight. However, Fig. 2 shows that increasing chamber pressure produces only a diminishing return in performance index, and in practice it is seldom profitable, on performance grounds, to employ pressures much above 500 lb. per sq. in. Higher pressures are sometimes used to procure faster or more stable burning of propellants.

For the usual rocket motor combustion chamber and nozzle design, and the usual fuel systems, the term involving the expansion ratio and the ratio of the specific heats can be taken as roughly constant at about 0·5. The influential factor, therefore, in determining the performance index is T_c/M, and it is noteworthy that the maximum value of I does not necessarily occur at the maximum value of T_c. With systems employed at the present time the molecular weight of the exhaust gases for most fuels is between 20 and 25, except in systems containing large quantities of hydrogen of which part remains unburnt in the jet gases. On the face of it, there is scope for improvement in I by reduction in M, but this improvement is not realizable unless means can be found for increasing the hydrogen content in practical rocket motor fuels.

It is of great practical interest to observe the variations in T_c and in T_c/M as the proportion of combustible to oxidant is varied in a rocket motor system. If T_c is plotted against the percentage of combustible, it rises steadily to a maximum at the stoichiometric mixture and then falls again quite steeply (Fig. 3).

On the other hand, M will usually be falling steadily over the whole range and consequently the curve for T_c/M will have the form indicated in Fig. 4. It is immediately evident that if it is necessary to reduce the combustion temperature (*c.* 3,500° C. for a stoichiometric ethyl alcohol/oxygen mixture) to safeguard the combustion chamber, performance will be impaired much less by dilution on the fuel-rich side than on the oxygen-rich side of the stoichiometric mixture.

Some Constructional Problems

Solid-fuel motors. Turning now to the factors governing the ratio of propellant weight to total rocket weight, it is apparent from Fig. 1 that, theoretically at any rate and actually in practice also, there is much to be gained in ballistic performance if the propellant weight/total weight ratio, α, can be significantly increased. The problems here are mainly those of materials and design. Up to the present time, all solid fuel rocket weapons which have seen Service use have employed steel as the main material

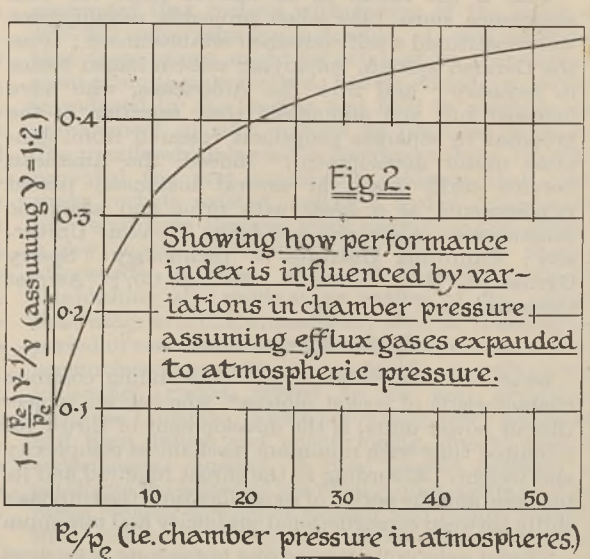


Fig. 2.

Showing how performance index is influenced by variations in chamber pressure, assuming efflux gases expanded to atmospheric pressure.

Fig 3.

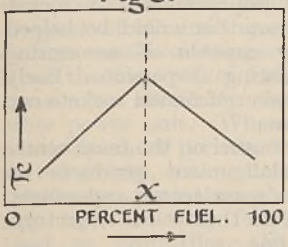
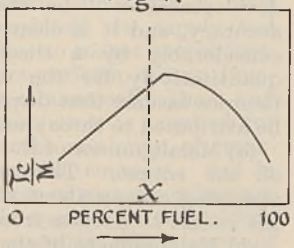


Fig 4.



of construction. The virtues of light alloys and plastics have long been recognized, and sporadic attempts have been made to utilize them; but the exigencies of the War prevented until recently any determined attack on the special problems associated with the use of these materials in rocket motors. The adoption of multi-stage rocket designs is another approach to the problem, and it is obviously possible to combine both techniques. But there are many incidental difficulties, particularly those arising from the broad practical considerations listed earlier.

When development of cordite rockets started in Great Britain, it was anticipated that the thin-walled steel tube containing the propellant would not survive the burning period of 1½–2 sec. if cordite gases (at some 2,500° C.) were allowed in contact with the bare tube. The charge design adopted, therefore, was one in which burning took place only on the inner surface, which was star-shaped so that as burning progressed and the star section deteriorated into a circle an approximately constant burning surface was retained. The outer surface of the charge was protected by a thin layer of plastic material intended to prevent any burning on the outer surface. In this way the propellant itself was used as thermal insulation, protecting the thin steel tube. Unfortunately, the plastic material developed for the purpose proved unsuitable in certain respects and the design was abandoned. It was replaced by a simple tubular charge design in which no attempt was made to restrict the burning surface; constancy being secured by the fact that the outer surface decreased as the inner surface increased. Surprisingly, as it seemed at the time, the steel survived the burning period. Heating was minimized just sufficiently for practical purposes by reducing the outer diameter of the charge somewhat, and providing a thin layer of refractory material on the inner surface of the tube, or by using a thicker steel tube. Although the ultimate temperature attained by the steel was often as high as 700° C., at which temperature the tensile strength was too low to withstand the burning pressure, the tubes survived because heat conduction through the walls was slower than the rate of heat input. Thus, at the instant when burning ceased and the internal pressure disappeared, a relatively cool and therefore strong outer skin of steel still existed. Only several seconds later was the mean temperature attained throughout.

While this arrangement served a good purpose during the War in avoiding the development of technique for controlling surface-burning of the cordite, it could not be employed in rockets with light-alloy tubes where the strength has practically disappeared at 400° C. One of the present problems, therefore, in the reduction of empty weight, is to perfect means for burning the propellant on its inner surface only. The problem may be tackled in two ways: by the application of suitable non-combustible material on the outside of solid or tubular charges; or by pressing or casting the propellant into the tube so that it adheres sufficiently to prevent burning on the interface. For the latter system cordite is unsuitable, and mouldable, putty-like or thermoplastic propellants are envisaged.

Rocket motors will undoubtedly appear in the fairly near future in which light-alloy tubes and coated or plastic charges are employed. It is a reasonable assumption that solid-fuel rockets utilizing this technique will attain a charge/weight ratio (for the motor, exclusive of payload) of 0·6 or even higher, compared with 0·4 as the best figure attained with existing designs. This represents a velocity increase of more than 50 per cent for a rocket with 25 per cent pay-load, and an increase in maximum range of more than 100 per cent.

It may be appropriate here to insert an example of the advantage obtainable by using multi-stage rockets. The object is to reduce the wastage of propellant energy absorbed in accelerating the dead weight of fuel containers, which perform no useful function at the target end.

Ideally, the emptied portions of fuel containers would be discarded as fast as the fuel was consumed, but this is obviously not practicable. Instead of this, discrete units are discarded immediately they have completed their function. In practice, owing to the reduction in benefit for each additional stage and the increasing structural complication, the number of stages which can be employed is small.

A single-stage rocket of 100 lb. all-up weight, with a pay-load of 25 lb. and a motor containing 40 per cent by weight of propellant, would achieve an 'all-burnt' velocity of about 2,100 ft. per sec. For the same all-up weight and pay-load, a rocket comprising a first-stage motor of 50 lb. and a second-stage motor of 25 lb. would achieve an 'all-burnt' velocity of 2,650 ft. per second. The first motor, discarded on completion of burning, would produce a velocity of 1,300–1,350 ft. per sec.; the second motor would increase the velocity by the same amount.

Liquid-fuel motors. A method of improving the ratio of propellant weight to total weight which is particularly applicable to liquid-fuel rockets is to extend the time of burning. The main items of weight in the rocket motor are the combustion chamber and nozzle, the fuel expulsion gear, the fuel tanks and structure supporting them, and the fuel itself. If the time of burning is increased while the thrust remains constant, the fuel must be increased accordingly and the tanks and supporting structure with it, but the other main items of weight will remain sensibly constant. It is clear, therefore, that by this means the ratio of propellant weight to total weight (α) will steadily increase, although at a declining rate as the period of burning is extended.

There is, however, a limit to the time of burning in projectiles above which overall performance declines. This will be clear on general grounds from consideration of a rocket in which the weight of fuel is increased to the point where the projectile weight is greater than the thrust. Assuming vertical launch, in such a case, burning would proceed uselessly until sufficient fuel had been consumed to reduce the weight to a figure lower than the thrust. The useful limit for projectiles is actually reached at a point much lower than this, and it is unlikely to be profitable to increase the rocket weight much beyond half the thrust.

With the relatively short times of burning commonly employed in rocket motors used for projectiles, the

survival of metal components is attributable largely to their heat capacity. By the use of massive nozzles it is possible to extend the period before failure, and for small thrusts of the order of 50–100 lb. this is generally satisfactory. But as the size of nozzle increases the practicable burning period diminishes, and for larger venturis liquid-cooling of the walls becomes imperative if a high performance index is desired. It is not practicable as yet to use liquid oxygen as coolant, and there are obvious risks with self-contained propellants of the 'Myrol' type where combustible and oxidant are already in close molecular association, but ethyl alcohol, nitric acid and hydrogen peroxide have been used successfully. In all cases where liquid cooling is employed, venturi construction is necessarily more complicated.

Accuracy

It is generally accepted that uncontrolled rockets are relatively inaccurate as weapons. Up to the present time this is, indeed, generally true ; but it is wrong to conclude that rockets are necessarily and inherently grossly inaccurate weapons. The position is that the factors governing the ballistic accuracy of rockets are by no means fully understood. None the less, where accuracy is of such outstanding importance that other conflicting requirements, mainly relating to performance, can be sacrificed, a good standard of accuracy can already be attained. It is quite reasonable to assume that this standard will gradually be extended to unguided rockets of high performance.

At the present time an angular dispersion of less than 0·4° (linear mean deviation) for a rocket of high performance, fired from a stationary projector of convenient length, would be commendable. For rockets launched from aircraft the intrinsic rocket dispersion is at present about half this figure, but in this case the situation is complicated by difficulties of sighting associated with curvature of the rocket trajectory, and by sensitiveness to flight direction relative to the aircraft.

Rockets designed for special purposes have attained dispersion figures of less than 0·1° mean deviation, and while this is still about five times greater than the corresponding figure for line (as distinct from range) dispersion with guns, it could reasonably be taken as the criterion of accuracy for high-performance rockets of the future. However, this very substantial improvement will not easily be obtained with rockets of the highest capabilities, the essential lightness of construction of which is prejudicial to rigidity.

As a point of general interest, tables are included to indicate 50 per cent zones for hypothetical rockets with the improved accuracy assumed above.

TABLE 1

Total weight (lb.)	Pay-load (lb.)	Maximum range (yd.)	Linear 50 per cent zones at maximum range	
			Line (yd.)	Range (yd.)
60	30	17,000	80	170
160	75	24,000	120	240
300	100	40,000	190	380

TABLE 2

Total weight (lb.)	Pay-load (lb.)	Maximum velocity (ft./sec.)	Diameter of 50 per cent circle at 500 yd. (ft.)
45	20	2,600	8
80	40	2,600	8

One of the most important objectives of future development will be the improvement of rocket accuracy, and it is clear that this would be helped considerably by a theory capable of accounting quantitatively for the existing dispersion. Early theories assume that dispersion of finned rockets can be attributed to three causes :

(*a*) Malalignment of the venturi on the mass centre of the rocket. The malalignment produces an upsetting couple about the mass centre and causes, the rocket to deviate from its theoretical trajectory.

(*b*) Malalignment of the fins.

(*c*) Unpredictable meteorological conditions, such as wind gusts.

Lack of rigidity in the projector and loss of propellant during burning are other contributory causes, but they are usually treated separately. For experimental purposes, complete rigidity of the projector can easily be ensured and the loss in range attributable to loss of propellant can be estimated from the reduction in velocity at the end of burning.

Of the three causes listed above, the first is predominant and the one around which most interest centres. The simple approach is the assumption that the axis of the resultant thrust on the rocket coincides with the geometrical axis of the emergent cone of the venturi. The malalignment can be measured for rounds before they are fired, and from these data the dispersion expected from this cause can be calculated. Trials have shown, however, that there is no clear-cut correlation, either in magnitude or in direction, between the deviations observed in firings and those estimated on the basis of this assumption.

It is an obvious criticism of the simple assumption made above that the malalignment measured on an unfired round may not be significant because the line of the jet may not coincide with the axis of the emergent cone ; and the hot propellant gases and sudden onset of pressure may shift or distort the venturi or alter the curvature of the rocket tube. Moreover, the head of the rocket is often attached to the motor tube in such a way that it might be temporarily displaced by pressure in the tube.

The experimental technique needed to elucidate the actual mechanism and intrinsic significance of these various occurrences is quite difficult and progress is being made rather slowly. The result is that it is not yet known precisely at what points extreme accuracy of manufacture and the greatest possible rigidity and freedom from distortion should be insisted upon, nor where manufacturing relaxations can be permitted with impunity.

It might be hoped that the difficulties encountered with finned rockets could be evaded by the adoption of gyroscopic stabilization. It would be expected that errors contributory to dispersion would be smoothed out by rotation about the rocket axis. To some extent this is certainly true, and rotated rockets have provided some good dispersion figures, but the disconcerting feature is that the disparity between calculated and actual dispersions for rotated rockets is of the same order as for fin-stabilized rockets. It is from the elucidation of this 'unknown factor' in rocket dispersion that major progress in accuracy may be derived.

Conclusion

In conclusion, it may be observed that after sporadic development through several centuries and quite intensive development during the last ten years, rockets have reached a stage where they can be

considered a reliable mechanism. As heat engines they are necessarily inefficient, and there is little prospect of eliminating completely the supply and storage considerations peculiar to rocket propellants. None the less, rocket motors perform certain functions more efficiently and economically than any other power unit. Wherever power is required for relatively short periods, for the minimum of transported weight, rocket motors will compete; and in the absence of air the technique of rocket combustion may offer the only feasible system of propulsion. Used as projectiles, the peculiar advantages of absence of recoil and comparatively low set-back inherent in rockets have already given rise to remarkable weapon applications. Of these, on the British side, probably the most outstanding were the aircraft rocket enabling a single-seat fighter to deliver a salvo equal in hitting power to the broadside from a small cruiser; the 'rocket ships', each capable of disgorging highly lethal ammunition on the chosen target area at the rate of half a ton a second, for nearly a minute; and the 'land mattress' (so called because it was a 'softening' weapon), in which a battery of 12–30 barrel mountings concentrated, under one command, medium artillery fire power comparable with the normal complement of a whole Army Group.

This article has been written by Dr. W. H. Wheeler, a member of the staff of the Ministry of Supply associated with the British development work described. Thanks are due to the Director General of Scientific Research (Defence) for arranging for the preparation of the article and for permission to publish the information.

TROPIC-PROOFING OF OPTICAL INSTRUMENTS BY A FUNGICIDE

By Prof. J. S. TURNER, Associate Prof. E. I. McLENNAN, Dr. J. S. ROGERS and E. MATTHAEI

University of Melbourne

IT is remarkable that the problem of the deterioration of optical instruments by fungi has remained so long without thorough investigation. Until 1939 very few people seem to have realized that fungi can grow actively on or over the internal optics of binoculars, cameras, etc., exposed to warm and humid conditions. The trouble became acute, however, in Australia when military units went into action in New Guinea.

Not only were the facilities for storage of instruments extremely primitive in the early stages of this campaign[1], but, as has since been shown, parts of New Guinea are climatically the worst possible places for fungal troubles. In a short time, the fungal infection of instruments designed for temperate regions became a major problem. Optical instrument workshops, adequately equipped and staffed for normal repair work, found themselves entirely unable to cope with the flood of fungus-infected instruments which descended upon them. Many types of instruments lasted only for four to eight weeks before infection; and, very often, new instruments awaiting issue in depots were found to be deteriorating rapidly on the shelves because of fungal attack. In fact, instruments in store were affected more than those in use, and the trouble was greatest where they were housed in leather cases and stored in wooden boxes.

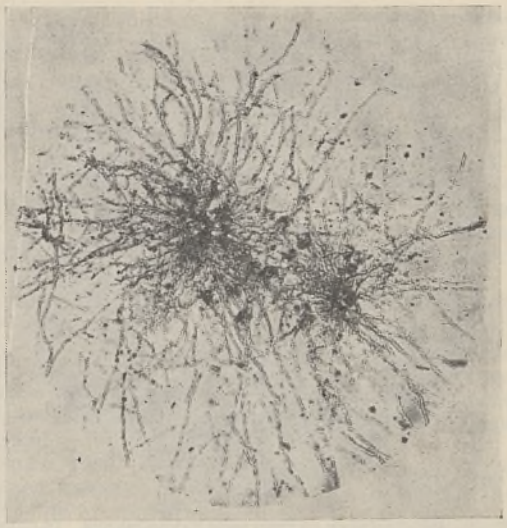


Fig. 1. *Penicillium*. Sporulating colony on binocular prism from New Guinea. × 50

Accordingly, in 1943, the Australian Scientific Instrument and Optical Panel (an advisory panel to the Ordnance Production Directorate of the Ministry of Munitions, Australia) set up a special subcommittee, which carried out research on this problem and which has issued interim reports from October 29, 1943, up to the present time[2]. Considerable research was carried out during the same period in both the United States[3] and Great Britain[4]. In this report we shall summarize the results of the Australian work, which led to a reasonably effective method of tropic-proofing optical instruments.

The fungi which grow in optical instruments belong to the groups Phycomycetes, Ascomycetes and Fungi Imperfecti. The following species were frequently isolated from instruments which had been in New Guinea: *Penicillium spinulosum*, Thom., *P. commune*, Thom., *P. citrinum*, Thom., *Aspergillus niger*, Van Tiegh., *Trichoderma viride*, Pers. ex-Fr., *Mucor racemosus*, Fres., and *M. ramannianus*, A. Moeller. So far, *Monilia crassa* has not been isolated from Australian instruments, although Dr. W. G. Hutchinson[5], of the United States, found this to be a common species in the Panama zone, and it has also been recorded as frequent in West Africa by Major I. G. Campbell[6].

The fungal spores germinate on the moist surface of the glass lenses or prisms or, more frequently, on particles of dust, luting wax, cork and other organic debris. The mycelium spreads thence over the whole surface of the clean optical glass (Fig. 1). The moulds are particularly troublesome when they grow on graticules, but they are also capable of obscuring lenses and prisms. The fine hyphal threads in contact with the glass surfaces are often surrounded by minute condensed water droplets (Fig. 2) or by droplets of alkali-soluble substances liberated from the glass itself. If the mycelium remains for many months in contact with the glass, it is capable of etching a pattern into it. More commonly, when removed, the mycelium leaves only a slight stain (Fig. 3) resembling an oil film which can be removed by cerium oxide polishing.

The committee concentrated at first on methods for tropic-proofing the many thousands of impressed

FIG. 2. SURFACE VIEW OF LENS FROM RANGE-FINDER. IN CENTRE IS A PARTICLE OF ORGANIC DEBRIS FROM WHICH THE MYCELIUM OF *Penicillium* HAS RADIATED. THE HALO OF LIQUID DROPLETS WHICH SURROUND EACH HYPHA IS CLEARLY VISIBLE. × 50

civilian binoculars which were to be issued to the Australian Services. It was early decided that it would be futile to attempt to desiccate these instruments or to ensure that they were optically clean and sterile when dispatched. A search was made, therefore, for a suitable volatile fungicide which could be placed in the instrument during its first reservicing and fitting with graticules. The requirements of the fungicide were: (*a*) toxicity to all possible contaminants, (*b*) action at a distance (that is, volatility) for the substance could not be placed directly on the optics, (*c*) stability in moist air and to a temperature of at least 60° C., (*d*) persistence of action over some months or, preferably, years, (*e*) lack of power to corrode metals, especially brass, steel, and aluminium alloys, (*f*) non-toxicity to man, (*g*) mite repellent (because mites have been shown to enter optical instruments carrying fungal spores with them), (*h*) availability in war-time.

As might be expected, very few of the known fungicides passed even the first of these tests. The initial laboratory experiment was designed to select a fungicide with the properties noted in (*a*) and (*b*) above. For this purpose the substance under test was incorporated in luting wax and a drop of this was melted on to a microscope slide. This was then inverted and a hanging-drop culture of mixed spores from optical instruments was set up around the wax.

The following known fungicides were shown to be ineffective under these conditions for some or all of the moulds concerned: 'Ceresan', 'Agrosan', 'Shirlan', 8-hydroxy-quinoline, penta-brom-phenol, tetramethyl thiuram disulphide, tri-brom-phenol, azo-chloranide, clove oil, copper naphthenate, phenyl mercuric acetate, tri-oxy-methylene, methyl alcohol and thymol. Many other fungicides were not tested here, following adverse reports on their properties from other workers, for example, naphthalene, paraformaldehyde. Thymol was the most promising, but further experiments with it were discontinued when it was found that an organic mercurial completely suppressed the germination of all the species with which we were concerned. This substance was sodium ethylmercurithiosalicylate, referred to here as 'M.T.S.'. It had been produced in Australia on a large laboratory scale by Prof. V. M. Trikojus and his associates of the Universities of Sydney and later of Melbourne. It was in use by the Australian Army Medical Corps for the preservation of blood. Prof. Trikojus suggested its trial for tropic proofing, and very extensive tests have shown it to be the best fungicide so far investigated by us for this particular purpose.

At first, the M.T.S. was incorporated only into luting waxes, but later it was mixed with a black lacquer, which was used to cover the interior metal surfaces of optical instruments. It was mixed with this paint to give a concentration of 0·2 per cent in the liquid and it was also incorporated in the microcrystalline wax which we used for luting purposes. Our experiments show that the dry M.T.S., pure, or in paint, is scarcely volatile at all, but in the presence of water vapour it is decomposed, probably by hydrolysis, to give a very active fungicidal and fungistatic vapour.

Following hanging-drop tests, binoculars and range-finders were painted internally with the poisoned lacquer and mixed fungal spores were dusted on thin agar films with which the optics had been coated. The instruments were then assembled in the normal way and placed in a tropic-proofing test cabinet under conditions of high humidities and temperatures. Some of the instruments were also wrapped in damp calico which had been sprinkled with spores, and living mites were introduced into the cabinets. Under these conditions, no fungal growth occurred inside the treated instruments, but there was abundant growth in the control instruments which had not been poisoned. In later experiments, cylindrical tins of 300 cm.^{3} capacity were painted internally with black lacquer, some of which had been poisoned with M.T.S. or with its butyl or methyl esters, in concentrations of 0·2 per cent. The space inside was saturated with water vapour, and each tin contained, for the actual test, a microscope slide covered with a film of nutrient agar and dusted with fungal spores. In no instances have spores germinated in tins containing the M.T.S.-poisoned paint, although some of these tests were carried out six months after the paint had been applied to tins open to the atmosphere through

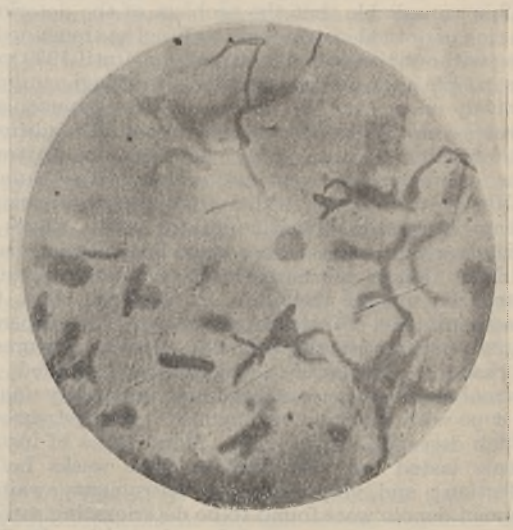


FIG. 3. LENS FROM TELESCOPE. ALL FUNGUS HAS BEEN REMOVED BY OPTICAL CLEANING, BUT THE 'OIL STAIN' IS STILL VISIBLE UNDER SUITABLE ILLUMINATION. × 30

minute holes. The vapour arising from the M.T.S. paint has been shown to kill the spores as well as to inhibit their growth. Further experiments, carried out by an officer of the Victorian Department of Agriculture, have shown that the vapour arising from the hydrolysis of M.T.S. is lethal to mites, but it does not act as a mite repellent. This corresponds with our own experience ; and we have found that, while mites entering M.T.S.-treated instruments are killed, their bodies do not then act as centres for the growth of fungi.

In the experiments with closed tins referred to above, some germination of spores did take place when the paint contained either the butyl or the methyl ester of M.T.S., but only when the tins had previously been stored for six months. The methyl ester was the less promising, but Dr. Hutchinson, of the United States, has informed us that the butyl ester which we supplied to him was rather more effective than M.T.S. itself in his Panama Zone experiments. This ester has the advantage of being soluble in lipoid solvents, and further trial may prove it to be a fungicide of better value than the sodium salt (M.T.S.) itself.

Once the value of M.T.S. as a fungicide was established, it became necessary to test its corrosive power. The first results were most discouraging, as it was found that aqueous solutions of M.T.S., both in the acid form and as the sodium, copper and zinc salts, brought about rapid accelerated corrosion of aluminium and some slight corrosion of brass. The corrosion was of a type which suggested that free mercury ions were released in solution and catalysed the reaction. However, it has since been found that when incorporated in a suitable lacquer, the M.T.S. causes no corrosion at all of the metal under the lacquer or of unpainted damp metal surfaces near by, even when the test piece is enclosed in a small volume of warm, damp air. On the contrary, the layer of lacquer protects the metal surfaces against the action of water vapour, which is known to cause extensive corrosion in optical instruments exposed to tropical conditions. So far as experiments have gone, there is no evidence that M.T.S. attacks lens cements (balsam or *n*-butyl methacrylate), nor does it cause the filming of optics.

This lack of corrosion by M.T.S. in paint may have been due in part to the special properties of the paint we employed. We have recommended the use of a nitro-cellulose lacquer which dries quickly to a reasonably matt surface. It is manufactured by B.A.L.M. under the name of 'Duco Enamel Lacquer'. Recent reports from England indicate that other lacquers are not necessarily suitable. We have also found it not advisable, from the point of view of corrosion, to incorporate the M.T.S. into the zinc oxide-retinax grease used as a lubricant for eyepiece threads. It should be noted here that the M.T.S. makes up 0·2 per cent of the liquid lacquer ; when this dries out, the mercurial poison is dispersed in the film at a concentration approaching 0·8 per cent.

Our corrosion tests are supplemented by observations on binoculars which have been tropic-proofed with M.T.S. and exposed for long periods as follows : (1) some instruments were kept for three months in the laboratory in Melbourne ; (2) others were exposed for two months in a test chamber to 100 per cent relative humidity and 30° C. ; (3) about thirty instruments were exposed to tropical conditions in New Guinea for two and a half months and then returned to Melbourne for examination.

Corrosion in all these instruments was limited to that taking place on exposed aluminium alloy surfaces and its extent was that which would be expected, from control experiments, to occur whether M.T.S. was present or not. Experiments at the Munitions Supply Laboratories, Maribyrnong, have also shown that black lacquer containing 0·2 per cent M.T.S. does not cause 'season cracking' of brass. Finally, although many thousands of optical instruments have now been tropic-proofed in the way recommended, there has been no report from the Services of corrosion in these instruments.

These tests and observations have convinced us that there is very little danger of corrosion by M.T.S. in paint. They have, at the same time, led us to recommend that all internal metallic surfaces of optical instruments for tropic use should be painted or anodized so as to render corrosion by *water vapour* negligible.

Since 1943, numerous field experiments in New Guinea have confirmed the value of M.T.S. as a fungicide in optical munitions. A short test in 1944 with thirty-four binoculars in stores at Milne Bay, Lae and Port Moresby was inconclusive in that many of the control instruments did not become infected. However, at Lae, four binoculars containing M.T.S. remained free from infection on all optics, while two untreated instruments were all infected on various optical surfaces.

Later, twenty binoculars and six range-finders were exposed in Kunai grass near the jungle for six months and then returned to Melbourne for examination. One side of each of the binoculars was tropic-treated, while the other side acted as control. Three range-finders were treated and three acted as control. After six months, there was no infection in any of the treated sides of the binoculars, except for one slight trace of non-sporing fungus on one prism. Practically all the untreated sides were infected, some badly. All three treated range-finders were free of fungus, while all the untreated instruments were badly infected. This is a striking proof of the efficacy of M.T.S., as the range-finders are badly sealed instruments and yet even in these the fungicide retained its activity.

A long-term experiment has just been started in New Britain. One hundred instruments (binoculars) have been assembled with exactly the same luting, lacquer and eyepiece grease ; but on one side of each instrument the lacquer and luting contain M.T.S., while the other side is free of this substance. Twenty-five pairs are to be returned to Melbourne at six-month intervals for examination. The efficacy of the fungicide will thus be tested over a period of two years.

Three pairs of binoculars treated with M.T.S. in Melbourne have been exposed to tropical conditions in the Panama zone. They are still under test, but they have so far remained free of fungus for a period of five months.

Perhaps the most striking evidence in favour of M.T.S. is its control of fungal infection in aircraft cameras, which are, of course, badly sealed instruments. At the beginning of 1944, the secretary of the Scientific Instrument and Optical Panel was approached by an officer of a camera repair unit of the U.S.A.A.F., who reported very severe damage to aircraft cameras caused by fungi. The unit adopted the M.T.S. treatment for all its cameras and has reported that none of the 350 cameras so treated became infected during a period when

approximately a hundred lenses, including fifty from aircraft cameras, were returned for the removal of fungi from the optics. One aircraft camera, treated with M.T.S., has remained internally free of fungus for a period of twelve months, although, on occasion, fungi have had to be wiped off the external lens faces. Officers of this unit have also found that the growth of fungus in fibre cases for carrying cameras could be prevented by coating the cases internally with black lacquer containing M.T.S.

The Australian Military Forces adopted the M.T.S. treatment in 1944, and all types of optical instruments manufactured or assembled in Australia, including thousands of binoculars, have been treated in this way. The R.A.A.F. and one section of the U.S.A.A.F. have also adopted the method, as has the Royal Australian Navy. Recent reports from Britain indicate that the method is undergoing tests by the R.A.F., although it is there recommended that internal metal surfaces should be anodized or covered with a primer before the poison lacquer is applied.

In aqueous solution M.T.S. will prevent the growth of *Penicillium* at concentrations so low as 1 in 2 millions. It is used locally in 1 in 1,000 solution, as a tincture for skin disinfection and as a nasal spray, and it has also proved of value for preserving blood serum[7]. It is regarded as most unlikely to cause any harm to man in the concentrations recommended for tropic proofing, as the lethal dose for man is believed to be about 1,000 milligrams. Its action at a distance is best shown as follows. Black paint containing 0·2 per cent M.T.S. is used to coat glass plates approximately 4 in. square; the painted surface is then apposed to a similar plate coated with thin agar dusted richly with *Penicillium* spores. The two plates are kept 2 mm. apart by spacing strips round the edges. No spores germinate (in fact they are killed) on the agar when the two plates are incubated under humid conditions. If, however, the paint is applied in two narrow bands forming a cross, spores do germinate to form a thin mycelium, but only in the corners of the plate. The mycelium then slowly spreads towards the middle where the concentration of toxic vapour is at the maximum. Under these conditions it appears that mutual reaction between the fungus and the vapour keeps the concentration down and allows slowly continued growth of mycelium. The vapour (which presumably contains a mercury compound) takes effect whether the paint lies above or below the agar; but in some experiments it was noticed that the inhibition of growth on plates held vertical was exerted over a greater distance on the lower sides of horizontal painted bands.

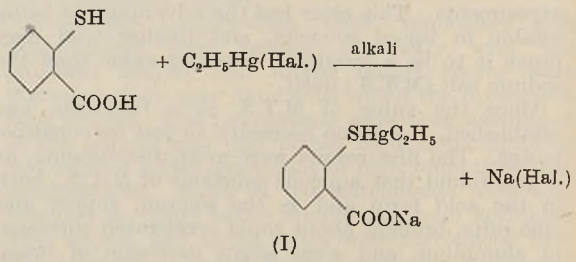
Incorporated into paints, M.T.S. may prove to be a useful fungicide apart from its application to optical munitions. For example, Mr. P. G. Law has suggested its use as a preventive of mould spotting in framed prints. Preliminary tests indicate that, if the wooden back of a picture frame is painted with M.T.S. lacquer on the side facing the print, mould growth in humid atmospheres is prevented. Technical officers in museums and galleries may find that further investigation along these lines is worth while.

The authors desire to acknowledge the valuable assistance of the other members of the Scientific Instrument and Optical Panel committee: Mr. P. G. Law, Mr. J. W. Blamey, of the University of Melbourne; Mr. G. C. Wade, of the Victorian Department of Agriculture. Our thanks are also due to Prof. V. M. Trikojus, Mr. G. M. Willis of the Metallurgical Department, University of Melbourne, Mr. M. Pack of B.A.L.M. and several officers of the Munitions Supply Laboratories, who all made contributions towards the solution of the problem. The Tropical Scientific Section of the Scientific Liaison Bureau, Melbourne, rendered assistance in the carrying out of the field tests in New Guinea.

CHEMISTRY OF SODIUM ETHYLMERCURITHIOSALICYLATE

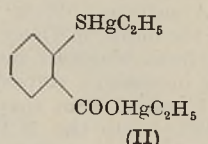
By Prof. V. M. TRIKOJUS
University of Melbourne

SODIUM ethylmercurithiosalicylate (I) is a white crystalline solid, melting at about 230° C. and easily soluble in water and the lower alcohols, but insoluble in lipoid solvents. Its preparation was first reported by Kharasch in 1928[8], who used the following reaction (cf. also Waldo[9]):

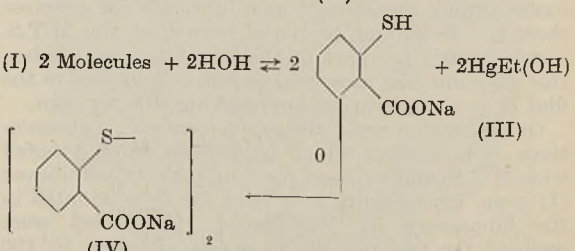


(I)

In the manufacture of the drug in Australia for plasma preservation and tropic-proofing, undertaken initially by J. E. Falk and since, in larger quantities, by R. H. Hackman, ethylmercuribromide was condensed with thiosalicylic acid (15 per cent excess) in aqueous-ethanol with the equivalent of 2·5 mol. sodium hydroxide. About a kilogram of thiosalicylic acid was used per batch. The crude ethylmercurithiosalicylic acid (by precipitation with hydrochloric acid) was purified by recrystallizing the sodium bicarbonate-soluble, acetic acid-precipitable fraction from 50, 75 and finally 98 per cent ethanol. The yield was up to 80 per cent of colourless crystals, m.p. 112°. One criterion of purity was that the sodium salt should give a clear 10 per cent aqueous solution. An unexpected impurity, isolated in small quantity, is probably di(ethylmercuri)thiosalicylate (II, colourless leaflets, m.p. 157°; Hg: found, 65·5 per cent; calc. ($C_{11}H_{14}O_2SHg_2$), 65·6 per cent).



(II)



Methyl-(ethylmercuri)-thiosalicylate (colourless solid, m.p. 40/41°; Hg: found, 50·5 per cent; calc. ($C_{10}H_{12}O_2SHg$), 50·55 per cent) and the corres-

ponding *n*-butyl derivative (pale liquid; Hg: found, 44·9 per cent; calc. ($C_{13}H_{18}O_2SHg$), 45·7 per cent) were obtained in practically quantitative yields from ethylmercuribromide, sodium hydroxide and the thiosalicylic esters. Both compounds are insoluble in water but readily soluble in lipoid solvents, an obvious advantage when applying the materials to paints and lacquers; moreover, the methyl ester can be obtained in a pure condition much more conveniently than the sodium salt.

The action mechanism of the sodium salt as a fungistatic and fungicidal agent is uncertain. It has been proved to act at a distance, but it is improbable that a sodium salt of this configuration would possess a significant vapour pressure. Kharasch has pointed out that aqueous solutions of the sodium salt tend to break down to ethylmercurihydroxide (III) and sodium thiosalicylate, the latter, in the presence of oxygen, passing irreversibly to the dithiosalicylate (IV). Thus the access of water vapour, providing conditions for fungal growth, might also favour a similar breakdown of the lacquer-incorporated mercurial, or even further to more volatile substances.

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[3] O.S.R.D. Reports, U.S.A., No. 1833, July 1943, No. 4188, September 1944.

[4] Reports of Optical Instruments Panel of Conference on Tropic Proofing, Controller of Chemical Research and Development, Ministry of Supply, Great Britain, papers issued under MG/OPT.

[5] Hutchinson, W. G., in O.S.R.D. Report, No. 1833, July 1943.

[6] Campbell, Major I. G., "Fungi in Optical Instruments under Tropical Conditions, and Possible Control", D.M.E. War Office, Great Britain, December 1944.

Simmons, R. T., and Woods, E. F., *Austr. J. Sci.*, **8**, 108 (1946).

[8] Kharasch, M. S., U.S.P., **1**, 672, 615 (1928).

[9] Waldo, *J. Amer. Chem. Soc.*, **53**, 993 (1931).

Comments by Dr. J. W. J. Fay, Ministry of Supply

I AM glad to have seen these two interesting papers, and take the opportunity of offering the following comments on British experience.

Two factors have militated against the use in Britain of M.T.S. on other than an experimental scale.

First, in the design of new instruments, or the modification of old types, the tendency has throughout been towards the improvement of sealing and of packaging. This, coupled with the use, if necessary, of a desiccating agent, is considered the ideal at which to aim, since the need of a fungicide is eliminated.

Secondly, in connexion with the protection of old instruments, including ex-civilian surrendered types of unknown history, the incorporation of volatile fungicides was not without its dangers. Thus, various substances tried gave rise to such troubles as softening of cements, corrosion and filming. Nevertheless, the need for a suitable fungicide was recognized and many were tested.

Among these, M.T.S., of which the vapour pressure is extremely low, was found to depend for its action upon a decomposition in the presence of moisture, giving rise to a volatile mercury compound which is presumably the active agent. The decomposition was found to be accompanied by a corrosion danger, and in the lacquers we have used this danger has not yet been overcome. We are, however, now awaiting samples of Australian lacquer for test.

In general, therefore, even in the case of old-type instruments, our attitude has been to improve sealing and methods of servicing, packing and storing, and the tendency is in any case to regard the incorporation of a desiccant as preferable to the use of fungicides.

With reference to the New Guinea experiments, we have had the opportunity of examining a few of the instruments tested, and our view is that while the results afford evidence of the superiority of the new *complete* Australian 'tropical treated' method over the old one, it is not entirely clear, in the absence of true controls, how much of the improvement is to be ascribed to the use of M.T.S. For this reason, we shall look forward with great interest to the results of the long-term New Britain experiments in which rigid controls are apparently included.

FIBROUS PROTEINS

BOTH the man of science and the technologist are greatly indebted to the Society of Dyers and Colourists for its enterprise in organising a symposium on fibrous proteins so soon after the end of the War. The meetings were held at the University of Leeds during May 23–25, and among the three hundred in attendance were visitors from Australia, Belgium, France, Holland, Norway, Sweden and the United States. Full details of the proceedings will appear in a volume which is to be issued shortly by the Society. Some thirty papers were read and discussed: they covered subjects ranging from the structure of protein molecules to the production of synthetic protein fibres; from the thermodynamics of water adsorption by proteins to the production of an unshrinkable finish on wool. No distinction could be drawn between science and technology, for new methods of examining the structure of wool and silk were shown to give results with a profound bearing on recent hypotheses concerning the structure of protein molecules in general, and technological advances were found to be the direct outcome of a clearer understanding of the nature of the proteins.

Our present conception of the structure of protein molecules is based to a large extent on the results of X-ray analysis in the hands of Prof. W. T. Astbury and his collaborators. In their view, proteins of the keratin-myosin-epidermis-fibrinogen group are characterized by long-range elasticity and the reversible α—β intramolecular transformation. When wool fibres are steamed for two minutes at 50 per cent extension, they contract to a length 30 per cent less than the original length on release in steam. Supercontraction of this type has been referred by Astbury to more severe folding of the polypeptide chains than in the case of α-keratin. Dr. K. M. Rudall pointed out at the time when this hypothesis was advanced that folding of this type should be revealed by a cross-β pattern on examination by X-ray methods. A cross-β pattern had been obtained by Astbury in work on the denaturation of egg-white in boiling water, and has since been observed in a number of other cases.

In his paper on the structure of epidermal protein, Rudall showed that a cross-β pattern could be obtained with strips of cow's lip epidermis which had been supercontracted in water at 100° C. Similar behaviour was observed with films of the protein extracted from the epidermis with 50 per

cent urea. The most striking of Rudall's observations was, however, the demonstration that the cross-β pattern of supercontracted epidermis and epidermin disappeared and was replaced by a normal α-pattern when the protein was treated with 50 per cent urea. This at once prompted Rudall to examine the effect of 50 per cent urea on steam-set β-keratin. Cotswold wool stretched 70 per cent and set in boiling water for five minutes showed a complete return of the α-photograph after forty-eight hours in saturated urea. The return was less complete with fibres which had been steamed for thirty minutes at 60 per cent extension; but Rudall was led to inquire whether the setting of β-proteins is not mainly a process whereby the chains are locked by close fitting in the backbone direction. Both Prof. J. B. Speakman and Mr. H. J. Woods pointed out, however, that the set released by saturated urea was probably simply temporary set, that is, the set which disappears when the fibres are released in steam. According to Speakman, true permanent set is due to disulphide bond hydrolysis, which permits relaxation, followed by linkage rebuilding, through the combination of basic side chains with the products of hydrolysis of the disulphide linkages, which gives stability to the relaxed structure. Further support to the structure is, of course, afforded by hydrogen bonding between the main peptide chains, but true permanent set was believed to be impossible without the formation of new cross-linkages between the peptide chains.

Curiously enough, Dr. H. Phillips, in his paper on the division of the combined cystine in wool into four sub-fractions of differing chemical reactivity, was led, on different grounds, to make the same suggestion that permanent set is due to hydrogen bonding between the main chains of the relaxed fibre. Phillips's reason for making this suggestion was a doubt whether disulphide bond hydrolysis could take place in the very short time of steaming necessary to relax the extended fibre. It seemed to him much more likely that the weaker hydrogen bonds of the extended fibre are broken by the initial steaming and re-form slowly in the relaxed fibre. Against this view it was pointed out that stretched fibres could not be set by immersion in concentrated solutions of weak acids which eliminate hydrogen bonding between the main peptide chains, followed by washing and drying to permit re-formation of hydrogen bonds.

The special problems involved in the structure analysis of high polymers by X-ray methods were discussed by Dr. I. MacArthur in a paper which included an exhaustive summary of recent developments in experimental technique. Data of great value in supplementing the results of X-ray analysis are likely to be obtained by Dr. A. J. P. Martin's methods of examining partial hydrolysates of proteins. He outlined the results so far obtained in an examination of a partial hydrolysate of wool, with an average chain length of a little more than two units, by ionophoresis and partition chromatography. Up to the present, only that fraction of the hydrolysate which moves towards the anode in ionophoresis has been examined; but the results are of far-reaching importance. Seventeen dipeptides involving aspartic and glutamic acids were isolated and identified, and Martin argued that the existence of so many dipeptides is sufficient to disprove Bergmann and Niemann's view that "the radicals of each sort of amino-acid occur at regular intervals in the peptide chain . . . the intervals being of the form 2^m3^n places". Further, as regards Astbury's view that the amino-acids in the polypeptide chains of keratin are alternately polar and non-polar, he concluded that the hypothesis cannot be correct because he succeeded in isolating from the partial hydrolysate a number of polar-polar dipeptides, including aspartyl glutamic, glutamyl glutamic, seryl aspartic, seryl glutamic and tyrosyl glutamic acids.

During the course of the subsequent discussion, Prof. Astbury replied that his proposal was that polar and non-polar residues *for the most part* follow one another alternately; wool is not necessarily a single protein, and room for the occurrence of polar-polar dipeptides is thus provided. Martin was, however, unable to accept even the suggestion that polar and non-polar residues follow one another alternately *for the most part* because, although he had no quantitative data, the individual dipeptide of the polar-polar type was not notably weaker than that of the polar non-polar or non-polar polar types. In fact, glutamyl glutamic acid "was one of the strongest present". Before any final conclusions can be drawn, however, data for the neutral and positive fractions of the partial hydrolysate must be obtained.

The Bergmann–Niemann hypothesis was also discussed by Dr. D. Coleman and Dr. F. O. Howitt in a paper on the structure of silk fibroin. They have found that silk can be brought into solution by means of cupri-ethylene diamine, each combined copper atom being co-ordinated with the nitrogen atoms of two adjacent amino-acid residues. When the solution is neutralized with acetic acid and dialysed until free from copper, a clear solution of fibroin is obtained. The mean molecular weight of the dissolved protein was about 30,000, but, on digestion with trypsin, a substance having a mean molecular weight of 8,000–10,000 separated out. This substance was free from proline and contained less than 1 per cent tyrosine. The Bergmann–Niemann hypothesis, however, requires that, of the 420–430 amino-acid residues in the silk molecule, the four proline and the twenty or so tyrosine residues are regularly spaced along the chain. Since the product of tryptic digestion is composed of molecules which are about one third the length of the parent molecule and contain no proline and very little tyrosine, it is obvious that the Bergmann–Niemann hypothesis is invalid for silk fibroin. All or most of the tyrosine residues and all the proline residues appear to be situated at points roughly one third and two thirds along the length of the molecule from one end.

Closely related to the work of Coleman and Howitt is that of Dr. C. S. Whewell and Mr. H. J. Woods, who found that roughly one atom of copper is associated with every two amino-acid residues when wool is treated with a solution of cuprammonium hydroxide. The wool does not, however, pass into solution, presumably because the main peptide chains are cross-linked by cystine. Instead, the fibres contract 26 per cent with progressive weakening of the α-photograph, which returns when the fibres resume their original length on removal of copper with sulphuric acid. Supercontraction appears to be due to additional folding of the main peptide chains, brought about by co-ordination of copper with neighbouring nitrogen atoms in the chains.

In the case of fibroin, solubilization by means of cupri-ethylene diamine is due to separation of chains in the β-configuration through hydrogen bond breakdown, when the nitrogen atoms of neighbouring amino-acid residues are co-ordinated with copper

atoms, followed by folding of the molecules at the points rich in proline and tyrosine. In agreement with this view, films prepared from the dissolved protein were found to be capable of extension to three or four times their original length. Further, whereas the original film was water-soluble, the stretched film was insoluble in water. These observations lend considerable support to Astbury's conception of a common structural pattern for all proteins, for fibroin appears to be an ideal example of denaturation, and Coleman and Howitt have succeeded in converting it into the globular form, and from the globular form into the fibrous form. Hitherto, in fibre technology, it has merely been possible to convert globular proteins, such as casein, arachin and egg albumin, into the fibrous form.

Various aspects of the production of fibres from globular proteins were discussed by a number of speakers. The optimum conditions for extracting protein from groundnuts and soya beans were defined in a paper by Mr. R. H. K. Thomson, but fibres spun from solutions obtained under such conditions are weak and highly extensible in water, even after hardening with formaldehyde. As indicated by Dr. M. Harris and Dr. E. Brown in their comparison of natural and synthetic protein fibres, more effective cross-linking of the main peptide chains in the latter is a pressing need. The problem was discussed by Dr. F. Happey and Dr. R. L. Wormell, who showed that the strength of casein fibre could be increased by after-treatment with basic zinc chloride and formaldehyde, owing to the formation of metal-containing cross-linkages. Even then, however, the rate of dyeing of casein fibre with acid dyes is much greater than that of wool, as indicated by Mr. C. P. Tattersfield. In practice, accurate control over the degree of cross-linking of the casein is essential, and Dr. L. Maaskant, in an interesting paper, showed how the surface film technique could be used for this purpose. The orientation of macromolecules by interfaces was also discussed by Dr. D. J. Crisp.

One of the most interesting features of the symposium was the discussion on the mechanism of water adsorption by proteins. Dr. G. A. Gilbert criticized the three theories at present in use for describing the adsorption of water by textile fibres, namely, those of Peirce, Cassie, and Brunauer, Emmett and Teller. Cassie's theory is a modification of that of Brunauer, Emmett and Teller, and its nature and consequences were summarized by the author. After discussing the effect of swelling on the sorption isotherm he proceeded to derive a stress-free isotherm. From an analysis of the latter he concluded that the water-attracting groups in keratin are —CO— groups. Objection to the view that the multilayer of water is under very great pressure was taken by Gilbert, and Dr. P. H. Hermans believed that "the entire theoretical reasoning in Dr. Cassie's paper supports the solution theory". Dr. R. M. Barrer thought it doubtful whether the model on which the Brunauer, Emmett and Teller isotherm is based can be applied to compact, non-porous sorbing media such as wool, and he outlined an alternative theory based on (*a*) an initial, rather energetic, sorption of water molecules upon a finite number of localized sites obeying the Langmuir type of sorption, and (*b*) a simultaneous and independent process of sorption by mixing of water and polymer chains. Opinion seemed strongly in favour of this conception, the elaboration of which will be awaited with interest. It has an important bearing on the attempts which have been made to determine the 'free' and 'bound' water in proteins, a problem which was discussed by Dr. H. Eilers and Dr. J. W. A. Labout in connexion with hides and the processes of leather manufacture.

Turning now to technological processes, a number of papers were concerned with the dyeing of textile fibres. Dr. B. Nilssen discussed the formation of strongly coloured complexes when tyrosine-containing fibres are treated with nitrites and metallic salts. As regards the usual methods of dyeing, Dr. R. M. Barrer believed that the art has outstripped its scientific foundation, and he laid the foundation for a fundamental study of the kinetics of dyeing by deriving four differential equations to describe the non-steady state of flow. Methods of obtaining the diffusion coefficient from each of these equations were indicated, and procedures for determining the activity of the sorbed molecules were described. The application of these methods to the study of dyeing processes is likely to bring about a marked improvement in our understanding of their nature.

The combination of wool with acids and acid dyes was also discussed by Prof. J. B. Speakman and Dr. G. H. Elliott, chief attention being given to the apparent conflict between the chemical and X-ray evidence concerning the mode of combination of colour acids with wool. The nature of the conflict is best illustrated by taking the case of Coomassie Milling Scarlet *G*. The combining capacity of wool for the colour acid is the same as for hydrochloric acid, suggesting that all the free amino groups of wool are accessible to the colour acid. X-ray examination of the dyed fibres by Dr. I. MacArthur, however, revealed no distortion of the normal α-photograph, suggesting that the dye anions had not penetrated the crystalline phase, though penetration of hydrogen ions was indicated by its impaired setting properties. The authors suggested that the two sets of observations could be reconciled if hydrogen ions were to penetrate the micelles and leave an equivalent number of dye anions on their surfaces. A safeguard against the development of an excessive potential is provided by micellar subdivision and by the electron mobility of the protein molecule itself.

The properties of damaged wools were discussed by Dr. D. R. Lemin and Dr. T. Vickerstaff, normal wool being compared with chlorinated, peroxide-treated, alkali-treated and carbonized wools. After establishing the isoionic points of the wools, they determined their titration curves with hydrochloric acid and their affinities for Naphthalene Orange *G*, but the differences in affinity for the dye were small. Analysis of the hydrochloric acid titration curve led the authors to suggest the presence of two types of carboxyl group in the fibre, but objection to the mathematical treatment was made by Mr. L. Peters. As regards the combination of wool with acid and determinations of the isoelectric point, he emphasized that much confusion would be avoided if attention were given to the internal *p*H of the fibre and not, as is usual, to the *p*H of the solution with which it is in equilibrium. Using the Donnan theory of membrane equilibrium, he was able to show that a single curve will describe the titration of wool with solutions of hydrochloric acid containing sodium chloride in all concentrations up to 1·0*M*. Similarly, Dr. T. H. Morton, in a paper on the equilibrium between silk and aqueous solutions, stressed the importance of the *internal* *p*H value of silk whenever its chemical reactivity is being studied.

Considerable attention was also given to processes for making wool textile materials unshrinkable, that is, for preventing the kind of shrinkage which wool fabrics, as distinct from those composed of cotton or rayon, undergo when they are rubbed in aqueous media. Shrinkage of this kind is due primarily to the surface scale structure of wool fibres. The scales function as a ratchet and cause the fibres to migrate under pressure in the direction of their root ends, thus consolidating the structure. Shrinkage can be prevented by treating the wool with gaseous chlorine or chlorine water, which leads to the formation of a gelatinous degradation product of keratin on or under the scales of the fibres. According to Speakman, the essential reaction in the chlorination process is disulphide bond breakdown in the surface layers of the fibre, and it is interesting that most present-day processes, which were exhaustively reviewed by Mr. M. Freney, are based on the use of reagents such as chlorine, sulphuryl chloride and sodium hydroxide, which are known to be capable of causing disulphide bond breakdown. Further support for this view was provided by Dr. R. F. Hudson and Dr. P. Alexander, who showed that when wool is made unshrinkable with fluorine, sulphur is removed as the volatile hexafluoride. Dr. Alexander also found that wool could be made unshrinkable by treatment for only fifteen seconds in a 0·5 per cent solution of potassium permanganate in 0·5*N* sulphuric acid. Curiously enough, the treated material shrinks on being worked in acid solution, although it is unshrinkable in soap solution, possibly because of the greater swelling of the degraded protein in alkali.

In recent years, several new methods of making wool fabrics unshrinkable have been proposed. Instead of attacking the surface scale structure of the fibres, their elastic properties are modified. One such method, which was described by Dr. J. R. Dudley and Dr. J. E. Lynn, consists in impregnating the fabric with a solution of methylated methylol melamines and an acid catalyst, drying, and baking at 285° F. A high degree of unshrinkability is obtained with 10 per cent of polymer within the fibres. Alternatively, the elastic properties of the fibres can be altered by increasing the number of cross-linkages between the peptide chains, and the advantage of these new processes is that the weight and wear-resistance of the fabrics are increased. Even better results, as regards wear-resistance, are obtained when anchored films of polymer are formed on the surface of the fibres, unshrinkability being obtained in this case by masking of the scales. In the light of these and other developments there can be little doubt that polymerization reactions will continue to find extensive applications in the textile industries.

J. B. Speakman

NEWS and VIEWS

Imperial College of Tropical Agriculture : Mr. O. T. Faulkner, C.M.G.

Mr. O. T. Faulkner has just retired from Trinidad, where he has occupied the post of principal of the Imperial College of Tropical Agriculture since September 1938. He had only been in charge for a year when war broke out. It fell to his lot, therefore, to administer the College during a period of exceeding difficulty, and all schemes for development and progress had perforce to be kept in abeyance. That he has been able to keep the Institution alive as a going concern and in a fit state to tackle future developments is all the more to his credit. For it must be remembered that the College is perhaps unique in that its governing body, from which its policy emanates, is four thousand miles away. In peace-time, this alone presents certain problems ; but during a war, when all communications are liable to be upset and personal visits are prohibited owing to transport dislocations, the difficulties are greatly increased. On the academic side, one of the main problems was to arrange for the lecture courses, as students were liable to arrive at all sorts of times owing to shipping difficulties. Further problems arose when, after the Cambridge School of Agriculture closed early on in the War, it was decided to send the Colonial Office agricultural scholars to Trinidad for two years instead of the customary one. With no additional personnel and a depleted staff long overdue for leave in a temperate climate, it can readily be imagined that the problem was not an easy one. In spite of this, and of the difficult economic and social problems in Trinidad caused by war conditions, the new duties were cheerfully accepted.

On the research side an immense amount has been done by Faulkner and his staff in planning for the future and in continuing existing lines of work. Although the report of the 1939 Royal Commission on the West Indies was not published in full until after the War ended, its recommendations to make the College the centre of research for all the Caribbean Colonies were examined in detail in conjunction with the Comptroller of Development and Welfare and his staff. Now after long discussion, a definite plan for the development of the College with greatly increased duties on the research side and wider contacts with other scientific and academic institutions has finally been achieved, and Mr. Faulkner will be able to retire with the full knowledge and satisfaction that all his labour and careful thought during the war years will not have been in vain.

Physics in the University of Dublin : Dr. E. T. S. Walton

The appointment of Dr. E. T. S. Walton to the Erasmus Smith professorship of natural and experimental philosophy in the University of Dublin, in succession to Prof. R. W. Ditchburn, will be welcomed by all those who know Dr. Walton's work. Dr. Walton joined the Cavendish Laboratory as a research student in 1927, after a good experimental record in classical physics at Trinity College. Rutherford suggested that he should investigate the possibility of a new method of accelerating electrons, by spinning them in the circular electric field surrounding a changing magnetic field—the method which was later to be developed into the betatron. Walton first investigated theoretically the conditions for stable orbits in the system and obtained two of the well-known betatron stability equations—the flux condition and the radial field variation condition. He built an apparatus in which the induction field was obtained by discharging a condenser through a coil wrapped round an evacuated glass tube of about

THE CHEMICAL SOCIETY
RESEARCH FUND

A meeting of the Research Fund Committee of the Society will be held in November next. All persons, therefore, who have received grants, and whose accounts have not been declared closed by the Council, are informed that reports must be received by the Society not later than November 1, 1946.

Applications for Grants, to be made on forms obtainable from the General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1, must be received on or before November 1, 1946. Applications from Fellows will receive prior consideration.

Attention is drawn to the fact that the income arising from the Donation of the Worshipful Company of Goldsmiths is principally devoted to the encouragement of research in Inorganic and Metallurgical Chemistry, and that the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the Coal Tar and Allied Industries.

CIVIL SERVICE COMMISSION

Applications are invited for the following posts in the Road Research Laboratory of the Department of Scientific and Industrial Research :

(a) Two posts of Deputy Director of Road Research, to take charge, under the Director of Road Research, in one case of research into problems of road safety and in the other case of research into road materials and methods of road construction. Candidates should have high scientific qualifications and proved ability in conducting scientific research and in organising and supervising the work of research teams. Good personality and ability to work effectively with other organisations is essential. The problems of road safety will be largely physical in character and involve the use of statistical methods. Salary scale : £1,500 per annum rising by annual increments of £50 to £1,700 per annum, with superannuation provision under the Federated Superannuation System for Universities.

(b) One post of Senior Principal Scientific Officer to take charge of a group of researches into the properties of soils and their use, from the engineering aspect, in road construction. Candidates should possess high scientific qualifications, good personality and proved ability in conducting research and in leading a research team. Salary scale : £1,100 per annum rising by annual increments of £50 to £1,300 per annum, plus consolidation addition (at present £120), and with superannuation provision under the Federated Superannuation System for Universities.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1648, with whom completed applications must be lodged by November 7, 1946.

SPECIAL COURSE ON ANALYSIS AND LANGUAGE FOR JUNIOR *ACADEMIC* SCIENTISTS

Science (including social science) graduates in or taking up junior academic posts (teaching, writing, research) are hereby notified that it is proposed to test a short, intensive, introductory ("exercise") course on Analysis and the Language of Science, possibly by correspondence. The Analysis would be along the lines of Analysis in mathematics, but more with reference to logical and empirical notions and concepts and the language side would comprise the critical examination of selected passages from scientific literature from a logico-linguistic and epistemological standpoint. A special feature would be instruction in definitional and other technique, some of it new, even to theoretical science. Apart from theoretical interest, the proposed course is believed to be desirable as a supplement to normal science training, and is designed to improve linguistic precision, the understanding of fundamental concepts, their scientific range, etc., and to promote the much-needed standardization of words. As the proposed course would, in the first instance, be somewhat experimental in nature, no fee would be charged, though a small charge might be necessary to cover clerical expenses. Those interested and requiring further details are requested to write to Mr. W. R. Dunlop, 57 (fifty-seven), Gordon Square, London, W.C.1.

UNIVERSITY OF LONDON
GRANTS FOR RESEARCH

Applications are invited from members of the University for grants from the Central Research Fund for assisting specific projects of research and for the provision of special materials and apparatus. Applications will be considered three times a year and must be received not later than March 31, July 31 and November 30. Forms of application and further particulars may be obtained from the Academic Registrar, University of London, Senate House, London, W.C.1.

CROWN AGENTS FOR THE COLONIES
COLONIAL GOVERNMENT APPOINTMENTS

Applications from qualified candidates are invited for the following post :

Laboratory Superintendent required by the Government of Nigeria for the Medical Department for one tour of 18–24 months with possible permanency. Salary according to age, experience and war service in the scale £400 rising to £600. On salary of £400 local allowance of £60 a year is payable. Separation allowance on same salary is between £84 and £204 according to number of dependants. Outfit allowance £60. Free passages and quarters. Candidates, not over 35, must be fully trained and experienced in modern laboratory technique, including Pathology, Bacteriology, Parasitology and Biochemistry. Previous experience in anti-variola vaccine production desirable. Preference will be given to Members or Associates of the Institute of Medical Laboratory Technology. Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience to the Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/17075, on both letter and envelope.

MINISTRY OF SUPPLY
APPOINTMENT OF DIRECTOR OF ORDNANCE FACTORIES (ENGINEERING)

The Ministry of Supply invite applications for appointment as Director of Ordnance Factories (Engineering) from suitably qualified male engineers, under 50 years of age on October 1, 1946 (including those serving with H.M. Forces who will be released in the near future). Candidates must be British subjects. The appointment is a full-time post. The successful applicant will be required to pass a medical examination and will be eligible for establishment in the permanent Civil Service subject to a probationary period of 12 months. The duties of the post, which is located in London, involve responsibility for the general engineering functions of a large group of factories. Applicants must be qualified engineers with a comprehensive knowledge of the engineering industry of the country, of materials, production processes and engineering estimates, and of production plant and services, and have the ability to plan and prepare layouts and schemes of extension, to control a Machine Tool service including purchase, repair and disposal on a large scale, and to negotiate with trade firms on contracting work.

The salary scale of the post is £1,600 to £1,800 per annum. A fair amount of travelling will be required, and travelling and subsistence allowance will be payable in accordance with the Ministry's scale.

Applications by letter stating age, and giving full details of qualifications and experience, should be submitted to :—The Secretary, Ministry of Supply, Est. 8, Room 151, Shell Mex House, Strand, London, W.C.2, not later than November 14, 1946.

HALIFAX EDUCATION COMMITTEE
MUNICIPAL TECHNICAL COLLEGE
Principal—B. R. HEASMAN, M.Sc., A.R.I.C.

Required, a Senior Assistant for Electrical Engineering to commence duties on December 1 or as soon as possible thereafter. Candidates should possess a good honours degree of a British University or hold equivalent qualifications, and have had good professional and/or industrial experience in Electrical Engineering. Previous teaching experience an advantage. The work of this post includes supervision of the Electrical Engineering laboratories, teaching up to the standards of an Honours Degree and Ordinary and Higher National Certificates in Electrical Engineering.

Salary scale £600–£25–£750 with addition for training as applicable under the Burnham Report for Technical Teachers. Applications from members of His Majesty's Forces considered by letter in the first instance. Further particulars from the Principal. Applications to be returned to the Chief Education Officer, West House, Halifax, by Monday, October 14, 1946.

DALHOUSIE UNIVERSITY
HALIFAX, CANADA
DEPARTMENT OF PHYSICS

Applications are invited for an Assistant Professorship at an initial salary of $3,200 per annum with yearly increases, to begin September 1, 1947. Duties will include a moderate amount of teaching, and the appointee will be expected to engage in research for which he will be given opportunity. If the applicant has had considerable research experience, the appointment may be raised to that of Associate Professor at a higher salary.

Applications, giving full particulars, including qualifications, experience and the names of two referees, should be forwarded, preferably by Air Mail, to the President of the University, to arrive not later than November 1, 1946.

NATAL UNIVERSITY COLLEGE
PIETERMARITZBURG

Applications are invited for the post of Director of Research of the Wattle Research Institute attached to the Natal University College, Pietermaritzburg (South Africa). The fields of research will include silviculture, genetics, pathology, entomology, biochemistry and economics. Experience in research and its direction and in administration is necessary. Research experience in silviculture or agronomy and genetics would be an added qualification for the post. The salary will be the maximum of a Professor (£1,000 at present) plus a non-pensionable allowance including cost of living allowance, which will bring the total emoluments to not less than £1,500 per annum. Membership of the University Teachers' Provident Fund is compulsory. The appointment will be in the first place for a probationary period of one year. The successful applicant will be expected to assume duties on January 1, 1947, or as soon thereafter as possible.

Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is October 31, 1946.

BIRMINGHAM UNITED HOSPITAL
The General Hospital.
The Queen Elizabeth Hospital.
(Also incorporating the Queen's Hospital 1840–1941).
THE QUEEN ELIZABETH HOSPITAL

Applications are invited for the post of Assistant in the Clinical Laboratory at the Queen Elizabeth Hospital. Candidates (female) should possess a B.Sc., or have had other scientific training. Salary £250 per annum, rising to £300, by annual increments of £25. Duties consist of routine blood examinations, previous experience not essential. Applications, together with three recent testimonials, should be made at once to the undersigned, from whom further particulars may be obtained.

G. HURFORD,
House Governor.

The Queen Elizabeth Hospital,
Birmingham, 15.

UNIVERSITY COLLEGE NOTTINGHAM
DEPARTMENT OF PHYSICS

The Council invites applications for the following appointments :

Assistant Lecturer in Physics. Salary £350–£400 per annum. Demonstrator in Physics, £250–£300.

For each appointment the initial salary will be fixed according to the qualifications and experience of the selected candidate. Full conditions of appointment and forms of application may be obtained from the Registrar.

NORTHAMPTON POLYTECHNIC
ST. JOHN STREET, LONDON, E.C.1

Applications are invited for the post of Principal. Candidates should be qualified to direct a large and important technical college concerned mainly with education (full-time and part-time) in relation to engineering, including much degree work, post-graduate study and research.

Salary scale : £1,300–£50–£1,600.

An initial salary above the minimum may be approved in the event of the previous experience of the successful candidate rendering this desirable.

Applications should be submitted by October 28, 1946. Particulars may be obtained from the Secretary.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE
TRINIDAD, BRITISH WEST INDIES

Applications are invited for the post of Professor of Botany at the above College. Salary £850–50–£1,000 but not necessarily starting at the lowest figure in the grade, with temporary cost of living bonus. F.S.S.U. Scheme. House or house allowance. Passages, including wife's, out and home every other year with four months leave. Candidates should possess good academic and research qualifications. Duties comprise some advanced lecturing and the supervision of post-graduate students. Ample facilities for research particularly in plant breeding and genetics. Previous tropical experience would be an advantage. Candidate selected would be required to assume duty in summer of 1947. Applications should be made to and on forms obtainable from the Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2, by December 31, 1946. Candidates from overseas should apply by airletter giving full particulars and naming three referees.

UNIVERSITY COLLEGE, EXETER

Applications are invited for a Graduate Scholarship in Zoology. Particulars may be obtained from the Registrar.

ROTHAMSTED EXPERIMENTAL STATION

The Statistical Department has vacancies for Scientific and Experimental Officers. Applications are invited from mathematicians and science graduates; previous experience of statistics is not essential, but interest in the application of modern statistical methods to problems of biological and agricultural research is necessary. The salary scales, at present under review, are likely to be similar to those of the Scientific Civil Service. Applications with full particulars of qualifications, etc., should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

UNIVERSITY COLLEGE LEICESTER

The Council recently invited applications for Professorships in English, History, Mathematics and Physics at a minimum commencing salary of £1,000 p.a. The Council, however, is now in a position to offer a higher commencing salary and has decided to re-advertise the four Chairs at a commencing salary of £1,200 p.a. with participation in the Federated Superannuation System for Universities. Further particulars may be obtained from the Registrar to whom applications should be submitted not later than November 16.

NORTH STAFFORDSHIRE ROYAL INFIRMARY

STOKE-ON-TRENT

(475 beds)

Applications are invited from Science graduates with experience in medical biochemistry for the post of Biochemist in the modern and extensive Pathological Department of the hospital. The successful candidate will work under the direction of the Pathologist. Commencing salary will be at the rate of £500 per annum with participation in the hospital's superannuation scheme.

Applications, with copy testimonials, should be forwarded by Wednesday, October 30, to the House Governor.

NOTTINGHAM UNIVERSITY COLLEGE

FACULTY OF

AGRICULTURE AND HORTICULTURE

Applications are invited for the post of Assistant Lecturer in Agricultural Chemistry. Salary will be in the range of £350 to £400. Candidates should possess an honours degree in Chemistry. Applications should be submitted not later than October 19 to the Principal, Midland Agricultural College, Sutton Bonington, Loughborough, from whom further particulars may be obtained.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Senior Lecturer in Physics. Commencing Salary £750 rising to £825 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses.

Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Junior Lecturer in Physics. Commencing salary £400 rising to £500 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Senior Lecturer in Geography. Commencing salary £750 rising to £825 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

UNIVERSITY COLLEGE, LONDON

Mechanic required immediately for experimental laboratory workshop in Department of Pharmacology. Minimum wage £6 per week, according to qualifications. Apply to Establishment Officer, University College, Gower Street, W.C.1.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Lecturer in Geography. Commencing salary £600 rising to £700 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Senior Lecturer in Philosophy. Commencing salary £750 rising to £825 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the post of Lecturer in Philosophy. Commencing salary £600 rising to £700 per annum (New Zealand currency). The appointment is for four years in the first instance. Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. The closing date for the receipt of applications is October 31, 1946.

HUDDERSFIELD TECHNICAL COLLEGE

Principal—DR. W. E. SCOTT, M.B.E.

Applications are invited for the post of full-time Lecturer in the Department of Mathematics, duties to commence as soon as possible. Candidates should possess a good honours degree of a British University. The work of the Department includes courses for the Final Degree (London University External) in Pure Science and Engineering, Higher National Diplomas and Certificates, etc.

Application forms may be obtained from the Principal, to whom they should be returned not later than 3 weeks after the date of publication of this notice.

H. KAY,
Director of Education.

AUCKLAND UNIVERSITY COLLEGE

AUCKLAND, NEW ZEALAND

Applications are invited for the Chair of Chemistry. Salary £1,200 per annum (New Zealand currency). Allowance for travelling expenses. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is November 15, 1946.

LEEDS COLLEGE OF TECHNOLOGY

Principal: C. CHEW, M.Sc.TECH., F.R.I.C.

DEPARTMENT OF CHEMISTRY AND BIOLOGY

Applications are invited for the full-time post of Head of the above Department, duties to commence January 1947. Applicants should possess high academic qualifications together with technical teaching, and industrial or research experience.

The Department is Grade II with a salary scale £750–£25–£850, to which scale is added the usual training allowance.

Further particulars and form of application—to be returned duly completed, within two weeks of the appearance of this advertisement—will be forwarded on receipt of a stamped addressed foolscap envelope.

GEORGE GUEST,
Director of Education.

Education Office,
Leeds, 1.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF ZOOLOGY

Applications are invited for the following posts: Lecturer in Zoology (Grade IIc) at a salary of £500–£550; Assistant Lecturer in Zoology at a salary of £400.

Duties to begin as soon as possible.

One copy of application, with references, should be sent to the undersigned (from whom further particulars may be obtained) immediately.

C. G. BURTON,
Secretary.

The University,
Edmund Street,
Birmingham, 3.

UNIVERSITY OF ABERDEEN

ASSISTANTSHIP IN PHYSIOLOGY

Applications are invited by October 11 for an Assistant in the Department of Physiology. Salary £400 or £450 according to qualifications and experience.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

UNIVERSITY COLLEGE OF WALES ABERYSTWYTH

There are vacancies for two Lecturers in the Department of Agriculture:—

(a) Specialist in Animal Husbandry.

(b) Specialist in Crop Husbandry.

Applications should be sent to the Registrar, from whom further particulars may be obtained, not later than October 19, 1946.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Assistant Lecturer in Geology. Salary £400 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 2, 1946.

The Imperial Bureau of Soil Science,

Rothamsted Experimental Station, Harpenden, Herts. Applications are invited for the posts of (a) Scientific Assistant. Duties include abstracting, indexing and other work involved in a scientific information service. Knowledge of at least one European language and training or experience in agricultural and especially soil science are essential. Salary scale £354–£18–£570. Commencing salary according to qualifications and experience. Superannuation in F.S.S.U. after a probationary period. Apply, stating age, qualifications and experience, to the Director.

(b) Indexer. Training in cataloguing and indexing scientific literature, and accuracy in proof-reading are essential. A knowledge of the U.D.C. would be an advantage. Salary in the scale £204–£15–£384 according to qualifications. Apply, stating age and qualifications, to the Director.

Vacancies exist in the Research

Laboratories, situated 25 miles from London, of a large group of Engineering and Scientific Companies, for Senior Engineers to take charge of:—

1. Laboratory engaged on the design and development of industrial control equipment.

2. Laboratory engaged on the design and development of communication type radio receivers and transmitters.

3. Laboratory concerned with the theoretical design of electrical circuits embodying electronic devices.

Applicants should hold 1st class honours degrees in Engineering or Science and have had at least 6 years experience in a laboratory. Age not less than 30 years. Initial salary £600–£800 per annum. Applicants for vacancy 3 should have a good knowledge of advanced mathematics. Apply Box 716, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited for temporary

appointments in the grade of Assistant Experimental Officer at the Atomic Energy Research Establishment of the Ministry of Supply. Candidates should be aged not less than 20 years and not more than 30 on November 1, 1946. They should be in possession of a School Certificate and have experience in General Physics, Radio, Electronics, Chemistry or Metallurgy. Salary, which will be determined by age, qualifications and experience, will be on the range £203 to £398. These rates are inclusive of bonus. So far as can be foreseen, the appointments will be for at least two years.

Applications, stating full details of age, qualifications and experience should be sent within 14 days of the appearance of this advertisement to the Secretary, Ministry of Supply (Est. 8(c)), Room 193, Shell Mex House, Strand, London, W.C.2.

Senior Physicist required to take

charge of Physics Section, Research Laboratory, Birmingham. Honours Degree, Physics, with at least five years research experience in physical metallurgy. Must have knowledge of modern theory of solids, X-ray crystal analysis, methods of determination of thermal, magnetic and electrical properties of materials and experience in the application of this knowledge to the study of metals and alloys. Evidence of administrative and organising ability advantageous. Apply to Manager, Development and Research Department, The Mond Nickel Co., Ltd., Grosvenor House, Park Lane, London, W.1, stating age, experience, qualifications, salary required, etc. Mark envelope "Confidential S.P."

(*Continued on page* iv *of Supplement.*)

(*Continued from page* iii *of Supplement*).

Openings for young men with honours degrees in Chemistry or Physics, aged 20–30 years. To carry out investigational work under supervision into the problems arising in the manufacture of metal boxes, with special reference to the formulation, application, and testing of organic protective and decorative coatings; rubber and other sealing materials; soldering operations; corrosion; and physical testing of containers. £350–£500 per annum according to age and experience. Applications in writing to Staff Division, The Metal Box Co., Ltd., The Langham, Portland Place, W.1.

Applications are invited by a research organisation for a position as Liaison Officer to co-ordinate medical and chemotherapeutic research. No upper age limit for candidates is imposed. It is not an essential condition that full time should be devoted to the work. Applicants should possess appropriate scientific qualifications. Suitable offices and clerical assistance are available. Remuneration offered £750 p.a. or according to qualifications. Box 717, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited for the appointment of Demonstrator in the Department of Medical Entomology at the London School of Hygiene and Tropical Medicine (Salary £600/50/750). Applications stating age, qualifications with dates and previous experience should be sent to the Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, by Wednesday, October 16, 1946.

Metallurgist required for large oil refinery in the North-West. Candidates must have First or Second Class Honours Degree (or equivalent) and age not over 30. Sound knowledge of corrosion and alloy metals essential. Some previous industrial experience desirable but not essential. Salary according to age, qualifications and experience. Reply to Box 718, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Steward (Grade B) required in the Department of Chemistry, Middlesex Hospital Medical School, London, W.1. Salary according to age and experience. Application should be made in writing and sent to the Medical School Secretary not later than October 31.

Chemists and Chemical Engineers required for service at home and abroad with large Petroleum Organisation. Vacancies exist for Research and Works Chemists. Previous industrial experience not essential but candidates must possess 1st or 2nd class honours degrees, or equivalent, and be under 30 years of age. Salary according to age, qualifications and experience. Reply to Box 710, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist or Physicist required for development work on magnetic iron problems; degree or equivalent essential, plus preferably experience in some branch of powder metallurgy. Northampton or Swindon districts. Write, stating age, experience, qualifications and salary required, to Box 707, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Established Electrical Component Manufacturers (Enfield District) require Works Chemist mainly for routine check of electroplating processes and occasionally for assay of alloys. Applicants should be under 30 years of age and possess qualifications to at least Inter.B.Sc. standard. Please state age, qualifications and salary required. Box 709, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

St. Thomas's Hospital Medical School, S.E.1. Anatomy Department—second technician (male) required immediately. Salary £5 weekly minimum, with superannuation under F.S.S.U. Previous experience of microscopic technique desirable.

Qualified Engineer for electrical design work in connection with high voltage equipment. Age 25–35. B.Sc. or equivalent with ability in application of mathematics to design problems. Write giving full details of training, experience and salary required to Staff Officer, British Insulated Callender's Cables, Ltd., Erith, Kent. Ref. SR/7.

Organic Chemist required for Research Laboratory of progressive firm in Manchester area. Honours degree essential, research experience desirable, salary in accordance with qualifications and experience. Apply Box 711, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

MICROANALYST required by organic microanalytical laboratory. Candidates should hold an honours degree or A.R.I.C. and should have had experience in standard micro-organic elemental and group determinations. Commencing salary of the order £400–£450 per annum depending on experience. Apply to Technical Director, Genatosan, Ltd., Loughborough, Leics.

Applications are invited from Metallurgists or Chemists with some knowledge of Metallurgy, for the post of information officer in a research laboratory in the London area; to organise an abstract service and to collect data from research staff for compilation into reports and publicity pamphlets. Salary £500–£850 according to experience. Box 712, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist and Physical or Inorganic Chemist required in modern research laboratory near London for work involving reaction of molten metals and fluxes. Only men with first-class qualifications are required. Salary according to experience. Box 713, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Paint Chemist required for large oil Laboratory in the London area. Must have good University degree. Age under 30. At least 2 years experience with an industrial paint firm essential. Permanent position. Salary according to age, qualifications and experience, details of which please supply, also when available, to Box 714, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Analyst Junior (Inter. or B.Sc. Standard) wanted for routine analysis of medicinal and vitamin specialities. N.W. London area. 5-day week. Pension Scheme. Box No. 1887, Scott's, 9 Arundel Street, W.C.2.

Research Chemist required with spectroscopic training to work on ultra-violet analyses, also on infra-red analyses. Honours graduate with research experience preferred. Box 715, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Optical Lens Computer needed with experience in the design and testing of high quality anastigmat lenses. Applicants are asked to state full particulars. Salford Electrical Instruments, Ltd., Times Mill, Heywood, Lancs.

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8 cm. diameter. A filament provided an electron source, and X-rays were looked for. These experiments did not succeed, but Walton's theoretical work was a guide leading to the later success of Wideroe and Kerst.

Walton built also about this time a very early model of a 'linear accelerator'. It is probably still to be found among the Cavendish 'junk'. Walton then turned to work with J. D. Cockcroft, who was building an apparatus for the acceleration of positive ions. During the years 1929–32 they developed together the voltage quadrupler steady potential generator of 600 kilovolts, and the acceleration tube for protons which led to their discovery of the disintegration of the light elements by protons. The nature of these disintegrations was established by Wilson chamber work carried out by P. I. Dee and Walton. For the work on disintegration of the light elements, Dr. Walton and Dr. Cockcroft were awarded jointly the Hughes Medal of the Royal Society in 1938.

Atomic Energy for Industrial Purposes

THE text of a report submitted to the United Nations Atomic Energy Commission in New York by the U.S. representative, Mr. Bernard Baruch, has been released through the U.S. Information Service. It sets out the results of a careful study of the costs of producing nuclear power by the relatively inefficient process in use at Hanford; that is, with a slow-neutron reactor, using a graphite moderator and ordinary uranium metal, modified to allow of heat extraction at a temperature where the heat-exchanging medium, gas or water, can be used efficiently in a gas or steam turbine. The report was prepared by the staff of the Clinton Laboratories (the experimental 'pile' at Oak Ridge, Tennessee), assisted by engineers of the Monsanto Chemical Co. Their conclusion is that by the use of existing techniques it should be possible to generate electric power at 0·8 cents per unit compared with 0·65 cents per unit for a coal-burning station, making the same assumptions in each case concerning amortization of capital charges and interest on capital. It is assumed with confidence that certain difficult technological problems connected with the extraction of the heat at a high temperature can be solved.

This is an important statement since it contradicts the pessimistic view about the industrial application of atomic energy which has been expressed in some influential quarters in Britain. The report emphasizes that nuclear power has many advantages over existing sources of energy for some specialized applications as, for example, where fuel or cooling water are unobtainable. It emphasizes that coal costs are tending to move upwards, while further research and development will undoubtedly make the cost of nuclear energy move downwards. These conclusions should give impetus to the development of nuclear energy for industrial purposes in Great Britain and the British Commonwealth, where conditions exist already for the rapid application of the new methods as an alternative to coal or hydro-electric power.

American Physical Society and the Freedom of Science

THE summer meeting of the American Physical Society was held in Chicago on June 20–22. It was mainly devoted to nuclear physics, and much of the work done under the Manhattan Project and only recently declassified was made public for the first time. There were ninety-seven contributed papers, the abstracts of which have since been printed in the *Physical Review* (70, 101; July 1946). In addition, there were eight invited papers. These included: "Elementary Pile Theory", by E. Fermi; "Theory of Nuclear Reactions", by G. Breit; "Physics Research and Release of Nuclear Energy", by A. H. Compton (this was delivered as an after-dinner address); "The Transuranium Elements", by G. T. Seaborg; and two papers dealing with neutrons.

The following resolution was passed by the Council of the Society: "The Council of the American Physical Society, being convinced that the national welfare and even the national security depend on the progress and diffusion of scientific knowledge, go on record as affirming that the restoration of freedom of scientific research and publication as it existed before the war is an urgent national necessity. The healthy condition of our science and technology, which was such a great national asset during the war years, will be greatly impaired if the freedom of science is not restored in the immediate future".

Atomic Energy and Political Propaganda

THE pamphlet "Atomic Energy and Social Progress" issued by the Communist Party demonstrates clearly how the words of men of science may be distorted to political ends. It is difficult to believe that any scientific worker will have the patience to read the mixture of dialectics, irrelevancies, distortion and prejudice which Mr. William Paul has woven into this piece of pure propaganda masquerading under a catchword title. Its existence is not merely a warning to men of science to weigh their words, but also an illustration of the difficulty due to titles which besets the compiler of any bibliography in rejecting the chaff while retaining the grain.

Geomagnetic Disturbance of September 16–23

A WEEK of geomagnetic disturbances, culminating in a 'great storm' during September 21–22, coincided with the epoch of the autumnal equinox as well as with the passage across the sun's disk of a large group of spots during September 13–26. Spots of area 500–1,000 millionths of the sun's hemisphere are, however, now fairly frequent with the rise towards maximum of the 11-year solar cycle; but the recent group with a maximum area around 1,000 millionths represented a renewal of activity in the region of the great July sunspot (*Nature*, Aug. 3, p. 160). This recent epoch of geomagnetic disturbance opened on September 16 at 13h. 47m. U.T. with a 'sudden commencement', but the small storm which followed may be taken as having ended on the following day about 6h. Fourteen hours later a long-continued disturbance began somewhat indefinitely, and lasted until September 20, 0h. The maximum ranges at Abinger during this interval of nearly three days were considerable, namely, 250 γ in horizontal force and 290 γ in vertical force, the latter range almost raising the status of the disturbance to that of a great storm. Although no specific solar flares can as yet be related to these two periods of magnetic disturbance, it should be noted that at the time of the sudden commencement on September 16, the centre of the spot group was within the central part of the sun's disk, which is effective in the known statistical relationships between the greater magnetic storms and individual large sunspots. However, storms of moderate intensity do in any event occur

with markedly increased frequency at the epoch of the equinoxes even at solar minimum.

The 'great storm' which next followed was, with a high degree of probability, directly associated with one or more solar flares within this sunspot region that had shown intense activity two months earlier. The magnetic storm began on September 21 with a marked 'sudden commencement' at 17h. 13m. U.T., but activity did not become conspicuous until 04h. 25m. on September 22. The most intense period was still later, between 10h. and 22h. Between 14h. and 15h., the movements of the traces were so rapid that ranges of 200 γ in H in one minute of time were frequent. The storm ended rather uncertainly about 8h. on September 23. The extreme ranges at Abinger (kindly communicated by the Astronomer Royal) were: 2° 16′ in declination; 925 γ in horizontal force, and 450 γ in vertical force.

A complete but short-lived radio fade-out beginning at 11h. 05m. on September 21 was reported to Greenwich by Cable and Wireless Ltd., and during this fade-out a solar flare (not of great magnitude) was partially observed at Greenwich. But the statistical average time-interval between the beginning of a great magnetic storm and its antecedent intense solar flare is 21½ hours. This interval from the 'sudden commencement' at 17h. 13m. on September 21 would place the probable flare during the Greenwich night hours. Solar observations in $H\alpha$ from America, Australia and India are required to pursue further the connexion between this storm and a specific solar outburst within the sunspot area.

Experimental Stress Analysis Group

A meeting was held at University College, London, on September 6, with the provost of the College, Dr. D. R. Pye, in the chair and some sixty persons from academic, government and industrial research establishments present to discuss the formation of a society concerning itself with photo-elasticity. It was decided to extend the scope to other techniques of experimental stress analysis, and to form an informal group the object of which will be the interchange of knowledge and experience among its members. Some of the research workers had suggested that the group should be part of the Institute of Physics rather than form a new society. The secretary of the Institute of Physics, who was present by invitation, stated that the Institute was always prepared to give sympathetic consideration to requests from informal groups interested in applied physics for a little assistance in the inaugural period, and that this could be accepted without prejudice to the ultimate decision. It was therefore agreed to leave the constitution open for the present, and in the meantime to make a formal request to the Institute for temporary assistance.

Colonel H. T. Jessop (University College, London) was elected chairman of the Group, and Mr. E. K. Frankl (Engineering Department, University of Cambridge), honorary secretary. The following were elected to the Committee: Mr. W. A. P. Fisher (R.A.E., Farnborough), Mr. R. G. Manley (Vickers Armstrong, Ltd., Newcastle-on-Tyne), Mr. C. W. Newberry (L.M.S. Railway, Research Dept., Derby), Dr. S. C. Redshaw (Boulton Paul Aircraft Co., Wolverhampton), Mr. D. G. Sopwith (Engineering Div., National Physical Laboratory, Teddington), Dr. J. Ward (Huddersfield Technical College). The Committee was instructed to: (1) widen the circle of membership by getting in touch with research workers in all fields of experimental stress analysis; (2) make arrangements for a meeting within twelve months at which papers shall be read and the future constitution of the Group shall be decided; (3) prepare and circulate bulletins of information which may be of interest to members. Any research workers or others who are interested in experimental stress analysis are invited to communicate with the honorary secretary of the Group.

Dissemination of Scientific Information

Among the papers presented at the Royal Society Empire Scientific Conference last July, a group dealing with the dissemination of scientific information among scientific workers do not appear to have been noticed in the scientific and technical Press, although they indicate possibilities recently discussed in these columns (see *Nature*, **157**, 745; 1946). Prof. J. D. Bernal's contribution, "The Form and Distribution of Scientific Papers", briefly summarizes ideas he expressed at the Conference last year of the Association of Special Libraries and Information Bureaux, while Dr. L. M. Lampitt's paper, "An Abstracting Service", discussing the difficulty of reconciling both the informative and indicative abstract, nevertheless concludes that a central abstracting science service should be developed which should issue both types of abstract. On the council or board of this body would be representatives of all the major publishing societies and institutions. Both types of abstract should be highly sectionalized and the scheme should be financed jointly by the State, industry and the scientific worker. Dr. Lampitt's proposals thus go some way towards meeting the ideas of Prof. Bernal; Miss Ditmas' paper on "Special Libraries" also touches on the question of abstracting, but it is mainly concerned with the library system and with bibliographical services. Ideas presented in Mrs. Lucia Moholy's paper, "A Central Office of Documentary Reproduction", have already been discussed in *Nature* (**157**, 38; 1946), while the largest paper in this symposium, a review of information services by Prof. R. S. Hutton, supplements the other four contributions, examining the fundamental requirements of the collection and distribution of scientific and technical information, the growing difficulties which face such services, and indicating some proposals which have been made for improvement. Neither Prof. Hutton nor Miss Ditmas refers to the earlier report of the British Commonwealth Science Committee (cf. *Nature*, **152**, 29; 1943), which contained a strong recommendation in favour of co-operation in abstracting services.

British Medical Students' Journal

"For the first time," says the editor of the first issue of this journal, "British medical students from all over the country are to produce a journal." The first plan for this journal was drawn up by A. Malone of the London Hospital and D. Whittingham of Durham, and the editorial board of three men and one woman propose to publish in the future technical articles and news, "complemented wherever possible by art and literature of a high standard". Resisting attempts to impose upon them a partisan approach to many problems, the editorial board have wisely decided to be guided only by the wishes of the majority. They will fight for international co-operation and have, for this reason, devoted the whole of this first issue to an account of the new International Students' Federation and of the re-birth of the Czech

universities; for it was in Prague at the World Students' Congress in November 1945 that an important part of the work on the foundations of this new organisation was done. The first ordinary issue of the *British Medical Students' Journal* (published from B.M.A. House, Tavistock Square, London, W.C.1) is appearing in October, and thereafter one issue will be published each term, each containing essays, articles and news interesting to medical students. An indication of the kind of fare to be provided is given by the announcement in this issue that the October number will contain articles by Sir Joseph Barcroft on fœtal respiration, by Prof. Samson Wright on hypertension, by Dr. James Marshall on penicillin and venereal disease, and by Dr. Charles Hill, secretary of the British Medical Association, on the National Health Service, together with news, short stories and articles contributed from all over Britain. An interesting feature will be a section devoted to nurses who wish to improve the efficiency and conditions of their service. It is particularly gratifying to know that medical students, like so many other sections of the community, wish to help the nurses to attain the status, remuneration and conditions of life and work which are merited by the important part they play in modern medical practice.

Man's Ancestry in Africa

FURTHER details of the circumstances and character of the recently announced discovery of relics of two early forms of extinct anthropoids have now been recorded by Dr. L. S. B. Leakey (*The Times*, August 23). Two lower jaws were found within 15 ft. of one another by Dr. Leakey, while on leave from war-time duties, in the Lower Miocene deposits of Rusinga Island which lies at the mouth of Kavirondo Bay in the north-east corner of Victoria Nyanza. Of these two specimens, one has since been identified as belonging to the genus *Proconsul*, the other as belonging to the genus *Xanopithecus*. These two genera with a third, *Limnopithecus*, were first discovered and described by Dr. A. T. Hopwood in 1931 when working as a member of the "Third Leakey East African Archæological Expedition" on the Lower Miocene deposits at Koru in Kenya. Further discoveries of fossil ape material were made by Dr. Leakey and other members of his expedition at Rusinga and elsewhere between 1931 and 1935. Dr. Hopwood regarded *Proconsul* as a very close relative of the chimpanzee, and *Limnopithecus* as being of the same stock as the gibbons. When the new specimens now recorded by Dr. Leakey had been cleaned and examined it was found that the *Proconsul* jaw, which is very nearly complete and the most nearly perfect of any fossil anthropoid jaw yet discovered, did not show so close a relationship to the chimpanzees as Dr. Hopwood had thought. It was, in fact, much more human in certain characters than not only the chimpanzee jaw but also that of the Piltdown skull. The chin is more vertical, there is no simian shelf (the ledge of bone on the anterior aspect of the symphysial area of the jaws of all apes) and the condyle in many ways is more like that of a man than an ape. Of possible alternatives, Dr. Leakey favours the view that in *Proconsul* we have a near approach to an ape-like form from which the human stem eventually was evolved, and goes on to suggest that notwithstanding recent tendencies to look to Asia, Africa may well be the place of origin of man.

The Old Moon in the Arms of the New

MOHD. A. R. KHAN, of the Hyderabad Academy, Begumpet, Deccan, has a paper with this title in *Popular Astronomy* (53, No. 7, August 1945) in which it is suggested that variations in the lunar earthshine may be partly due at times to intense meteoric activity on the moon. It is not necessary to suppose that the moon has an atmosphere to make this theory feasible, because bombardment of the moon's unprotected surface could explain the appearance. A profitable piece of research would be to try to correlate the luminosity of that portion of the moon visible under earthshine with meteoric displays observed on the earth. Reference is made to a paper by Walter H. Haas, "Concerning Possible Lunar Meteoric Phenomena" (*Contributions of the Society for Research on Meteorites*, 3, 98), which describes two lunar flares that he observed with his 4-in. refractor in 1938. It would be interesting to know what conclusions, if any, have been drawn from these observations.

Swelling Pressure in Gels

FOREST PRODUCTS RESEARCH SPECIAL REPORT No. 6 (London: H.M. Stationery Office. 1*s*.) deals with "Swelling Stresses in Gels, and the Calculation of the Elastic Constants of Gels from their Hygroscopic Properties". The results are of importance in the use of composite wood products or synthetic plastics derived from natural fibres, and the general aspects of the subject are also dealt with. The abstruse theory is concisely but adequately set out, and the tendency of the paper is theoretical, very little experimental material being presented.

Announcements

THE Royal Astronomical Society will celebrate the discovery of Neptune on September 23, 1846, by holding a conversazione on October 8. Prof. W. M. Smart, regius professor of astronomy in the University of Glasgow, will deliver an address on "John Couch Adams and the Discovery of Neptune", and there will be exhibits relating to Adams, Le Verrier, Tycho Brahe and John Flamsteed.

SIR JAMES CHADWICK, professor of physics in the University of Liverpool, will deliver the Melchett Lecture for 1946 of the Institute of Fuel on October 8, at 6.0 p.m., at the Central Hall, Westminster, London, S.W.1; he will speak on "Atomic Energy and its Applications".

DR. J. RAMSBOTTOM is giving lectures at the British Museum (Natural History) on edible fungi on Mondays and Wednesdays at 2.30 p.m. The lectures will be continued until October 16.

THE Committee of Privy Council for the Organisation and Development of Agricultural Research has appointed Dr. A. N. Drury, Dr. Joseph F. Duncan and Prof. T. J. Mackie to be members of the Agricultural Research Council. They succeed Prof. D. Keilin, Major James Keith and Prof. F. T. Brooks, whose terms of office have expired.

THE Committee of Privy Council for Medical Research has appointed Mr. C. A. B. Wilcock, M.P., Prof. C. A. Lovatt Evans (Jodrell professor of physiology in the University of London) and Prof. R. A. Peters (Whitley professor of biochemistry in the University of Oxford) to be members of the Medical Research Council.

LETTERS TO THE EDITORS

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

Cryoscopic Proof of the Formation of Nitronium Ion

As the result of work on the optical absorption and electrical conductivity of mixtures of nitric and sulphuric acids, and on the depression of the freezing point of sulphuric acid by added nitric acid, Hantzsch concluded that in such solutions nitric acid is largely converted into two cations, $H_2NO_3^+$ and $H_2NO_3^{++}$, the latter being the principal form present in excess of sulphuric acid[1]. The optical and electrical work showed essentially that the nitric acid is converted into an altered form, and that this consists of or contains ions. The cryoscopic work furnished a specific argument in favour of the bivalent ion. For the univalent ion corresponds to a two-fold, and the bivalent ion to a three-fold, depression by nitric acid of the freezing point of the sulphuric acid solvent: the van't Hoff i-factors would be as shown. Experimentally, Hantzsch found a three-fold depression ($i = 3$):

$$HNO_3 + H_2SO_4 = H_2NO_3^+ + HSO_4^- \quad (i = 2)$$
$$HNO_3 + 2H_2SO_4 = H_3NO_3^{++} + 2HSO_4^- \quad (i = 3)$$

The remaining evidence of a specific nature consists in Hantzsch's claim to have isolated crystalline perchlorates corresponding to each of his ions, namely, the salts $(H_2NO_3^+)(ClO_4^-)$ and $(H_3NO_3^{++})(ClO_4^-)_2$ (cf. the following note).

The purpose of this note is to record a revision of the freezing point evidence; for when corrected it provides an unambiguous proof that the cation into which nitric acid is actually converted in sulphuric acid is neither of Hantzsch's ions, but the nitronium ion, NO_2^+.

Hantzsch's conclusion in favour of a three-fold depression of freezing point was later supported by Robles and Moles[2]; but the methods employed were not accurate, nor were the results concordant. However, the technique of cryoscopy in sulphuric acid has since been much improved by Hammett[3]; and, using essentially his methods, we have established that the depression produced by nitric acid is four-fold, that is, that each molecule of nitric acid added to the sulphuric acid solvent produces four solute particles. Only one interpretation is possible, namely, that NO_2^+ is formed according to the equation

$$HNO_3 + 2H_2SO_4 = NO_2^+ + H_3O^+ + 2HSO_4^- \quad (i = 4)$$

We also find that each of the oxides of nitrogen, N_2O_5, N_2O_4 and N_2O_3, produces a six-fold depression of the freezing point of sulphuric acid. The corresponding equations are

$$N_2O_5 + 3H_2SO_4 = 2NO_2^+ + H_3O^+ + 3HSO_4^- \quad (i = 6)$$
$$N_2O_4 + 3H_2SO_4 = NO_2^+ + NO^+ + H_3O^+ + 3HSO_4^- \quad (i = 6)$$
$$N_2O_3 + 3H_2SO_4 = 2NO^+ + H_3O^+ + 3HSO_4^- \quad (i = 6)$$

Furthermore, Mr. D. J. Millen has confirmed the presence in the relevant solutions of all the ions represented in these equations by the method of Raman spectroscopy—excepting for H_3O^+, which, as is well known, cannot be detected by this means.

Our experimental values for the i-factors of van't Hoff are as follows:

HNO_3	10 determinations	$i = 3{\cdot}82$
N_2O_5	10 ,,	5·85
N_2O_4	6 ,,	5·84
N_2O_3	5 ,,	5·85

Hammett's results for H_2O lead to $i = 1{\cdot}92$. The small deviations of all these figures from integral values give mean activity coefficients of $0{\cdot}96 \pm 0{\cdot}01$ for the formed binary electrolytes, $(H_3O^+)(HSO_4^-)$, $(NO_2^+)(HSO_4^-)$ and $(NO^+)(HSO_4^-)$.

R. J. Gillespie
J. Graham
E. D. Hughes
C. K. Ingold
E. R. A. Peeling

Sir William Ramsay and Ralph Forster Laboratories,
University College, London.
Sept. 2.

[1] Numerous papers (1907–32).
[2] *Anal. Fis. Quim.*, **32**, 474 (1934).
[3] *J. Amer. Chem. Soc.*, **55**, 1900 (1933); **59**, 1708 (1937).

Isolation of Salts of the Nitronium Ion

Hantzsch[1] has claimed to have prepared, from anhydrous nitric and perchloric acids, two nitracidium perchlorates, and to have established their compositions by analysis. He represents their formation as follows:

$$HNO_3 + HClO_4 = (H_2NO_3^+)(ClO_4^-)$$
$$HNO_3 + 2HClO_4 = (H_3NO_3^{++})(ClO_4^-)_2.$$

He states that either salt could be obtained by using the acids in the appropriate proportions, while with intermediate proportions mixtures were produced, which by crystallizing from warm nitric acid could be converted into the pure monoperchlorate or by crystallization from warm perchloric acid could be completely transformed into the diperchlorate.

Hantzsch's experimental methods, however, were not wholly suitable for the treatment of such sensitive compounds. We have therefore repeated the work, employing a vacuum technique designed completely to exclude atmospheric moisture, and using temperatures low enough to prevent decomposition of the pure acids, with the consequent production of such contaminants as nitrosonium perchlorate, $(NO^+)(ClO_4^-)$.

We find that it is readily possible to obtain a solid product of the approximate composition of $(H_2NO_3^{++})(ClO_4^-)_2$; it is not even necessary that the two acids should be used in the theoretical proportions. However, this product is a mixture, separable by fractional crystallization from nitromethane into two components. The less soluble has been shown to be nitronium perchlorate, $(NO_2^+)(ClO_4^-)$; the other is the salt $(H_3O^+)(ClO_4^-)$, well known as the hydrate of perchloric acid.

We have not been able to prepare any dry salt, or dry mixture, of the composition of $(H_2NO_3^+)(ClO_4^-)$. However, we find that adhering nitric acid is somewhat difficult to remove from $(NO_2^+)(ClO_4^-)$ by pumping, and it is possible that Hantzsch, who dried his preparations only on porous tile, may have obtained compositions approximating to that of $(H_2NO_3^+)(ClO_4^-)$ from certain of his mixtures of $(NO_2^+)(ClO_4^-)$ and $(H_3O^+)(ClO_4^-)$ which by chance contained roughly the right amount of adhering nitric acid.

The separation of $(NO_2^+)(ClO_4^-)$ from $(H_3O^+)(ClO_4^-)$ by crystallization from nitromethane is tedious, and can be avoided by decomposing the $(H_3O^+)(ClO_4^-)$ by means of N_2O_5. The reaction is conveniently conducted in nitromethane, with such concentrations that the formed $(NO_2^+)(ClO_4^-)$ crystallizes.

Nitronium perchlorate has almost certainly been prepared before, Gordon and Spinks[2] having obtained a deposit of the composition $NClO_6$, which with water gave nitric and perchloric acids, by mixing gas-streams containing ozone, nitrogen dioxide and chlorine dioxide. An analysis of our salt may be quoted: acid equivalent, 73·0 (calc., 72·7); chlorine, 24·3 (calc., 24·4); nitrogen, 9·52 (calc., 9·63 per cent). The salt has a very low vapour pressure, scarcely fumes in air, and dissolves in water with but slight liberation of heat. The constitution of the solid salt has been established by Mr. D. J. Millen by the observation of its Raman spectrum, which consists simply of the combined known spectra of the ions NO_2^+ and ClO_4^-. Other physical properties of the salt are being examined, and other nitronium salts, including the bisulphate, biselenate and bipyrosulphate, are being studied.

Our failure to isolate nitracidium perchlorate, $(H_2NO_3^+)(ClO_4^-)$, is consistent with the following note, which shows that the immediate effect of adding a small amount of perchloric acid to nitric acid is to produce the NO_2^+ ion. Thus it appears that any ion $H_2NO_3^+$ formed with the aid of perchloric acid is largely converted into NO_2^+ in an anhydrous nitric acid medium. The ion $H_2NO_3^+$ itself is probably not detectable by the Raman effect, just as the ion H_3O^+ is not detectable by this means.

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Sept. 2.

[1] *Ber.*, **58**, 958 (1925).
[2] *Canadian J. Res.*, B, **18**, 358 (1940).

Spectroscopic Identification of the Nitronium Ion

Extensive studies of the Raman spectra of mixtures of nitric and sulphuric acids have been made by Chédin[1]. He showed that such spectra were characterized by the appearance of two prominent, polarized lines, at 1,050 and 1,400 cm.$^{-1}$, which did not belong to the spectrum of either the nitric acid or the sulphuric acid molecule. The same two lines appeared if he added either nitrogen pentoxide or phosphorus pentoxide to pure nitric acid. He therefore assigned these lines to nitrogen pentoxide; but, since solutions of this substance in organic solvents gave a different Raman spectrum, he supposed that the nitrogen pentoxide, when in solution in nitric or sulphuric acid, exists in some special form.

Bennett and Williams have interpreted these results on the basis that Chédin's special form is an ionized form[2]. In particular, they have assigned the line at 1,400 cm.$^{-1}$ to NO_2^+, comparison with the isoelectronic molecule CO_2 having shown that a polarized Raman frequency would be expected to appear in this region. They have attributed the line at 1,050 cm.$^{-1}$ to NO_3^-, or, in the presence of sulphuric acid, to HSO_4^-, assignments which are consistent with the known spectra of these ions.

The purpose of this note is to supply a spectroscopic demonstration of the correctness of Bennett and Williams's suggestion concerning the origin of the frequency 1,400 cm.$^{-1}$: it is an important suggestion, because it renders Raman spectroscopy the most convenient and certain method for the identification of NO_2^+.

With the mixtures mentioned, Chédin had always obtained his two lines, 1,050 and 1,400 cm.$^{-1}$, together, and roughly in proportion to each other as regards intensity. Neither he nor anyone else[3] has hitherto observed the line 1,400 cm.$^{-1}$ without the other line. Chédin naturally assumed the two to originate in the same molecular source. The spectroscopic selection rules show, however, that, if two such lines should come from the same source, that source could not be NO_2^+; for this belongs to the small class of molecules which cannot have more than one strong Raman line. It is permissible to avoid the difficulty by assigning the other line to either NO_3^- or HSO_4^-; but the decisive experiment to determine whether the source of the line 1,400 cm.$^{-1}$ has in fact one or two lines in its Raman spectrum would, of course, be to produce the line 1,400 cm.$^{-1}$ without its hitherto constant companion, by mixing nitric acid with any other acid which (*a*) has no line in the neighbourhood of 1,050 cm.$^{-1}$, (*b*) gives an anion which has no line near 1,050 cm.$^{-1}$, and (*c*) is a strong enough acid to destroy nitrate ion. Both perchloric acid and selenic acid fulfil these conditions; and we find that the addition of each of these acids to

nitric acid produces a strong appearance of the Raman line at 1,400 cm.$^{-1}$ without any accompanying line at 1,050 cm.$^{-1}$.

The only molecules which possess but one fundamental Raman frequency are (i) diatomic molecules, (ii) linear, symmetrical, triatomic molecules. In the present problem the former can be excluded on both spectroscopic and chemical grounds, and thus the demonstration given identifies the derivative of nitric acid responsible for the frequency 1,400 cm.$^{-1}$ as the linear, symmetrical, triatomic molecule $O=\overset{+}{N}=O$. Evidently the Raman-active stretching vibration, of frequency 1,400 cm.$^{-1}$, is spectrally similar to the vibration of a diatomic molecule, the symmetry securing that during the vibration the central atom remains stationary.

Chédin obtained the lines 1050 and 1400 cm.$^{-1}$ from solid N_2O_5, which, we therefore suggest, may have the ionic structure $(NO_2^+)(NO_3^-)$.

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Derivation of Meteor Stream Radiants by Radio Reflexion Methods

Since October 1944 we have carried out investigations of the short duration scatter echoes observable in the neighbourhood of the *E* region of the ionosphere at frequencies well above the critical frequencies for either the normal or abnormal *E* layers. The general occurrence of such echoes was first reported by Appleton, Naismith and Ingram[1] in their observations during the Polar Year 1932–33. Schafer and Goodall[2], who worked in collaboration with Skellett[3] in an investigation of meteors as a source of abnormal *E* region ionization, had also noted them as a specific feature of the Leonid shower of 1931. An adequate reference to subsequent research cannot be given in a brief communication; but the work has for the most part led to the view that the transient ionospheric echoes are caused by meteors (see, for example, Appleton[4]). Our experiments have led us to confirm that the majority of scatter echoes must be of meteoric origin and are due to reflexions from meteor trains or streaks: these columns of ionized gas, caused by meteoric impact with the molecules of the upper atmosphere, present their maximum echoing areas when viewed at right angles to their length.

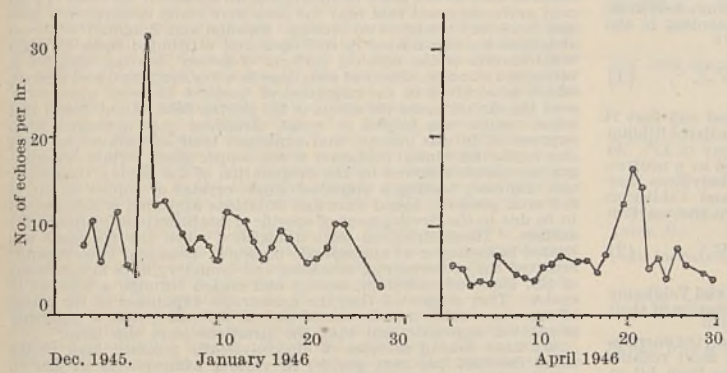

Fig. 1. Mean hourly echo rate

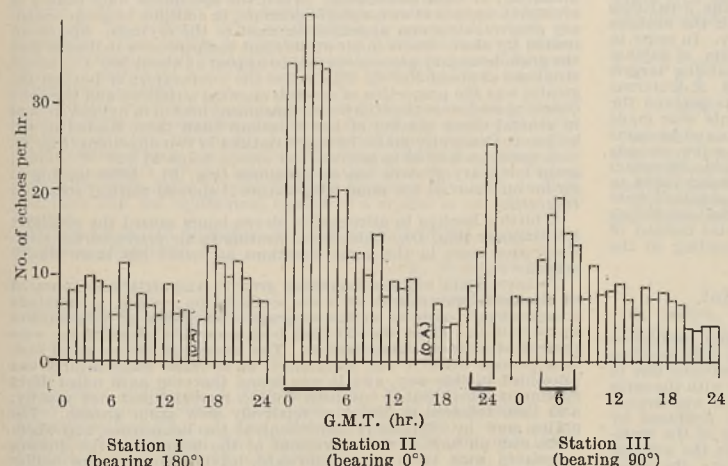

Fig. 2. Diurnal variation of mean hourly rate of echoes July 26–Aug. 1, 1945. Times at which radiant (R.A. 345°, Dec. −10°) is favourable are indicated by heavy lines. O.A., station out of action

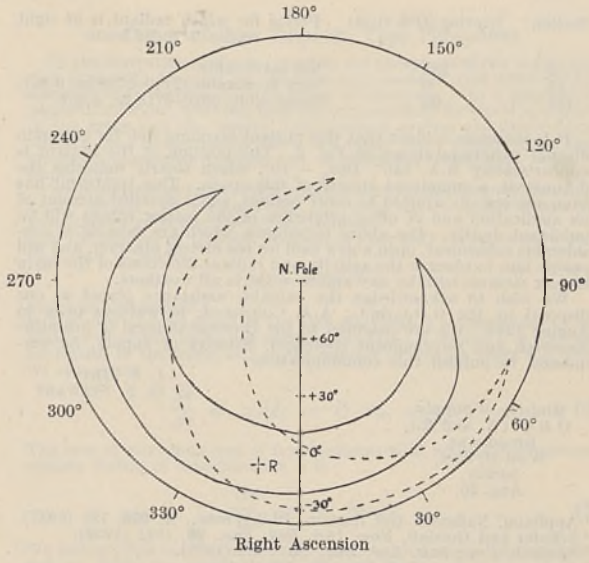

Fig. 3. Coverage of possible radiant positions of main peaks of Stations II and III. *R* is the derived radiant Station II, ————; Station III, - - - - - -

In our investigations, pulse transmitters with Yagi aerials were operated on wave-lengths of 4–5 metres at 150 kW. peak power. With the radio beam directed vertically upwards, observations of scatter echoes were made simultaneously with a visual watch for meteors during the nights of April 20, 21 and 22, 1946. This revealed that those meteors which passed nearly overhead coincided with radio reflexions. There were, in addition, about seven times as many radio echoes with no meteors seen. It is well known that telescopic meteors exist in large numbers, so that it is reasonable to assume that many meteors not discernible to the naked eye may cause radio reflexions.

To test this hypothesis we must consider whether the characteristics of all the echoes are such that they could be classified as of one type with a close correspondence to the properties of meteors. One simple example is shown in Fig. 1, in which the mean hourly rate of occurrence of echoes for a vertical-looking station is given for December 27, 1945–January 27, 1946, and for April 1–30, 1946 (the results are the average for 0915–1200 hr. and 1400–1630 hr. G.M.T., except during April 20–22 when the times were 2030–2400 hr. to coincide with the visual meteor watch). Reference to J. P. M. Prentice's Meteor Diary in the B.A.A. Handbook, 1946, indicates that the important showers during these periods are the Quadrantids on January 3, 1946, of duration one day only, and the Lyrids, April 20–22, with a maximum on April 21. Fig. 1 shows marked peaks coinciding both in date of incidence and duration with these two important showers.

Even more striking has been the derivation of certain of the most active meteor radiants by means of stations with inclined beams set on different bearings. It was discovered that the variation of diurnal rate was different according to the bearing of the equipment. Fig. 2 shows the average of results obtained for the period July 26–August 1, 1945, for three stations on bearings 0°, 90° and 180° respectively. These results indicate that the echoing source is sensitive to aspect. Assuming that the echoes are due to meteor trains or streaks presenting the most favourable aspect when viewed at right angles to their length, we have marked in Fig. 3 the radiant positions corresponding to the peaks in hourly rate for Station II at 0230 hr. and Station III at 0530 hr. These coverages of possible radiant directions intersect, and we may assume that the centre of overlap, *R* in Fig. 3, is in the vicinity of a very active radiant. The periods for which such a radiant is favourable may now be tabulated.

Station	Bearing (O.S. Grid)	Period for which radiant is at right angles to radio beam
I	180°	Not favourable.
II	0°	Very favourable, 2140–0730 hr. G.M.T.
III	90°	Favourable, 0320–0710 hr. G.M.T.

It is therefore evident that this radiant accounts well for the main diurnal variations shown in Fig. 2. The position of the radiant is approximately R.A. 345°, Dec. − 10°, which clearly indicates the δ Aquarids, a prominent stream of this epoch. This treatment has been successfully applied to other periods, and a detailed account of its application and of other properties of the scatter echoes will be published shortly. The above techniques, which are capable of considerable refinement, open a new field for the meteor observer, and will enable him to observe the activity and radiant directions of the main meteor streams both by day and by night in all weathers.

We wish to acknowledge the valuable assistance placed at our disposal by the G.O.C.-in-C., A.A. Command, in watches prior to August 1945. We are indebted to the Director General of Scientific Research and Development (Defence), Ministry of Supply, for permission to publish this communication.

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Short-lived Radioactivity from Lithium Bombarded with Neutrons

The production of a short-lived activity as a result of the neutron bombardment of lithium was first reported in 1936 by Knol and Veldkamp[1], who found a β activity of period 0·8 sec. after irradiating a lithium sample with slow neutrons from a 90 mc. radium–beryllium source. This activity they ascribed to Li^8 formed according to the reaction

$$Li^7\ (n,\gamma)\ Li^8 \qquad (Q = +\ 1{\cdot}9\ \text{MeV.}). \quad . \quad (1)$$

Rumbaugh, Roberts and Hafstad[2] afterwards pointed out that it should be possible to observe delayed α-particles from irradiated lithium due to the break up of the Be^8 formed from the β decay of Li^8. As they could find no delayed α-particles from Li^7 irradiated by a neutron source of a strength equivalent to 70,000 mc. of radon–beryllium they tentatively ascribed the activity observed by Knol and Veldkamp to He^6 produced by residual fast neutrons according to the reaction

$$Li^6\ (n,p)\ He^6 \qquad (Q = -\ 2{\cdot}9\ \text{MeV.}). \quad . \quad (2)$$

As He^6 and Li^8 have almost identical periods, and Knol and Veldkamp measured only the period of their product, this interpretation of their results is quite permissible.

Although the periods of Li^8 and He^6 are almost identical, the energies of the β-particles emitted are by no means so. The most reliable measurements[3,4] place the end point for the β-particles from Li^8 at 12·5 MeV., and those from He^6 at 3·5 MeV., and it is therefore possible to decide which of reactions (1) and (2) takes place during the neutron irradiation of lithium by comparing the energy of the β-particles emitted by the radioactive body of 0·8 sec. half-life with the energies of the β-particles emitted from He^6 and Li^8 respectively. In order to investigate these β-particle energies a sample of 20·5 gm. of lithium metal was irradiated by neutrons produced by bombarding targets of beryllium, boron or heavy phosphoric acid with 50 μA. of deuterons at 900 keV. For slow neutron irradiations both the target and the sample were surrounded by paraffin wax. Arrangements were made to interrupt the ion beam of the high voltage apparatus and to count the induced β-activity of the lithium for a period of a few seconds immediately following irradiation. Both the period and absorption in iron of the β-particles were measured, precautions being taken to eliminate background effects. The absorption curves obtained were compared with those measured under similar geometrical conditions using samples of boron carbide and of beryllium metal instead of lithium, which are known to yield Li^8 and He^6 according to the reactions

$$B^{11}\ (n,\alpha)\ Li^8 \qquad \text{and} \qquad Be^9\ (n,\alpha)\ He^6.$$

In this way it was established that the slow neutron irradiation of lithium leads to the production of Li^8 in accordance with reaction (1). Efforts were then made to detect the delayed α-particles due to the break-up of Be^8 using a lithium-coated ion chamber with the same irradiation technique, and evidence was obtained for the appearance of extra α-particles above the α-particle background produced by stray neutrons from the high-tension set. An estimate of the cross-section for process (1) was made by a comparison with the activity induced in an indium foil by the slow neutron source; the value obtained was

$$\sigma\ [Li^7\ (n,\gamma)\ Li^8] = \sim 10^{-27}\ \text{cm.}^2,$$

which is consistent with the upper limit given by Rumbaugh and Hafstad. The number of delayed α-particles obtained in the lithium chamber was such that their observation would have been rather difficult with a source of the intensity used by Rumbaugh and Hafstad.

Evidence has also been obtained that reaction (2) takes place when lithium is bombarded by fast neutrons, a weak activity exhibiting the absorption characteristics of He^6 being observed with neutrons of energies from 13 MeV. down to 4 MeV. No effect of this type comparable in intensity with the $Li^7\ (n,\gamma)\ Li^8$ process is obtained by slow neutron irradiation. This is consistent with the negative Q value for reaction (2).

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Thermal Etching of Silver

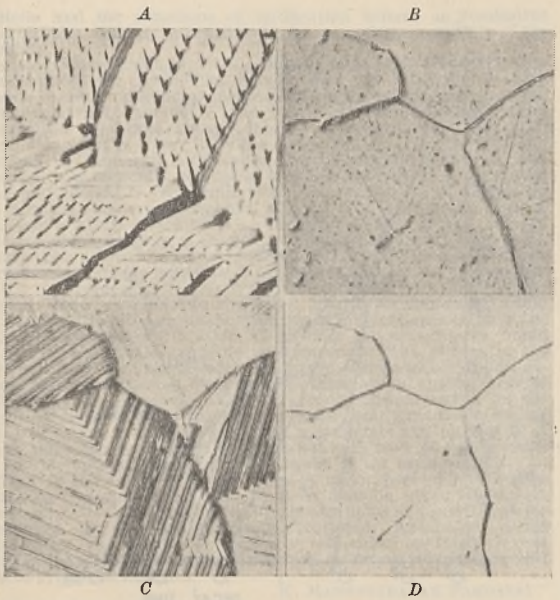
Numerous workers have observed that polished surfaces of metal specimens frequently develop an etched appearance when the specimens are heated in atmospheres with which chemical reactions would not be expected. Two types of etching effect have been recorded: (*a*) the formation of grooves at the grain boundaries, and (*b*) the development, on the surfaces of crystal grains, of striations which change their direction at grain and twin boundaries. In some cases the boundary grooves form when there are no striations, but when striations appear the boundaries invariably develop grooves. Rosenhain and Ewen[1], heating silver, copper and zinc *in vacuo*, observed boundary grooves, and on heating silver in air both grooves and striations. Together with Day and Austin[2], who observed grain boundary grooves in many different types of steel heated in hydrogen, they explained the development of grooves as being due to the preferential evaporation of metal from the grain boundaries. Carpenter and Elam[3] observed the development of lines at the grain boundaries of an antimony-tin alloy (1¼ per cent antimony), and said that the lines were really differences of level and were only produced on cooling. Rawdon and Berglund[4] observed striations on iron heated in hydrogen and attributed them to slight volatilization of the polished surface. Johnson[5], heating tungsten in nitrogen and argon, observed striations in wires carrying direct current, which he ascribed to the migration of 'positive tungsten atom-cores' over the surface under the action of the electric field. Elam[6] found that when copper was heated *in vacuo*, striations only appeared when cuprous oxide was present, and explained their appearance as being due to the differential oxidation of the copper along certain crystallographic planes followed by the evaporation of the oxide. Gwathmey and Benton[7], heating a spherical single crystal of copper in air at 0·3 mm. pressure, found that fine striations appeared which seemed to be due to the development of specific crystallographic planes in the surface. These striations were diminished when the specimen was heated in hydrogen at atmospheric pressure. Boas and Honeycombe[8] reported the occurrence of striations and boundary lines in specimens of tin, zinc and cadmium, heated and cooled through a number of cycles. They suggested that the anisotropic expansion of the grains of these non-cubic metals caused plastic deformation in a randomly orientated aggregate and that the striations were slip lines.

We have heated samples of electrolytically polished high purity silver (99·9997 per cent purity) in various atmospheres at 920° C. and found that *in vacuo* (10^{-3} mm. pressure), in nitrogen and in hydrogen, grooves appeared at the grain boundaries and, very much less distinctly, at twin boundaries. When the specimens were heated in air and in oxygen at atmospheric pressure, in addition to grain boundary grooves, striations appeared on most of the crystals. Specimens heated for eleven hours in air at different temperatures indicated that the grain boundary grooves started to appear at about 300° C. and the striations at about 500° C. The higher the temperature of heating the greater was the proportion of crystals showing striations and the more closely spaced were the striations. Specimens heated in oxygen showed in general closer spacing of the striations than those heated in air, and more frequently grains having striations in two directions (Fig. *A*).

A specimen heated in nitrogen for eleven hours at 920° C. showed grain boundary grooves but no striations (Fig. *B*). After heating in air for one hour at the same temperature it showed marked striations (Fig. *C*).

A further heating in nitrogen for eleven hours caused the striations to disappear (Fig. *D*). Subsequent heating in air produced the striations once more in the same directions as before but more closely spaced.

To investigate whether boundary grooves and striations appeared at elevated temperatures or were produced on cooling, a technique was developed to enable photomicrographs to be taken at temperatures up to 940° C. These showed that both grooves and striations were present at elevated temperatures. The behaviour of the metal over long periods while it was maintained at elevated temperatures was examined in this way, and it was found that the hard rolled silver specimens when heated to about 900° C. recrystallized very rapidly, and then followed a period of relatively slow grain growth. The grains grew by the steady movement of the boundaries, and where there was no halt in the movement of the boundaries the grooves associated with them moved forward, leaving no traces of earlier grooves. Where for some reason there was a halt in the boundary movement, scars were left when the grain boundaries moved on. The striations were found to increase in number in any particular grain with time, and where a striated grain grew at the expense of its neigh-



A, SILVER HEATED IN OXYGEN FOR 11 HOURS AT 920° C. (×2000); *B*, SILVER HEATED IN NITROGEN FOR 11 HOURS AT 920° C. (×250); *C*, SAME FIELD AS *B*, AFTER SUBSEQUENT HEATING IN AIR FOR 1 HOUR AT 920° C. (×250): *D*, SAME FIELD AS *B*, AFTER FURTHER HEATING IN NITROGEN FOR 11 HOURS AT 920° C. (×250)

bour, the new material in that grain developed striations in the same direction as those already exhibited by the growing grain.

In considering an explanation of the phenomena of thermal etching observed in silver the following points arise. That the striations in silver cannot be slip lines is clear, since the crystal structure of silver is cubic and it expands isotropically, the striations increase in number with time when the metal is maintained at a constant temperature and heating in nitrogen causes their disappearance. Since it has been shown by Benton and Drake[9] that, at a partial pressure of oxygen of 790 mm., silver oxide does not form above 200° C., the phenomena observed cannot be due to oxidation even when the silver is heated in oxygen, and the fact that new portions of grains show striations having the same direction as the striations already present means that the striations cannot be due to previous preferential oxidation of certain crystallographic planes.

The following tentative explanation of the phenomena is offered. When silver is heated in an inert atmosphere at constant temperature any changes which occur must be such as to reduce the free energy of the system, and it will approach the equilibrium conditions appropriate to that temperature. As the boundary region between two grains is a region of less order than the regions within the grains themselves there is excess free energy at the boundary which can be pictured as a surface tension. Where the boundary meets the surface, three surface tensions act at a line and the equilibrium condition is one where the surfaces meet at angles determined by the relative magnitudes of the surface tensions. For a positive surface tension in the boundary, therefore, the surfaces of adjacent grains should curve inwards at the boundary when equilibrium is approached and a groove appear on the surface. The mechanisms by means of which the equilibrium configuration is approached can include those of preferential evaporation and ionic surface migration, and because of its lower activation energy the latter is probably the more important, especially at low temperatures.

To explain the striations, it is necessary to assume that an adsorbed layer of oxygen so modifies the free energy of the surface that the condition of lowest free energy is not a plane but a stepped or corrugated surface. This is possible if the planes exposed in the corrugations have free energies per unit area sufficiently below that of the original surface to compensate for the increase in area. Frenkel[10], in fact, maintains that the equilibrium surface of a crystal is not plane but stepped.

It is intended to publish a detailed account of the experiments mentioned elsewhere.

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Decay of Zinc Sulphide Type Phosphors

IN the derivation of the decay curve for phosphors of the recombination type with traps at one single depth, Randall and Wilkins[1] have assumed that there is no retrapping of electrons. In a subsequent paper[2] they show, however, that the cross-sections for electron capture of the traps and the 'empty' luminescence centres are about equal. After a long decay period there are many more empty traps than empty luminescence centres and consequently retrapping must be important.

We endeavoured to calculate luminescence intensities over the whole decay period. We assumed that the traps have a depth E and are independent of the luminescence centres.

If the number of trapped electrons is l per unit volume they escape at a rate γl, where

$$\gamma = se^{-E/kT}, \quad . \quad . \quad . \quad . \quad (1)$$

and s is a constant[3].

The rate of retrapping of the free electrons is proportional to the number of empty traps per unit volume $(L - l)$, where L is the concentration of the traps, and to the number of free electrons n_e. Then we can write

$$\frac{dl}{dt} = \alpha (L - l)\, n_e - \gamma l. \quad . \quad . \quad (2)$$

The rate of recombination of free electrons with ionized luminescence centres (holes) of concentration n is

$$\frac{dn}{dt} = -\beta n_e n. \quad . \quad . \quad . \quad . \quad (3)$$

We assume that each recombination process produces a light quantum and we define the emitted light intensity by

$$I = -\frac{dn}{dt}. \quad . \quad . \quad . \quad . \quad (4)$$

In the simplest case with only one type of luminescent centre

$$n_e = n - l. \quad . \quad . \quad . \quad . \quad (5)$$

Eliminating n_e and l from (2), (3) and (5) leads to

$$\frac{1}{n}\frac{d^2n}{dt^2} - \left(\frac{1}{n}\frac{dn}{dt}\right)^2 \left\{1 + \frac{\alpha}{\beta}\right\} + \frac{1}{n}\frac{dn}{dt}$$
$$\{(\beta - \alpha)n + \alpha L + \gamma\} + \beta\gamma n = 0. \quad . \quad (6)$$

For long decay times this leads to a bimolecular law

$$\frac{dn}{dt} = -\beta R n^2, \quad . \quad . \quad . \quad . \quad (7)$$

where

$$R = \frac{\gamma}{\alpha L + \gamma}. \quad . \quad . \quad . \quad . \quad (8)$$

Thus from (3) the ratio of free electrons to holes tends to a constant value R.

In terms of this ratio, putting $r = 1 - \frac{l}{n} = -\frac{1}{\beta n^2}\frac{dn}{dt}$ in (6)

$$\beta n^2 \frac{dr}{dn} = \alpha L + \gamma - \frac{\gamma}{r} + (\beta - \alpha)(1 - r)n \quad (9)$$

When $\beta = \alpha$ there is a very simple expression for r, namely,

$$r - r_0 = \{1 - e^{-(\beta L + \gamma)t}\}(R - r_0), \quad . \quad (10)$$

where r_0 = value of r at $t = 0$.

The intensity as a function of time is then

$$I = \beta \frac{R + (r_0 - R)e^{-(\beta L + \gamma)t}}{\left[\frac{1}{n_0} + \beta R t + \frac{\beta(r_0 - R)}{\beta L + \gamma}\{1 - e^{-(\beta L + \gamma)t}\}\right]^2}. \quad (11)$$

n_0 and r_0 can easily be calculated as functions of I_0 if during excitation equilibrium has been reached.

The decay curves can then be calculated for different values of I_0 and for different temperatures.

The accompanying figure gives some typical examples. The following constants were used:

β = 10^{-14} cm.^{3} sec.$^{-1}$ [4]
s = 10^8 sec.$^{-1}$ [2]
E = 0·48 eV.
L = 10^{16} cm.$^{-3}$.

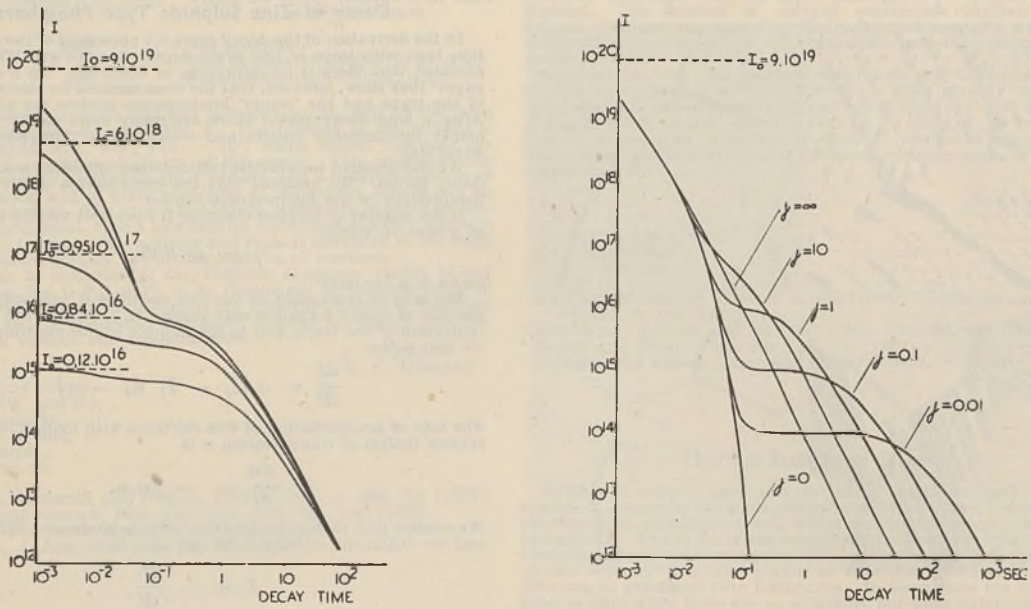
n_0 cannot, of course, exceed the concentration of luminescence centres, which is usually of the order of 10^{18}.

The curves usually consist of two parts. The later part is obtained by neglecting the exponential terms in (11).

$$I \sim I' = \frac{I_0'}{\{1 + \sqrt{\beta R I_0'}\, t\}^2}, \quad . \quad . \quad (12)$$

where

$$I_0' = \frac{\beta R}{\left\{\frac{1}{n_0} + \frac{\beta(r_0 - R)}{\beta L + \gamma}\right\}^2}$$



THEORETICAL DECAY CURVES FOR DIFFERENT VALUES OF THE INITIAL INTENSITY AND FOR DIFFERENT TEMPERATURES

I' is strongly temperature-dependent and may be called phosphorescence in agreement with a suggestion put forward by Pringsheim[5]. I_0' is then the phosphorescence intensity extrapolated to $t = 0$.

r decreases during the decay to its asymptotic value R. At very low densities of excitation r_0 may be equal to R. The decay then reduces to one bimolecular curve. With increasing densities of excitation I_0' approaches an upper limit corresponding to $l_0 = L$ and $r_0 = 1$. The phosphorescence is then saturated.

At very low temperatures $I_0' = 0$. All traps are filled during excitation and the phosphorescence is then frozen in. The decay is bimolecular initially if $L \ll n$ but always changes to an exponential curve ($n - L \ll n$).

At very high temperatures when $\gamma \gg \beta L$, the whole decay is given by

$$I = \frac{\beta n_0^2}{(1 + \beta n_0 t)^2}, \quad . \quad . \quad . \quad (13)$$

This corresponds to the "Obere Momentanzustand" of Lenard.

It can be seen from formulæ (8) and (1) that this occurs if

$$T > \frac{E}{k} \frac{1}{ln\ s/\beta L}, \quad . \quad . \quad . \quad (14)$$

in our example if $T > 400°$ K.

At room temperature no phosphorescence will be observed if $E \ll kT\ ln\ s/\beta L$.

In our example this would have occurred for trap depths less than 0·35 eV.

Fuller details will be published elsewhere.

We wish to thank Mr. van Moll and the directors of Philips Lamps, Ltd., for permission to publish this work.

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Diffraction of Light by Ultra-sonic Waves of Very High Frequencies

USING a specially constructed rectifier giving 1,100 volts and a Taylor *T* 55 valve with amphenol bases and special inductances, frequencies up to 100 megacycles per second have been produced. A tourmaline plate prepared in this laboratory with a thickness of 2 mm. and a fundamental of about 2 Mc./sec. is made to oscillate up to its 54th harmonic, and at all stages it could be employed to maintain stationary waves in a column of water in the usual manner. Diffraction patterns at almost all the frequencies in the range 2 to 100 Mc./sec. could be observed. The highest frequency so far adopted[1] for such work is only 52·5 Mc./sec. In order to detect dispersion, if any, of ultra-sonic velocity in water, the crystal has been simultaneously excited by us at two frequencies and both patterns photographed on the same plate at the same instant.

Frequency measurement has been effected by beating the oscillator with a standard Philips heterodyne wave-meter, using an audio amplifier for hearing the beat note. Results for two frequencies are given below, the temperature of water at the time of the experiment being 32·6° C.

Order of harmonic	ν Frequency in megacycles per second	d Fringe width in cm.	ν/d	Velocity calculated in metres per second
5	9·465	0·3655	25·89	1526
49	92·28	3·569	25·86	1524

Results may be taken as indicating that there is no dispersion of ultra-sonic velocity in distilled water. Bär's values when extrapolated to 32·6° C. give a velocity of 1,523 metres per second.

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Symbiotic Aspects of Nitrification

IN an interesting article on the symbiosis between myxobacteria and nitrifying bacteria, Imsenecki[1] describes an observation which he made during his studies on the biology of myxobacteria, when he was able to isolate from a culture of *Nitrosomonas*, grown in its elective medium, a heterotrophic organism which he has named *Sorangium symbioticum*. He postulates a symbiotic existence for these two organisms, suggesting that the development of the nitrifying bacteria precedes that of the myxobacteria, and that these chemotrophic nitrifiers synthesize the organic material needed for the heterotrophic organisms, afterwards making this available by the autolysis of the *Nitrosomonas* cells. Unfortunately no quantitative data have been published[1].

Since the question of the metabolism of the nitrifying bacteria has evoked considerable interest in recent years, it was thought worth while to record the observations made by me in an attempt to correlate the rather incompatible phenomena of nitrification by the classical organisms described by Winogradsky as it occurs in artificial cultures and in their natural environment. The possibilities that the nitrifying bacteria function in close association with the saprophytes of the soil, and that the nitrifying organisms are themselves heterotrophic in some stage of their lives were examined. It was shown[2] that when *Nitrosomonas* was cultured in its elective medium in the presence of organisms well known to take part in the transformations of nitrogen in the soil, as *B. megatherium*, *B. mycoides*, *Azotobacter chroococcum*, etc., there was always enhanced nitrification in presence of added organic matter. These results question the strictly autotrophic character of the organisms tacitly assumed by Winogradsky and rather rigidly demonstrated by other workers. We have thus to assume that in mixed cultures, as in soil and sewage, the necessary carbon dioxide is obtained from the normal respiration of the heterotrophic

bacteria and the organisms of nitrification behave as facultative heterotrophs. Indeed, Bejerinck held the view of the mutability of the nitrifiers.

A noteworthy finding in this connexion is that of Bomecke[3], who demonstrated the prevailing concept that the nitrifying bacteria possess no measurable metabolism other than the oxidation of ammonia and nitrite to be untenable, and that a heterotrophic dissimilation metabolism does exist, though only at a comparatively slow rate. From this point of view, the close correlation observed by Starkey[4] between the enhanced nitrification, carbon dioxide production and abundance of microbial population found in the regions of maximum root development is very significant. The profuse use of oxygen by the nitrifying bacteria, contrasted with the fact that the adsorbed or condensed oxygen in soil has an unfavourable effect on the ordinary heterotrophic microflora of the soil, emphasize the fact that organisms in their natural environments derive mutual benefit from one another. Fermentable organic matter is rapidly destroyed by the saprophytes of the soil, rendering conditions favourable for vigorous nitrification. Indeed, there is evidence to show that *Azotobacter chroococcum* could fix atmospheric nitrogen in the presence of different ammonium salts, and the enhanced nitrification observed in my experiments would be due to the greater amounts of ammonium salts present in the system as a result of nitrogen fixation by the *Azotobacter* fed by glucose. Here, unlike as observed by Imsenecki, there are no autolytic effects suffered by the *Nitrosomonas* cells to render organic matter for the growth of the associate organisms, and consequently not the intriguing point of doubt as to how long such a symbiosis can proceed if at every stage the synthesized *Nitrosomonas* cells have to be expended to provide energy material for the growth of the myxobacteria.

Thus it has to be recognized that a major part of nitrification occurring in Nature is brought about by bacteria which function in close association with the heterotrophic organisms of the soil, and the occurrence of a regulated chemomixotrophic metabolism seems established[5], at least for the organisms responsible for this moiety of nitrification. In other words, nitrification in Nature is at least in part due to symbiotic agencies.

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Aug. 16.

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Formation of Hydrogen Peroxide by Spermatozoa and its Inhibitory Effect on Respiration

The biological formation of hydrogen peroxide has often been postulated in the past, particularly in connexion with the presumed function of catalase and peroxidase; but so far its actual detection has been successful only in cultures of some bacteria[1,2,3] and some moulds[4,5] and in certain enzymic oxidations catalysed *in vitro* and requiring molecular oxygen for the oxidation of their respective substrates. The chemical identification of H_2O_2 as a product of metabolic processes of animal tissues has up to now been unsuccessful. Indirect evidence for H_2O_2 formation during respiration of bovine spermatozoa in egg-yolk medium has been submitted in a previous communication[6], and some evidence of its possible formation in human sperm has been given[7]. Using suspensions of washed spermatozoa in presence of a substance separated from egg-yolk, we have now been able to demonstrate chemically the formation of hydrogen peroxide.

In the previous communication[6] we showed that during respiration of whole semen diluted with egg-yolk medium, the rate of oxygen absorption gradually decreases. As the cause of this inhibition of respiration we postulated a gradual formation of peroxide, since both catalase and peroxidase completely abolished this effect, while heat-inactivated catalase, cytochrome *c*, hæmatin and ferrous iron did not reverse it. Since then we have carried out a series of experiments using suspensions of washed spermatozoa, and we have found that inhibition of respiration develops in presence of egg-yolk or its dialysable portion. Furthermore, we have isolated in considerable purity from the dialysable portion the substance which on oxidation by spermatozoa yields as a metabolic product the inhibitor of sperm respiration which we now identify as hydrogen peroxide.

For the detection of H_2O_2 a suspension of washed spermatozoa containing 800 million cells in 3·925 ml. *M*/15 phosphate buffer (*p*H 7·4) and 0·075 ml. solution containing 1·8 mgm. of the purified substance (a quantity comparable with that in a corresponding amount of egg-yolk medium) was shaken in air at 37° in a Barcroft–Dixon manometer. After a certain time, when the inhibition of respiration had fully developed (1–1½ hr.), the suspension was centrifuged and the clear supernatant fluid examined for the presence of H_2O_2 by means of the benzidine – peroxidase reaction, the optimum conditions of which were carefully predetermined so as to allow a maximum colour development in low concentrations of H_2O_2. The concentration of H_2O_2 formed was determined, by comparing the intensity of colour with that formed with known concentrations, and was found to be of the order of 10^{-1} μmol. H_2O_2/1 ml., this amount corresponding to about 1 μl. oxygen.

That the inhibition is in fact caused by such low concentrations of H_2O_2 is supported also by the following evidence. (*a*) The addition of 6×10^{-1} μmol. H_2O_2 to 800 million washed spermatozoa suspended in 4 ml. *M*/15 phosphate buffer (*p*H 7·4) almost completely inhibited the endogenous respiration of the spermatozoa, and lower concentrations gave correspondingly lower inhibition. (*b*) In such experiments, if catalase was added at an early stage, before much damage was done to the spermatozoa, it almost completely reversed this inhibition, provided that all the intracellular substrates had not already been utilized. At the end of experiment (*a*) it was not possible to detect H_2O_2 chemically, because a large part of the H_2O_2 added was eliminated from the system by the sperm. However, H_2O_2 was detected at the end, if the original concentration added was 8×10^{-1} μmol. H_2O_2 or higher. The elimination of H_2O_2 by spermatozoa was quantitatively ascertained, in experiments with somewhat higher concentrations of H_2O_2, by estimating the amount of H_2O_2 with catalase before addition of the spermatozoa and after their incubation with H_2O_2 for an appropriate length of time. Thus, bovine spermatozoa must be equipped with a mechanism for the elimination of H_2O_2 from the system at a low rate.

So far we have not been able to detect chemically H_2O_2 as a metabolic product of spermatozoa when their oxygen uptake was measured in presence of: (*a*) phosphate buffer alone, (*b*) egg-yolk medium, (*c*) the dialysable portion of the egg-yolk, (*d*) seminal plasma, (*e*) seminal plasma after yeast-fermentation, or (*f*) media containing either fructose or glucose. Since in both egg-yolk medium (*b*) and the dialysable portion (*c*) the substance was present which gives rise to H_2O_2, and yet the latter was not detectable, we suggest as a possibility that some constituent of the egg-yolk obscures detection of H_2O_2 by the benzidine peroxidase reaction.

The concentration of H_2O_2 present at any stage of respiration of the spermatozoa is, therefore, a result of two simultaneous yet diametrically opposed reactions, those of biological formation and elimination of H_2O_2. Its actual detection by the benzidine – peroxidase reaction is possible only if the rate of formation exceeds the rate of elimination by an amount which permits not less than 3×10^{-2} μmol. H_2O_2 to accumulate in 3 ml. of the supernatant fluid, provided that substances which interfere with the detection of H_2O_2 are absent from the medium in which the benzidine – peroxidase reaction is tried.

A positive benzidine – peroxidase reaction is definite proof of H_2O_2 in concentrations at least as high as 3×10^{-2} μmol. H_2O_2/3 ml. of supernatant fluid, but a negative reaction need not necessarily mean that H_2O_2 is not formed during the metabolic processes of the spermatozoa.

Although we have proof of the formation and elimination of H_2O_2 by spermatozoa we cannot yet specify all the conditions which affect its detection. We can tentatively, at least, say, however, that the following are some of the necessary factors for its chemical detection: (*a*) an adequate concentration of active spermatozoa; (*b*) presence of a substrate, in sufficient concentration, which on oxidation by spermatozoa yields H_2O_2; (*c*) a ratio between the rates of formation and elimination of H_2O_2 by spermatozoa such that not less than 3×10^{-2} μmol. H_2O_2 in 3 ml. of the supernatant fluid accumulates by the time the chemical test is made, and (*d*) absence of interfering substances present in complex organic media (for example, egg-yolk, seminal plasma) which may obscure detection of hydrogen peroxide by the benzidine–peroxidase reaction.

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Vernalization of Sponge Gemmules

Sponge gemmules were collected at Cambridge in September 1945 and brought to Glasgow in a small bottle of water from the River Cam. On September 29, being impatient to make some observations on developing gemmules, I placed some of them in water from Loch Lomond in a refrigerator working at 50° F. The rest were kept in Cam water on my laboratory bench, where the temperature varied roughly between 55° and 65° F.

On December 2, that is, after about two months had elapsed, single gemmules were cleaned so far as possible, placed each in the centre of a coverslip lying in a Petri dish of water from Loch Lomond, and so left on the laboratory bench.

Dish *A* contained 9 *Spongilla* gemmules from the refrigerator; dish *B* contained 8 *Ephydatia* gemmules from the refrigerator; dish *C* contained 17 *Spongilla* and 9 *Ephydatia* gemmules which had been kept all the time on the laboratory bench.

A week later a white halo appeared around two of the *Spongilla* gemmules in dish *A*, and after another two days round two of the *Ephydatia* gemmules in dish *B*.

By December 21, development had begun in 7 of the 9 *Spongilla* gemmules in dish *A*, and in 7 of the 8 *Ephydatia* gemmules in dish *B*; while in dish *C* there was no sign of development in any of the gemmules of either genus. Some of these, however, did develop later, for when the dishes were next inspected on February 24, 1946, one of the *Spongilla* and all the *Ephydatia* excepting three very small ones had evidently hatched out.

Similar results were obtained in the second half of March, when the time of natural activity would be much nearer. All 26 gemmules (20 *Spongilla* and 6 *Ephydatia*) from the refrigerator had hatched ten days after being planted out in Petri dishes in natural water as before, while only 3 (all *Spongilla*) hatched out in that time of 28 gemmules (21 *Spongilla* and 7 *Ephydatia*) from the bench. The time taken for development to have begun in all the vernalized gemmules (ten days) is less than in December (two to three weeks); perhaps because the natural date of hatching was imminent, and/or because the temperature was a degree or two higher. Another batch of gemmules also, all *Ephydatia*, from a loch near Glasgow (for which I am indebted to Dr. Harry D. Slack of this Department), refrigerated only since December 2, gave 20 out of 24 gemmules hatching in the same ten days.

This method of vernalization is extremely simple and may well be more widely applicable to provide active material at desired times

for students of all kinds, especially during the naturally inactive season of the year.

Its usefulness as a method of storage is, in this case at least, rather limited; for another set of gemmules similarly planted out early in May (by which date young sponges apparently developing from gemmules had already been found in Loch Lomond by Dr. Harry D. Slack) gave no development at all in three weeks of 22 *Ephydatia* gemmules still kept in the refrigerator, and 2 *Spongilla* out of 26 gemmules (23 *Spongilla* and 3 *Ephydatia*) kept on the laboratory bench.

Incidentally, little sponges grown in this way are excellent for showing the economy of a sponge and the activities of its constituent cells, including the action of the contractile vacuoles. A paper on this subject is in the press. Formation of young spicules could be observed from about the ninth day of the December cultures in *Spongilla*; and, even with no special attention to feeding the spongelets or to conditioning the water, oscula were developed, and the currents maintained by the choanocytes could be demonstrated over a period of two weeks or so, especially by the use of carmine particles or coloured food. The little sponge spreading out over the coverslip makes a beautiful permanent preparation.

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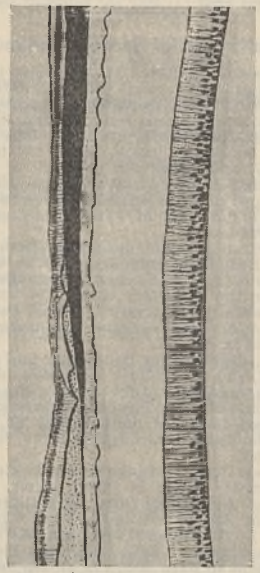
Enamel Formation in the Rat's Incisor Tooth

ACCOUNTS have been already published of the effects of vitamin D, alteration of the Ca : P ratio of the diet, and dietary restriction, upon the dentin of the incisors of rachitic rats[1]. It was noted during this work that the formation of organic enamel was sometimes upset by these procedures in animals on the Steenbock and Black rachitogenic diet of high Ca : P ratio; but that the organic enamel of animals made rachitic by low Ca : P ratio diets was scarcely ever affected. The fact that organic enamel formation in rats on a high Ca : P ratio diet is easily upset by various metabolic changes has been confirmed by recent experiments, which were undertaken in a different way and originally for another purpose[2]: after twenty-eight days on the usual Steenbock and Black diet, the animals were subjected to dietary restriction for 5–6 days. By this time it was found by examining a control rat that the epiphyses showed a well-marked 'line test' response. The remainder of the litter was then placed back on to full Steenbock and Black diet, and rats were killed and examined at intervals up to fifteen days thereafter, depending on the litter size and length of survival. Five litters of rats were treated in this way.

Examination of the upper incisor teeth at the third day of re-feeding showed that organic enamel formation had stopped. By the sixth day of re-feeding and sometimes earlier, the formation of organic enamel had begun again, often very irregularly at first, with globular material replacing proper enamel matrix. The old organic enamel matrix was not further laid down. This process is illustrated in the accompanying figure. The drawing was made from the tooth of a rat re-fed for twelve days. In some cases, as here, the proximal end of the old organic enamel was overlaid with globular material, and sometimes the new enamel overlapped the old to a slight extent. Measurements of the distance from the proximal end of the old enamel to the curve of Hertwig's epithelial sheath were made in four of the litters, and the distances plotted against the time of the events of the experiment. Extrapolation showed that enamel formation had stopped at the time the full diet was restored. The serum calcium, which was initially high, as is usual, fell somewhat when the animals' diet was restricted, and rose again when the full diet was given.



DIAGRAM, BASED ON A CAMERA LUCIDA DRAWING, OF THE ORGANIC ENAMEL AND DENTIN OF A RACHITIC RAT. (× 66.) *a* = AMELOBLASTS, *b* = ORGANIC ENAMEL, *c* = CALCIFIED DENTIN, *d* = PREDENTIN, *e* = ODONTOBLASTS. THE OLD ORGANIC ENAMEL IS DRAWN BLACK, AND THE GLOBULAR MATERIAL AND NEW ORGANIC ENAMEL ARE STIPPLED. THE PREDENTIN IS WIDE AS IS USUAL WITH THIS TYPE OF DIET. THE GAP BETWEEN THE GLOBULAR MATERIAL AND THE AMELOBLASTS IS AN ARTEFACT

The formation and maturation of the organic enamel were affected in different ways. The old enamel remained the same as when amelogenesis stopped, but calcified at about the same place along the tooth as it would have done if left undisturbed. It became slightly wider just prior to calcification, but was much narrower than normal at this point in the animals killed late in the experiment. The old proximal organic enamel retained the honeycomb structure typical of the deposition of new enamel (Wasserman[3]), although no more was formed and the ameloblasts over the old enamel were of the short variety. Once new enamel formation was established, it was accompanied by the presence of the normal tall ameloblasts associated with the formation of enamel (Diamond and Weinman[4], Wasserman[3,5]). The fact that the old organic enamel is associated with short ameloblasts and that it matures and calcifies, but little more is formed, is consistent with Wasserman's concept of these cells being active in enamel maturation only. The chief effect of the dietary change on the enamel organ existing at the time was to prevent the further formation of tall ameloblasts and to reduce those already present. As a result, enamel formation stopped, but maturation appeared to proceed normally. In certain places, especially at the proximal end of the old enamel, the ameloblasts were changed into small amorphous cells. Here granular material was laid down, but no enamel matrix, these cells apparently being able to form the former but not the latter.

The changes described above are similar in some ways to those found by Weinman[6] after strontium injections. In his experiments, however, the hypoplastic enamel matrix did not undergo maturation. Many other nutritional and endocrine conditions, such as magnesium or vitamin A deficiency or parathyroidectomy, also affect amelogenesis, but not in the same way as here.

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Tests for *Rh* Isosensitization of Red Cells in the Newborn

Coombs, Mourant and Race[1,2,3] have described an indirect method for the detection of weak and 'incomplete' *Rh* agglutinins in human serum, and a direct method for the detection of *in vivo* isosensitization of red cells in babies with hæmolytic disease. The tests have been found to work equally well with the following rabbit antisera after absorption with *A*, *B* and *O* cells: (1) rabbit anti-human-pseudo-globulin; (2) rabbit anti-human-globulin; (3) rabbit anti-human-whole-serum. In the direct method the red cells of the baby are freed from serum by washing three times in a large volume of saline, a 2–5 per cent cell suspension in saline is then prepared and a drop of this suspension is mixed with a drop of the absorbed rabbit anti-human-serum. Cells which have been sensitized to the *Rh* factor show obvious agglutination within 5–10 minutes at room temperature.

The principle of the test has been explained on the basis that sensitized cells have antibody globulin adsorbed at some points on their surface and that when these cells are brought into contact with an anti-human globulin serum rapid agglutination results.

The test as described by the authors is simple and efficient, and will, no doubt, be utilized later as a routine test in the better equipped maternity hospitals to detect sensitization of the red cells of newborn babies. The use of this test offers a new field of research in various diseases for blood workers which they, no doubt, will be quick to grasp. The only difficulty the average laboratory worker will have to meet is the preparation of a high titre anti-human serum in rabbits, and the satisfactory absorption of this serum with normal *A*, *B* and *O* cells to remove the hetero-agglutinins for these cells. The test serum may, of course, be used at a dilution beyond the point at which the hetero-agglutinins are no longer active for normal cells but at which the serum agglutinates sensitized cells. This, of course, is a method of testing for potency any anti-human serum prepared in the rabbit, particularly with successive trial bleeds. Red cells may be sensitized *in vitro* with ease by adding two drops of selected blood to two drops of glucose-citrate and two drops of anti-Rh_0 'blocking' or 'incomplete' serum. The mixture is stood for one hour at 37° C., or room temperature, and the cells washed with saline and then re-suspended in saline to give a concentration of 2–5 per cent. The actual testing may be carried out on slides or tiles.

While work on this test was being conducted at these Laboratories it was decided to find out if the test would give positive results only with rabbit anti-human serum, and not with rabbit anti-sera prepared with the serum of various animals. This work was facilitated by having available small quantities of various precipitating sera which had been prepared in rabbits by Mr. J. J. Graydon and Mr. E. F. Woods during 1943–44 for use by Australian research workers in malarial studies. The methods of preparation quoted are those used by Graydon and Woods, to whom I acknowledge my gratitude for the serum samples and for the details of preparation. Two methods of preparing the serum antigens for rabbit immunization were employed.

(1) An alcohol precipitation, by mixing 40 ml. serum, 160 ml. saline and 500 ml. absolute alcohol. The mixture was stood at 5° C. or room temperature for 1–2 hr., centrifuged, and after the removal of the supernatant the deposit was re-suspended in normal saline equal to the original volume of the serum. The rabbits received doses of

6 ml. I.P. of the precipitated antigen suspension on approximately six successive days. In some cases the rabbits also received additional doses of native serum and were bled 2–3 weeks later if the titres were satisfactory.

(2) An alum-precipitated antigen prepared by the method of Proom[4] was also used. The rabbits receiving this antigen were injected with 10 ml. I.M. into both hind legs, and were finally bled approximately three weeks later.

Both methods of immunization gave satisfactory precipitating sera, and these were used in the tests reported below. The antisera on testing mostly gave positive precipitin ring tests with the homologous test serum when the latter was used at dilutions of 1/3,000–1/20,000. However, none of the rabbit anti-sera used by me when tested with *Rh* sensitized cells, after absorption with *A*, *B* and *O* cells, gave titres as good as those reported by Coombs *et al.*

The rabbit anti-sera which had been prepared during 1943–44 contained 0·02 per cent 'Merthiolate' as a preservative and had been Seitz-filtered through E.K. pads, ampouled and stored at 5° C.

Results. The cells employed in the following tests were the washed red cells of a baby of Group *O* sensitized *in vivo*; normal cells of Group *O*; cells of Group *A* sensitized *in vitro* with a human serum of Group *A* containing pure anti-Rh_0 (Δ') 'blocking' or 'incomplete' antibody; normal cells of Group *A*, and normal cells of Group *B*.

Some rabbit anti-sera tested were first absorbed with *A*, *B* and *O* cells, and others were used diluted beyond the range of hetero-agglutination which, in most cases, did not extend beyond a dilution of 1/5. With some animal anti-sera heteroagglutination was seen only in the undiluted serum and then was extremely weak.

The following precipitating anti-sera prepared in rabbits gave positive results with *Rh* sensitized cells, and negative results with normal cells.

Rabbit anti-human	(2 lots)
Rabbit anti-porcine (pig)	(2 lots)
Rabbit anti-feline (cat)	(1 lot)
Rabbit anti-equine (horse)	(1 lot)
Rabbit anti-caprine (goat)	(2 lots)
Rabbit anti-canine (dog)	(1 lot)
Rabbit anti-bovine (ox)	(1 lot)

Negative results with *Rh* sensitized cells were obtained with rabbit anti-galline (fowl) (3 lots). Two of these anti-sera showed no evidence of hetero-agglutinins for normal *A*, *B* and *O* cells, while the other, prepared by the alum-precipitated method, showed the presence of heteroagglutinins only undiluted. Tests made on these anti-sera as a further check showed that they had not deteriorated as precipitating sera on storage for over two years at 5° C.

The above results are reported because they are interesting, and because data of this kind may help to throw further light on the immunological basis of the test described by Coombs, Mourant and Race. The test is one which promises to have wide applications and general use. It should be noted that Coombs *et al.* have shown that the test is not confined to *Rh* sensitization, but has been the means of detecting a new antigen and antibody. The test to date has been found to give negative results when the baby has hæmolytic disease due to blood group agglutinins anti-*A* or anti-*B*, and the reason for this has not yet been proved.

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The Incomplete Antibody: a Quantitative Aspect

It is widely believed that the titre of the incomplete or blocking (Δ') antibody, as determined by the quantitative 'saline test'[1], is dependent on the dilution of the anti-Rh_0 (Δ) serum added to the mixture of red cells and unknown serum[2]. Coombs, Mourant and Race[3] stated in a recent article, "It is remarkable that the 'blocking' effect at this time still remained proof against our strongest Δ serum". However, if the incomplete antibody is 'univalent', as suggested by Wiener[4], and if the 'blocking' effect is a quantitative reaction, the presence or absence of agglutination in the 'saline test' would be expected to be dependent on the absolute amount of incomplete antibody (Δ') present and not on the amount of the anti-Rh_0 (Δ) serum added.

The results of the 'saline tests' with various dilutions of serum containing the anti-Rh_0 (Δ) serum provide some information of the nature of the reaction.

The serum containing incomplete antibody (Δ') was serially diluted with saline and to each dilution was added an equal volume of a 1 per cent suspension of Rh_0 (*cDe*) red cells. The mixtures, which were made in small test tubes, were incubated at 37° C. for thirty minutes. A volume (equal to that already contained in the tube) of serum containing the anti-Rh_0 (Δ) agglutinin in high titre was then added to each tube, and the tubes incubated for a further sixty minutes. At the end of this time a small quantity of the sedimented red cells was carefully removed from each tube with a fine capillary pipette and placed on a microscope slide. The cells were examined under the low power of the microscope for the presence or absence of agglutination. The titre of the incomplete antibody (Δ') was taken to be the last dilution of the unknown serum in which agglutination was absent.

Four different sera containing an incomplete antibody (Δ') were tested against various dilutions of the anti-Rh_0 (Δ), and all gave consistent results. A typical protocol is shown in the accompanying table.

Dilution of anti-Rh_0 (Δ) serum	Dilution of serum containing incomplete antibody (Δ')				
	1/2	1/4	1/8	1/32	1/128
1/2	—	—	+	+	+
1/4	—	—	+	+	+
1/8	—	—	+	+	+
1/10	—	—	+	+	+
1/20	—	—	+	+	+

The titre of the incomplete antibody (Δ') in the other three sera was similarly independent of the dilution of the serum containing anti-Rh_0 (Δ) agglutination.

The results are consistent with the concept that there is a common receptor on the surface of the *Rh*-positive red cell for anti-Rh_0 (Δ) agglutinin and the incomplete antibody (Δ'). If the incomplete antibody (Δ') forms a union with all these receptors then even large amounts of the anti-Rh_0 (Δ) serum will not produce agglutination. On the other hand, if the amount of the incomplete antibody (Δ') present is insufficient to unite with all the receptors, added anti-Rh_0 (Δ) serum will unite with the remaining receptors and produce agglutination of the red cells. However, although the results are consistent with this quantitative concept, they do not necessarily provide confirmation of this theory.

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Testicle and Spermatic Tract Lesions in Lymphogranuloma Venereum

In a report on venereal diseases in West Africa by Lieut.-Colonel R. R. Willcox[1], when referring to other tropical conditions, he says: "Hydrocœles are very common in the African though considering the amount of gonorrhœa it is not surprising". According to him, lymphogranuloma venereum (inguinale) is also very common among these natives.

L.V. is responsible for a certain number of cases of epididymal inflammations, many of them of a subclinical type[2–6], others, especially when the infection with Neisseria gonorrhœa has been simultaneous, with intense inflammatory symptoms. Some of these cases are accompanied by vaginalitis, which is rapidly reabsorbed; others follow a different course and hydrocœle is installed. Both subclinical or associated L.V.–gonorrhœa cases may follow a slow course and occasionally small epididymal abscesses adhere to the scrotum, break down and leave draining sinuses that heal spontaneously or under treatment. In all mentioned types, L.V. infection is seldom suspected[7].

In some cases the process mainly affects the blood-vessels and lymphatics of the spermatic cord; the vas or ductus deferens remaining normal or slightly enlarged. Thrombo-angiitis, phlebitis and lymphangiitis with micro-abscess formation can be found on study of sections of these structures.

Lesions of L.V. nature of the testicle proper have also been recorded[8,9].

Our observations have all been made in a country where filariasis is unknown.

W. E. Coutts

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National Service of Health,
Santiago, Chile. Aug. 2.

[1] Willcox, R. R., *Nature*, 157, 416 (1946).
[2] Coutts and Vargas Zalazar, *Ann. Malad. Venér.*, **31**, 895 (1936).
[3] Sato Akira, *Japan. J. Dermat. and Urol.*, **39**, 75 (1936).
[4] Bizzozero and Franchi, *Minerva Med.*, **2**, 241 (1937).
[5] Coutts and Martini Herrera, *Ztschr. f. Urol.*, **32**, 439 (1938).
[6] Huard and Joyeux, *Ann. d'Anat. Pathol.*, **16**, 228 (1939).
[7] Coutts, *Brit. J. Ven. Dis.*, **19**, 37 (1943).
[8] Bastos de Sequeira, *Bol. Soc. Med. e Cir. de Sao Paulo*, **26**, 13 (1942).
[9] Midana, *Dermatologica*, **85**, 403 (1942).

Dr. Coutts's letter is very interesting as the writer has made a particular study of intra-urethral infections of lymphogranuloma venereum (inguinale).

As regards hydrocœles in West Africa, however, the matter of their origin is difficult to determine. Gonorrhœa is extremely prevalent there and, apart from lymphogranuloma venereum, which is also very common, there are also filariasis, dracontiasis and schistosomiasis, as well as other genito-urinary conditions, which may subscribe to their production.

As a basis of probability, gonorrhœa is singled out as the most likely antecedent while the other diseases mentioned are probably more common causes than the comparatively rare one of lymphogranuloma venereum. This matter is very hard to prove as a hydrocœle in a patient showing a positive Frei test is by no means proof that the hydrocœle is due to lymphogranuloma venereum, as the Frei test may remain positive for a very long time after infection.

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RESEARCH ITEMS

Food of the Wigeon

Investigations by J. W. Campbell at North Uist into the food habits of the wigeon (*Anas penelope*) have shown that the widely held opinion that the broad-leaved *Zostera* is the main food of these ducks needs qualification. In some areas *Ruppia* was found to be preferred to all other foods, and the narrow-leaved *Zostera* was found to be eaten in greater quantities than the broad. In recording these results, Campbell stresses the need for observations of the bird's environment before statements, which are often based on stomach analyses alone, are made about food habits. In the inquiries at North Uist attention was paid to the locality, foods available, mode of capture, season when obtained, activities prior to capture, field observations on feeding habits, age, weather conditions, and the competitors for food. Similar work was carried out on the feeding habits of the brent goose (*Branta bernicla*).

Diurnal Variation in Tumour Production

J. C. Mottram (*J. Path. Bact.*, 56, 181 and 391; 1944) described a method whereby an abundance of tumours could be produced by a single application of benzpyrene to the skin of mice. He found that the yield of tumours depended on the degree of mitotic activity in the epidermis at the time of application, which suggested that benzpyrene acts only on dividing cells. There is known to be a marked diurnal variation of mitosis in the epidermis of mice, with a maximum at midnight and a minimum at midday. Midnight application of benzpyrene should therefore yield more tumours than midday application, and such proves to be the case. Mottram (*J. Path. Bact.*, 57, 265; 1946), using groups of mice, painted one flank at midnight and the opposite flank at midday with the result that about twice as many tumours developed on the midnight flank as on the midday one. Control of lighting conditions did not influence the result.

Blood Viscosity and Rate of Oxygen Exchange

J. Fegler and J. Banister (*Quart. J. Exp. Physiol.*, 33, 163; 1946) describe a special form of tonometer for measuring the rates of oxygen and carbon dioxide exchange of blood *in vitro*. Study of various factors influencing the rate of oxygen exchange showed that blood viscosity was often the underlying limiting factor. Rise of temperature (from 22° to 38° C.), or reduction in red cell concentration, increased the rates of uptake and release of oxygen, and the increases could be exactly accounted for by the concomitant decreases in viscosity.

Skeletal Anatomy of Fleas

Under this title, the well-known American insect morphologist, Dr. R. E. Snodgrass, has published a very detailed anatomical study of the skeletal parts of adult fleas (*Smithsonian Mis. Coll.*, 104, No. 18). The adult flea, it may be added, is an extremely specialized creature showing no very clear affinities with any other order of insects. What few indications it does give have led many entomologists to conclude that it has relationships either with the Mecoptera or the Diptera, or possibly with both these orders. The object of the present memoir, the author states, is to interpret the skeletal anatomy of fleas according to the general principles of insect morphology. His account of the mouth-parts includes a discussion of the homologies of the organs concerned. He discards the older interpretations and regards the paired stylets as being the laciniæ of the maxillæ and not the mandibles, as has been usually believed. The musculature of these stylets is in accordance with that of the insect maxillæ, and the unpaired stylet is accepted as being the greatly drawn-out epipharynx. The food channel is the minute tube formed laterally by the curved inner walls of the laciniæ combined above with the epipharynx. Concrete evidence of the winged ancestry of fleas is apparently revealed (as was first shown in 1935 by Sharif) by the presence of what seem to be vestiges of true wing-buds on the mesothorax of the pupa of certain species. The male genitalia come in for detailed treatment, and, as the author remarks, are probably the most complicated apparatus of their kind to be found in all the Insecta. The memoir is illustrated by 21 plates portraying many anatomical details of structure.

Purification of Tobacco Mosaic Virus

Estimations of the size and shape of tobacco mosaic virus have often given conflicting results which suggest that it could occur in a range of different sizes. F. C. Bawden and N. W. Pirie (*Brit. J. Exp. Path.*, 26, 294; 1945) confirm this and show that the properties of different preparations can vary much more than was previously suspected. Tobacco mosaic virus aggregates with the constituents of sap of its host plant, and with other agents. A method for minimizing the aggregation of virus as extracted from plant sap is described, and it is shown that virus can be separated by differential ultracentrifuging into fractions with widely different properties. The most rapidly sedimenting fractions contain little but virus nucleoprotein; the slower deposited fractions have little virus, which has indeed different serological and physical properties from the earlier deposited virus. All fractions are unstable and rapidly assume the serological behaviour of flagellar antigens, with intense anisotropy of flow. This change is usually accompanied by the elimination of non-virus material. The primary virus particle seems to be small, not greatly elongated, and combined with extraneous material in the plant. Removal of this matrix allows the virus to combine into the rod-shaped masses in which it is commonly found.

Effect of X-Rays upon Agricultural Seeds

In 1940 the Svalof Plant Breeding Station began an extensive programme of the induction of mutations for plant-breeding by radiation with X-rays. A. Gustafson (*Hereditas*, 30, 165; 1944) describes the effects of treating dormant seeds of various crops with X-rays. The critical dosage above which great lethality occurs varies considerably between species. Thus peas require about 7,500 r., but *Brassica napus* and *Linum* are still highly resistant at more than 50,000 r. The author points out the X-rays were hard (highly penetrating) and that the resistance was probably due to the oily or fatty nature of the cell contents. A useful table of critical doses is provided.

Sunspots and Magneto-Hydrodynamic Waves

Hannes Alfvén has put forward a new theory of sunspots (see *Nature*, 157, 522, April 20), and a second paper on the subject has now appeared (*Mon. Not. Roy. Astro. Soc.*, 105, 382; 1945). The main object of this paper is to discuss the shape and orientation of the magneto-hydrodynamic whirl rings created in the solar core. Theory requires that a bipolar sunspot is produced when a whirl ring intersects the solar surface;

when the ring reaches the surface, two sunspots of different polarities, created very close together, would be expected, provided no secondary phenomena existed. The subsequent behaviour of the spots conforms largely to theoretical predictions, except the last phase, in which the spots are not often observed to move close together again and disappear, as theory requires. Observations of the shape of the bipolar sunspot make it possible to construct the shape of the whirl ring, and three diagrams show these. During the motion from the core outwards, the whirl rings are deformed because of the changes in the magnetic field and the velocity; in the case of a homogeneous field out to about $1{\cdot}4 \times 10^{10}$ cm. the whirl is almost circular, and it is also circular for a dipole field outside this limit. An investigation of the motion of a whirl proceeding as a magneto-hydrodynamic wave in a liquid with variable density under the action of gravitation shows that when the whirl velocity is high, the acceleration or retardation is most rapid for whirls with planes parallel to the magnetic field. The results are applied to conditions in the sun, and it is shown that it is impossible to adopt the current stellar models of the sun—a convective core from the centre to about 10^{10} cm. and a non-convective region outside this limit—because convection in one part of the sun causes magneto-hydrodynamic waves which give rise to convection in other parts also, and it is not appropriate to speak of a 'non-convective' region. No account has been taken of the Coriolis force, and it is admitted that ignoring it is one of the most conspicuous deficiencies of the theory. An exact treatment of its effect, however, encounters mathematical difficulties.

Theory of Pulsating-Field Machines

A PAPER by Dr. Robert Pohl (*J. Inst. Elec. Eng.*, 93, Pt. 2, No. 31, February 1946) suggests that, instead of attempting to adapt the rotating-field theory to pulsating field machines, it is more satisfactory to employ an independent theory developed by finding an expression for the pulsating permeance of the magnetic path and considering the total magneto-motive force acting upon that permeance, both on open-circuit and on load. A new method for determining rapidly the air-path permeance as a function of time leads to the 'belt characteristics', thence to the electromotive force and its wave-form on open-circuit, to the armature reaction including its effect on the wave-form, and to the necessary excitation for a given load. The analytical results are supplemented by simple vector diagrams. The means for controlling the wave-form are then discussed, among them a new device for eliminating undesirable odd harmonics in addition to the even harmonics. Finally, suggestions are made for simplifying the work in design offices by standardizing the most favourable slotting and the corresponding characteristics.

Phthioic Acid

PHTHIOIC acid, $C_{26}H_{52}O_2$, is a liquid saturated fatty acid isolated from the lipoids of tubercle bacilli, and has been claimed to be the specific cellular stimulant responsible for the tubercle. N. Polgar and Sir Robert Robinson (*J. Chem. Soc.*, 389; 1945) summarize previous attempts to find its constitution, and point out that the evidence suggests that the phthioic acid molecule contains only one long chain, which must have a greater length than previously thought possible on the X-ray evidence. This view is confirmed by the experiments recorded in the paper. A number of analogous long-chain acids were synthesized, and they show film properties analogous to those of phthioic acid. The structure $CH_3.[CH_2]_3.CHMe.[CH_2]_5.CHMe[CH_2]_9.CHMe.CH_2.CO_2H$ is shown to be feasible by the synthesis of the substance which is found to have properties tallying with those of phthioic acid.

Dry Ice

SOLID carbon dioxide, commonly known as 'dry ice', with a sublimation temperature of $-78{\cdot}5°$ C., is a commercial product, which has found many applications. H. N. Brown (*J. Franklin Inst.*, 240, 487) describes equipment using dry ice as a source of cold which can be applied in testing or other low-temperature work, for example, in testing small electronic parts on a mass-production basis. This is much simpler than conventional refrigerating machinery. The apparatus consists of test chambers with close-coupled piping and positive-pressure blowers circulating cold gas liberated from dry ice containers. Rate of temperature change is achieved by valve adjustment. Testing other materials, and metal shrinking and other low-temperature treatment could be carried out with such equipment.

Constitution of Trumpler's Star NGC 6871,5

JAAKKO TUOMINEN has published a number of papers on Trumpler's stars, in which their observed luminosities were compared with the theoretical results derived from Eddington's mass-luminosity formula, and also his theory to explain the differences is expounded. In a recent paper (*Mon. Not. Roy. Astro. Soc.*, 105, 256; 1945) Tuominen discusses the relatively low luminosities of Trumpler's stars, as compared with Eddington's mass-luminosity formula. This formula is based on the assumption that there is a purely radiative transfer of heat throughout the star; but the theory that the transfer of heat is partly convectional and partly radiative is now adopted. To avoid very high turbulent speeds, it is necessary that the density should rise relatively quickly from the surface inwards. The density is assumed constant in the innermost part of the star, but it may decrease inwards, and this is explicable from the fact that radial convection currents are hampered by a high turbulent viscosity. The turbulence is maintained by large-scale currents, and subatomic heat is responsible for keeping the whole mechanism going.

Variations in the Lunar Formation Aristarchus

IN a paper on this subject, H. Percy Wilkins (*J. Brit. Astro. Assoc.*, 56, 1, December 1945) suggests a possible explanation of certain 'glows' on the surface of the moon, with special reference to those associated with Aristarchus, in which dusky streaks have often been noticed. The majority of the fluorescent or glow effects observed within Aristarchus and in connexion with other objects have been detected around the period of sunspot maximum, and it is suggested that these glows may be caused by electronic impact due to electrons emitted by the sun striking the lunar surface. The theory postulates that certain portions of the lunar surface consist of materials capable of deflecting electrons, or alternatively, the emission of gases like argon from the deeper cavities or clefts. The theory is very interesting, and it is to be hoped that further research will be carried out on the subject.

INDIAN SPECIES OF *ARISÆMA*

By Dr. D. CHATTERJEE
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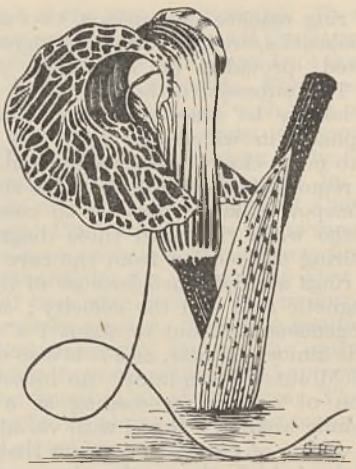
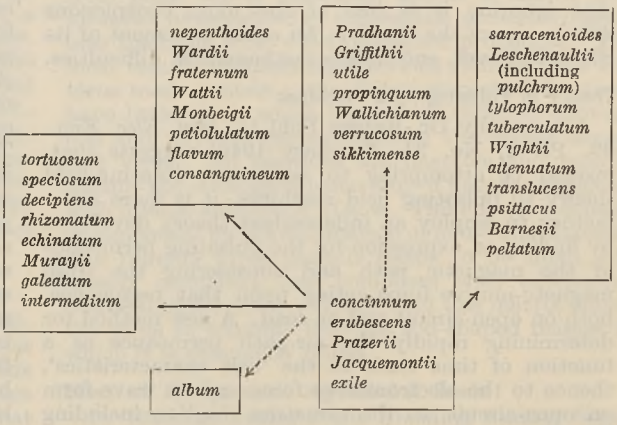
THE arum family (Araceæ) is well represented in tropical parts of the world, and, in India, genera like *Colocasia*, *Alocasia*, *Typhonium*, *Amorphophallus* and *Pothos* belonging to this family are commonly found. Some of these genera are associated with the hydrophytes and others form constituent plants of the secondary vegetation of the '*terai*' forests or the foothill vegetation of the Himalayas. The '*terai*' should be regarded ecologically as the real tropical rain forest. The arum family as a whole, therefore, comprises plants which are not found in high altitudes in India in places like Simla, Darjeeling or Sikkim. We are apt to think of plants like lofty *Magnolias*, *Cedrus*, *Quercus*, *Rhododendrons* and other plants like *Primulas*, *Gentianas* and *Senecios* when we imagine the vegetation at high altitudes in the Himalayas. An exception to this is the interesting and fascinating genus *Arisæma* belonging to the arum family. The species of this genus are always found in high hills and some reach altitudes of 15,000 ft. (5,000 m.) in the Sikkim Himalayas.

Some of the Himalayan *Arisæmas* are plants of great beauty, and their cultivation in gardens of temperate countries should open up a novel line to horticulture. The peculiar hood-like and deeply coloured spathe is the most attractive part of the plant, and species like *A. Pradhanii* (see accompanying figure), *A. Griffithii*, *A. utile*, *A. Wallichianum*, *A. sarracenioides* and *A. nepenthoides* should find a ready appeal to plant lovers. The coloration of the spathe of *A. Pradhanii* is described by Dr. Cromar-Watt of Aberdeen as follows: "When seen in sunshine the spathe looks more like some burnished metal than any vegetable production. A combination of velvety chocolate purple, chrysoprase green and pearly white with ribs of shining burnished copper in the inside." The plants flourish well in a cool greenhouse in a compost of rich loam, decayed leaf mould and sharp sand. They require plenty of moisture during the growing season, but afterwards they should be kept moderately dry and rested during the winter months.

Our knowledge of the Indian species has been enriched in recent years by some fine collections made in the South Indian hills by the late Prof. E. Barnes of Madras. Although Prof. Barnes was a chemist and had been teaching chemistry in India, his casual interest in plant collections has resulted in the discovery of eight new species of *Arisæma*. It is now possible in view of ampler materials to study the group and the interrelationship of the species. Hitherto, no one has attempted to arrange the Indian species in natural groups excepting perhaps Engler ("Pflanzenreich—Araceæ", 1920). Unfortunately, Engler's first group, *Fimbriata*, does not seem to contain plants with a simple spathe and appendix. Besides, there are fourteen other groups, and although some of them contain plants of natural alliance the interrelationship of the groups are somewhat obscured by sorting some one hundred species into fifteen groups. The Indian species should have a basic plexus in plants like *A. exile* and *A. Jacquemontii* and not in *A. alba* of the *Fimbriata* group as proposed by Engler. I have attempted a simpler



arrangement, and the species have been sorted in four main groups. The linear development from the basic species *A. exile* ends in *A. Griffithii* and *A. Pradhanii*. A parallel development is indicated in south India and the line must have separated from the main phase early in the evolutionary history. Besides these, there are two other smaller developments in northern India ending with species like *A. tortuosum* and *A. nepenthoides*. The general plan of *Arisæma* may be outlined as shown below:



A detailed account of the Indian *Arisæmas* has been prepared and will be published elsewhere.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

ANNUAL CONFERENCE

THE twenty-first annual Conference of the Association of Special Libraries and Information Bureaux, held at the Polytechnic, Regent Street, London, during September 13–15, while less well attended than the previous conference and possessing the advantage of a single venue, was scarcely so successful in providing the opportunities for informal discussion and contacts, apart from the conversazione with which the Conference opened. This was again

followed by the annual general meeting, and the reports submitted to that meeting on the year's work again showed an increase in membership, which now stands at 712, and an increase in the subscriptions to £2,215. The honorary treasurer was able to report a surplus for the year on the income and expenditure account of £671, and in addition to grants of £300 from the British Council and £1,000 from the Department of Scientific and Industrial Research, the income included £253 from the Documentary Reproduction Service recently established. In view of the discussions at the previous Conference, a special Policy Committee was appointed during the year to review the memorandum and articles of association, to make recommendations regarding the relation between the Council and its committees and on the internal organisation of the Association. Certain broad proposals for the alteration of the articles of association were approved by the annual general meeting, and legal aid will now be obtained in redrafting, having regard, however, to the relations of the Association with the British Society for International Bibliography. Establishment of a special joint committee of the two bodies to work out a definite scheme of co-operation or possible coalescence was also approved by the annual general meeting, when Sir Reginald Stradling was elected president, Mr. T. M. Herbert re-elected honorary secretary, and Miss I. M. Shrigley honorary treasurer.

In his presidential address at the first session of the Conference, Sir Reginald Stradling discussed "The Place of the Intelligence Group in a Technical Team", dealing particularly with its place in the group of industries concerned with building and civil engineering with which he is connected. Sir Reginald pointed out first that in research on the problems of an old traditional industry there are usually no ready-trained scientific workers, and there is no division of science specifically directed to the practical need of the industry. The service of such large-scale human needs as building demands a combination of many branches of science, each contributing its own quota to the development of the applied science required. This determines the type of organisation required; and stressing the vital importance of team-work, which must provide for the biological and social sciences as well as the physical, Sir Reginald emphasized that the problem of the leader of such a research team is to create the conditions under which his specialist colleagues can work without the feeling of frustration which results from too much regimentation. In creating such conditions the intelligence group often holds a key position in a research team, and Sir Reginald devoted most of his address to a discussion of the qualities desired in such an intelligence officer and of the training of senior men for such work. That training, he thought, should be as wide as possible, with a general degree in science as a minimum, industrial experience and two or more foreign languages. Moreover, selection by academic standards only is useless; although the presence in a research team of a man intimately acquainted with the resources of information at his disposal and also understanding the requirements of the research worker and fully and professionally aware of the team's objectives is one of the major advantages of team-work, recent trends in official circles suggest that the value of scientifically trained leaders in intelligence work is not yet appreciated. Sir Reginald Stradling's persuasive presentation of the dynamic aspects of intelligence work and library service concluded with a brief survey of the activities of the Association of Special Libraries and Information Bureaux, in which he referred to the steady growth in the industrial membership and indicated a future for the Association more on the lines of a learned society. We now particularly need to explore, he said, the best methods of getting the information already collected used effectively.

Following the presidential address, Mr. Theodore Besterman presided over a session at which Mr. A. D. Roberts presented a paper on "The Preparation and Coverage of Critical and Select Bibliographies". Mr. Roberts distinguished three types of bibliography: select and critical bibliographies of the literature of one subject as it stands at a named time; critical bibliographies published serially or in serials; and guides to the literature of various subjects. Works of the first class have always been needed by librarians and by subject specialists, and Mr. Roberts cited a number of examples drawn from various branches of science, pointing out both the need for sifting material for inclusion and referring to the difference of opinion as to what should be included. He also stressed the value of classification so as to facilitate their wider use and incorporation, but neither in his paper nor in the discussion that followed was the important point made that the basis of selection (other than a period basis) should be clearly stated. The effort involved in doing this might eliminate some of the disagreement between experts to which Mr. Roberts referred. Commenting on the second type of bibliography, Mr. Roberts emphasized the need for good critical surveys of many more subjects to enable men of science and librarians to get quickly at the most important writings on scientific subjects, thus reducing the necessity for laborious searches. In some subjects there is a need for critical literature surveys at different levels; and commenting on the tendency, in annual review volumes dealing with scientific subjects, to limit the survey to periodical articles, Mr. Roberts stressed the value of including monographs and books published during the period and also of quoting authoritative reviews for the works entered. Mr. Roberts recognized the limitations of such bibliographies and directed attention to the desirability of abstracting services doing more than list literature surveys without comment. His third type of bibliography covers a larger field, and very few books of this type have been published apart from some efforts in chemistry. Here, above all, it is important that the compiler of the bibliography should indicate clearly the class of reader to whom his work is addressed and the basis of selection. Indifference to these elementary principles has been responsible for much unsatisfactory work in all three types of bibliography, and yet neither in the paper itself nor in the discussion, except perhaps in a remark of Mr. Greenaway, of Messrs. Kodak, Ltd., regarding the date or period of a bibliography, did they appear to be sufficiently appreciated.

The paper "What an Industrialist Expects of an Information Service", which Sir Arthur Fleming and Miss B. M. Dent read before the following session, proved scarcely as challenging as might have been expected. Sir Arthur indeed, after stressing the importance of new knowledge and ideas in industry as a condition of progress, said that the industrialist requires accurate and comprehensive information and needs it quickly; but for the rest he contented himself with describing the information service developed during the last thirty years to meet the needs of the

research and other departments of the Metropolitan-Vickers Electrical Co., Ltd. Sir Arthur paid tribute to the pioneer work of Mr. J. G. Pearce in the development of this service, the cost of which now he put at about £10,000 a year. A recent development is the issue weekly from 1945, in response to a request from the works senior staff, of an *Industrial Digest*, each number of which contains about fifty brief abstracts on factory processes and workshop practice likely to be of interest to factory executives.

Sir Arthur Fleming's paper was followed by one from Prof. R. S. Hutton on the communication of specialist information to business executives, in which he emphasized that the problem of bridging the gap between the academic world and the so-called practical man is essentially one of interpretation. There are psychological factors, and the scientific worker sometimes pays too little attention to the consideration of the most appropriate form of communication; but Prof. Hutton stressed the importance of clear and brief exposition. Referring to T. H. Huxley and W. H. Hudson as examples, he urged that however important clear expression and the planning of reports may be, the prime necessity is to concentrate attention on the actual target to which one's written or spoken word is directed. This aspect of the work of the research associations is of increasing importance, and Prof. Hutton concluded his paper with some hints to the individual information officer and a plea for more imagination, alertness and experience to be brought to bear on the problems of exposition and interpretation. While Prof. Hutton's remarks were generally appreciated, it seemed clear from the brief discussion which followed that the effective communication of scientific and technical information demands not merely much skill on the part of the research worker and information officer but also a considerable improvement in the general standard of education and scientific training of the average business executive himself. An evening session at which Dr. L. J. Comrie, of the Scientific Computing Service, Ltd., presented a paper on "Machines and Tables" closed the proceedings on September 14.

The opening session on September 15, over which Mr. A. E. Cummins presided, was given over to a symposium of papers on some aspects of documentation in Europe to-day. Although short papers by John Ansteinsson on special library facilities in Norway, by Dr. F. Steggerda on the present position of information services in the Netherlands, by Dr. Erik Hernlin on the technical information service in Sweden, by W. Janicki on the Swiss Centre of Documentation, and by J. Wyart on scientific and technical documentation in France were circulated in advance and not read at the Conference, quite inadequate time was allowed for discussion on present conditions in Germany. If the first paper at this session, by Mrs. J. Lancaster-Jones, on "Some Aspects of the Demand for British Scientific and Technical Books for Europe", could be allowed as a contribution to the particular theme under discussion, Miss Esther Simpson's account of the Society of Visiting Scientists seemed irrelevant, and the Conference's organisers failed to gauge the strength of the desire for full information about the position in Germany, especially from British observers. In the absence of Mr. Ronald Fraser, of the Control Commission for Germany and Austria, present conditions in Germany were described by Colonel P. K. Blount, who had just returned from Germany for the purpose, and by Mr. K. Garsides. It would be impossible to do justice to either speaker's contribution here by attempting to summarize their account of the position of the university and technical libraries in the British Zone, beyond the statement that roughly some fifty per cent of the holdings of books in both British and American zones have been destroyed. As regards periodicals, little was added to the picture of chemical publications given by Dr. Conant in his report to the American Chemical Society, except to indicate some better prospect of the continuation of "Beilstein's Handbuch". Colonel Blount indicated that British policy favours the resumption of old, rather than the initiation of new, periodicals. The general impression left by the papers themselves, by the chairman's own contribution and by the whole of the lively discussion, was that far too little has been done to secure for Great Britain either books or sets of periodicals published in Germany during the War, and that the energy of the Library of Congress Bureau and other American activities have now left the field bare. Dr. Hutton cited examples of action taken by the Cambridge University Library which enabled that Library to complete its holdings of the German periodicals to which it had subscribed in 1939, and similar action may have been taken by other British libraries. A resolution moved by the chairman was unanimously adopted, urging the Council to give close consideration to the whole position with the view of urging appropriate action on the British authorities. Beyond this, however, the session gave some disconcerting and melancholy evidence of the obstacles that yet exist to the free interchange of knowledge through the medium of print.

At the afternoon session, over which Mr. E. H. Lindgren presided, Mr. Colin Dean described the organisation of the Central Film Library, and during the session there were shown the films "Library of Congress" and "Book Bargain". The final session, when Dr. J. E. Holmstrom presided, was devoted to a discussion on technical dictionaries and glossaries, which was introduced by Miss M. Gossett.

RE-OPENING OF THE GEOLOGICAL MUSEUM, SOUTH KENSINGTON

THE Geological Museum at South Kensington was re-opened on September 18 after being closed for seven years. From 1935, when the new building in Exhibition Road was opened by the King, then Duke of York, until the outbreak of war, there were considerably more than a million visitors to the Museum, which is still the most modern and well-fitted of its kind in the world. Throughout the War the building was occupied by the headquarters staff of the London Civil Defence Region. The galleries were converted into offices; the more valuable exhibits were evacuated to North Wales, and the remainder were stored. Although a heavy bomb fell on the pavement near the main entrance, and another struck the Geological Survey and Museum offices at the west end of the building, no major structural damage was caused by enemy action; but a vast amount of repair and restoration work has been necessary, including some 15,000 sq. ft. of window and roof glazing.

The reconstruction of the exhibits has been taken in hand and has now proceeded far enough for the main hall to be re-opened to the public. Among the more

striking permanent exhibits in this hall are the unique rotating relief globe 6 ft. in diameter coloured to show world geology—this most fortunately survived the explosion of a 1,000 lb. bomb about 50 ft. away; illuminated dioramas of past and present scenery; large relief-models of south-eastern England; many hundreds of photographic enlargements of geological subjects; and the Museum's collection of precious and ornamental stones. There are also three special exhibits of topical interest. The largest of these, "British War-time Geology", illustrates some of the contributions to the war effort made by British geologists in both the industrial and the military spheres.

The examples in the Museum of geological work carried out within the British Isles, which are demonstrated by maps, diagrams, photographs and specimens, include intensive survey and search for outcrop coal, for the ores of iron, lead, zinc, tungsten and tin, and for many other essential minerals such as mica, barytes, fluorspar and sand for the manufacture of optical glass; the survey and development of underground water-supplies for new factories, camps and aerodromes; and advisory work on the construction of underground factories, ammunition stores and other works.

Other parts of the display now available to the public deal with the application of geology to military operations overseas. Examples are shown of maps prepared by geologists during the planning of each major operation to predict the suitability of enemy-occupied territory for the passage of tanks, and for the rapid construction of airstrips, trenches and camp-sites. Other maps show the occurrence of rock for road and aerodrome construction and repair, and the prospects of obtaining underground water. There are examples of specially vital work on water supply in Egypt and the Western Desert. A related small exhibit of German military geological maps shows analogous work done by the enemy; of particular interest is an inch to the mile German map of the Brighton–Eastbourne district, revised to June 1940 in preparation for invasion, bearing notes on landing beaches, geology, topography and water-supply. A third special exhibit of current interest illustrates radioactive minerals from the principal producing localities throughout the world.

THE IRAVAS AND CULTURE CHANGE

THE Irava, who live on the Malabar coast, form a suitable subject for a study of culture change as they are a large and vigorous section of the Hindu community. Although not actually caste Hindus, neither do they belong entirely to the depressed classes, standing as they do at their head. Great changes have come over the life, social and economic, of the Irava since the British rule; and A. Aiyappan, himself a member of the tribe, is well qualified to record the culture changes wrought by the impact of the West on the Hindus (*Bull. Madras Gov. Mus.*, 1; 1944).

Starting with an explanation of his method, Dr. A. Aiyappan describes the setting of the problem, both geographical and historic, and the early political history of the district. There follows a most illuminating section dealing with the caste customs of the district and of the two million Irvanas in particular, fining it down to a certain village which he describes in great detail. He dwells at some length on untouchability, which may almost be said to reach its apotheosis in Malabar; the term is perhaps misleading and the expression 'contact taboo' is to be preferred.

The marriage customs and kinship systems of the Irvana form a most interesting chapter, the domestic life and in-law relationships being sympathetically described. In this caste the rather rare form of marriage, fraternal polyandry, used to be, and to some extent still is, practised, as many as five brothers being married to one wife.

Although the main occupation is the cultivation of coconut palms for the traditional occupation of toddy-making, there is also a good deal of agricultural labour, principally in the rice field. Toddy-tapping is a popular occupation as it only occupies a small portion of the day, although the palms need attention every day, and as a supplier of drinks the toddy drawer enjoys plenty of company. As is customary among Dravidian peoples, the Irvana women work in the fields with the men and are not secluded like those in the north of India. Food, houses and clothing are then described, in common with other economics, including the gains and losses due to culture contact. Further chapters on education, magic and religion, and law and order bring to a close this most interesting study.

On the whole, the author is optimistic regarding the future of this large tribe; he feels that culture contact may produce beneficial results, and is not unhopeful of the ultimate acceptance of the oppressed classes by the Hindus. K. RISHBETH

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 7

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 2.30 p.m.—Discussion on a paper entitled "Improvements of Hill and Marginal Farms", by Capt. A. R. McDougal (to be opened by Mr. Moses Griffith).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. C. F. Booth and Mr. J. L. Creighton: "Piezo-Electric Quartz and its Use in Telecommunications".

PHYSICAL SOCIETY (in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1), at 5.15 p.m.—Prof. M. L. E. Oliphant, F.R.S.: "Rutherford and the Modern World" (Rutherford Memorial Lecture).

Tuesday, October 8

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Sir Arthur MacNalty, K.C.B.: "Sir Thomas More as Public Health Reformer".*

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Messrs. D. G. Murdoch and M. Cuckney: "The Removal of Phenols from Gas Works Ammoniacal Liquor".

ROYAL SOCIETY OF MEDICINE, SECTION OF EXPERIMENTAL MEDICINE AND THERAPEUTICS (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Prof. H. P. Himsworth: "Protein Metabolism in Relation to Disease" (Presidential Address).

ILLUMINATING ENGINEERING SOCIETY (at the School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 p.m.—Mr. J. S. Dow: Presidential Address.

INSTITUTE OF FUEL (at Central Hall, Westminster, London, S.W.1), at 6 p.m.—Sir James Chadwick, F.R.S.: Melchett Lecture.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. N. J. L. Megson: "Recent Advances in Plastics" (Chairman's Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 8 p.m.—Prof. W. M. Smart: "John Couch Adams and the Discovery of Neptune" (Conversazione).

Wednesday, October 9

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Willis Jackson: Inaugural Address as Chairman.

ROYAL AERONAUTICAL SOCIETY (in the Lecture Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. R. Smelt: "A Critical Review of German Research on High Speed Air Flow".

Thursday, October 10

SHEFFIELD METALLURGICAL ASSOCIATION, MODERN METHODS OF ANALYSIS GROUP (at the Metallurgical Club, 198 West Street, Sheffield 1), at 7 p.m.—Mr. E. J. Vaughan: "The Application of Absorptiometric Methods to Metallurgical Investigation".

Friday, October 11

TEXTILE INSTITUTE, LANCASHIRE SECTION (at the Textile Institute, Manchester), at 1 p.m.—Mr. J. W. Howell: "Scientific Lighting in Cotton Mills".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, University of Manchester, Oxford Road, Manchester, 13), at 5 p.m.—Discussion on "The Mathematical Training of Physicists" (opened by Prof. E. C. Stoner, F.R.S.).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. Scott: "Chemical Engineering in the Tar Industry".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (joint meeting with the CARDIFF AND DISTRICT SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY and the SOUTH WALES SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY) (at University College, Cathays Park, Cardiff), at 6.30 p.m.—The subject will be Electrometric Analysis.

INSTITUTE OF ECONOMIC ENGINEERING (at the Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Prof. Meyenberg: "My Visit to Germany—Investigation of Time Study and Motion Study Developments on the Continent".

TEXTILE INSTITUTE, DUBLIN BRANCH, at 7.30 p.m.—Mr. R. S. Greenwood: "Past, Present and Future Development of Rayon and Rayon Spun Fabrics".

APPOINTMENTS VACANT

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

LECTURER IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (October 10).

COUNTY HORTICULTURAL INSTRUCTOR; ASSISTANTS (two Women) for Lecturing and Demonstration Work, at Essex Institute of Agriculture, Writtle—The Chief Education Officer, County Offices, Chelmsford (October 12).

LECTURERS IN (i) MECHANICAL ENGINEERING, (ii) MATHEMATICS, and ENGINEERING WORKSHOP SUPERINTENDENT at Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton 1 (October 12).

SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING at the Municipal Technical College—The Chief Education Officer, West House, Halifax (October 14).

SENIOR BIOCHEMIST at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School, Denmark Hill, London, S.E.5—The Medical Officer of Health (B), Mental Health Services, County Hall, Westminster Bridge, London, S.E.1, quoting 2437 (October 14).

DESIGN ENGINEERS (5) (Ref. C391); TECHNICAL ENGINEERS (2) (Ref. C422); DESIGN ENGINEER (Ref. F597), for Directorate of Atomic Energy at Risley, near Warrington—Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting appropriate reference (October 15).

DEMONSTRATOR IN PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (October 19).

BROTHERTON RESEARCH LECTURER IN PHYSICAL CHEMISTRY in the Department of Textile Industries—The Registrar, University, Leeds 2 (October 21).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER, for the Division of Forest Products, Melbourne, Vic., Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting appointment No. 999 (October 26).

POST OF PRINCIPAL—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (October 28).

HEAD OF A SMALL UNIT FOR THE DEVELOPMENT OF SPECIALIZED COMMUNICATIONS EQUIPMENT, near Farnborough, Hants—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1639 (October 30).

RESEARCH ASSISTANT FOR THE PHONETICS LABORATORY (with honours degree in either Physics or Electrical Engineering)—The Secretary, University College, Gower Street, London, W.C.1 (October 31).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Singleton Park, Swansea (November 2).

LECTURERS AND DEMONSTRATORS IN ENGINEERING (several)—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (November 4).

PRINCIPAL RESEARCH OFFICER and SENIOR RESEARCH OFFICERS (2) for the Physical Metallurgy Section of the Council for Scientific and Industrial Research, at the University, Melbourne, Vic., Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting appointment No. 998 (November 4).

PRINCIPAL RESEARCH OFFICER (PHYSICIST), for Section of Tribophysics, Melbourne, Vic., Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting appointment No. 982 (November 4).

LECTURER IN BACTERIOLOGY—The Registrar, University, Manchester 13 (November 9).

APPOINTMENT TO THE TEACHING STAFF OF THE APPLIED OPTICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

ASSISTANT CHEMIST—The Director, Experimental and Research Station, Cheshunt, Herts.

ASSISTANT METALLURGIST—Staff Officer, B.I.C.C., Belvedere, Kent, quoting S.R.6.

ASSISTANT MUNICIPAL ENGINEER for the Accra Town Council, Gold Coast—Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/12630.

CHIEF ANALYST for London factory; CHIEF ANALYST for new factory in Poole, Dorset—The Production Manager, The British Drug Houses, Ltd., Graham Street, City Road, London, N.1.

HEAD OF THE DEPARTMENT OF TEXTILE INDUSTRIES—The Principal, Technical College, Bradford.

LECTURER IN CHEMISTRY—The Professor of Chemistry, University of Manitoba, Winnipeg, Canada (applications by air mail).

PHYSICIST—The Secretary, British Filters, Ltd., Old Court, Cox Green, Maidenhead, Berks.

RESEARCH BIOCHEMIST—The Secretary, Liverpool Heart Hospital's Institute of Research for the Prevention of Disease, 117 Grove Street, Liverpool 7.

SENIOR ASSISTANT IN THE DEPARTMENT OF PHYSICS, and LECTURERS in (i) MATHEMATICS, (ii) PHYSICS, (iii) CHEMISTRY, (iv) CHEMISTRY WITH BIOLOGY, (v) MECHANICAL ENGINEERING—Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

TEMPORARY ASSISTANT FOR THE DEPARTMENT OF MATHEMATICAL PHYSICS—Prof. P. P. Ewald, Queen's University, Belfast.

HORTICULTURAL LECTURER AND MANAGER OF THE HORTICULTURAL DEPARTMENT at Farm Institute, Sparsholt, near Winchester—The County Education Officer, The Castle, Winchester.

LECTURERS IN (i) STRUCTURAL ENGINEERING, (ii) MECHANICAL ENGINEERING at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Water Pollution Research. Technical Paper No. 9: Animal Life in Percolating Filters; Identification of Flies, Worms and some other Common Organisms. By T. G. Tomlinson. Pp. iv + 19. (London: H.M. Stationery Office, 1946.) 9*d*. net. [145

The Fishermen's Struggle against Pollution, with Special Reference to the River Trent. By J. I. Spicer. Pp. 28. (Nottingham: Trent Fishery Board, 1946.) 9*d*. [145

Geological Survey of Great Britain: England and Wales. Wartime Pamphlet No. 46: Barium Minerals in England and Wales. By Dr. K. C. Dunham and H. G. Dines; with Contributions by T. Eastwood, J. V. Stephens, Dr. S. E. Hollingworth, W. Anderson and Dr. J. R. Earp. Pp. v + 150. (London: Geological Survey and Museum, 1945.) 6*s*. 9*d*. [165

Other Countries

Bergens Museum. Årsberetning, 1943–44. Pp. 84. Årsberetning, 1944–45. Pp. 91. (Bergen: A.-S. John Griegs Boktrykkeri, 1944–1945.) [193

Bergens Museums Årbok, 1944. Hefte 1, Naturvitenskapelig rekke. Pp 220. (Bergen: A.-S. John Griegs Boktrykkeri, 1945.) [193

Eclipse total de sol del 20 de Mayo de 1947: su desarrollo en el continente Sudamericano. Por Alfredo Volsch. Pp. 62. (Córdoba: Observatorio Nacional Argentino, 1946.) [193

Annals of the New York Academy of Sciences. Vol. 46, Art. 5: The Diffusion of Electrolytes and Macromolecules in Solution. By L. G. Longsworth, Charles O. Beckmann, Margaret M. Bender, Edward M. Bevilacqua, Ellen B. Bevilacqua, Douglas M. French, A. R. Gordon, Herbert S. Harned, Lars Onsager, Jerome L. Rosenberg and J. W. Williams. Pp. 209–346. Vol. 47, Art. 1: The Golgi Apparatus. an Interpretation of its Structure and Significance. By Leonard G. Worley. Pp. 56. (New York: New York Academy of Sciences, 1945–1946.) [193

Annual Report of the Indian Central Jute Committee for the Year 1944–45. Pp. ii+171. (Calcutta: Indian Central Jute Committee, 1945.) [193

Slovenska Akademija Znanosti in Umetnosti v Ljubljana: Matematično-prirodoslovi razred. Dela 3: Turbelarijska teorija knidarijev. By Jovan Hadži. Pp. 240. (Ljubljana: Slovenska Akademija Znanosti in Umetnosti, 1944.) [193

Nigeria. Annual Report on the Forest Administration of Nigeria for the Period 1st January 1944 to 31st March 1945. Pp. 47. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1945.) 4*s*. [213

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 97, 1945. Pp. iii+287+30 plates. (Philadelphia: Academy of Natural Sciences, 1945.) 7.50 dollars. [253

U.S. Department of Agriculture. Technical Bulletin No. 905: Biology and Control of the American Dog Tick. By Carroll N. Smith, Moses M. Cole and Harry K. Gouck. Pp. 74. (Washington, D.C.: Government Printing Office, 1946.) 20 cents. [253

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