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TEAM WORK IN SCIENCE

IN the accounts of scientific effort during the War on which the veil of secrecy has now been lifted, one common feature stands out on even the most casual reading. Whether we look at the efforts which went to the development of the atomic bomb, of radar, of 'Pluto', 'Fido', and British flame weapons, or in a vastly different field, of penicillin, the extent to which the achievements depend on team work is unmistakable. Sir Cecil Weir was at pains recently to emphasize the way in which in 1942 the Ministry of Supply brought together potential manufacturers of penicillin and interested men of science, and the fact that production was under way or about to commence in twelve factories run by eight firms was the direct outcome of the team work thus engendered. As a particular instance is the help given by experts of the Medical Research Council, and especially Dr. R. I. N. Greaves, of the Serum Drying Unit, Cambridge, in the design of the freeze-drying plant of the Glaxo penicillin plant at Greenford.

Again, Mr. Geoffrey Lloyd, who was in charge of the Petroleum Warfare Department from its formation in 1940 until the resignation of Mr. Churchill's Government, in reviewing the lessons from petroleum warfare, stressed the immense value of research and development teams, and the advantage, in dealing with a particularly stubborn problem, of getting almost completely separate teams to work from quite different aspects. Research and experiment, while they must be directed towards definite objectives, should proceed on a broad front, and policy control should be elastic. Mr. Geoffrey Lloyd was urging the need for a forward surge over the whole range of creative inquiry and invention for peace purposes, and it would be easy to multiply examples of this need and of the place of team work and co-operation in meeting it.

No field better illustrates this truth than the development of radar, and whether we take the Department of Scientific and Industrial Research's papers released in August by the Ministry of Production, the United States Government account "Radar : a Report on Science at War", or the article "Radar in War and Peace" which Sir Robert Watson-Watt recently contributed to *Nature* (156, 319 ; Sept. 15, 1945), the extent to which this great scientific achievement depended on a most remarkable integration of pure and applied science is clearly shown. In a statement to a Press conference at the Ministry of Information on August 14, Sir Stafford Cripps attributed to the bringing together of the Air Staff and their scientific advisers, distinguished outside scientific workers with wide contacts and fresh outlook, and the members of the National Physical Laboratory radio team, who had been encouraged by the Radio Research Board in fundamental research going right down to the root of radio problems, the immediate solution of the basic problem of air defence. From the appointment of this committee by Lord Swinton in 1935, considering the great complexity of the subject, progress was rapid, and an official document, cited by Sir Robert

Watson-Watt, describes the formation of this Committee for the Scientific Survey of Air Defence, with the contact between a user Department with a great need, and a Department which had fostered scientific discovery not wholly directed towards specific needs, as one of the most important events in our history.

Sir Robert Watson-Watt is at pains to bring out the way the story illustrates the need for encouraging scientific research in all fields and for making the needs of the State known to those who are engaged in scientific research, though he alone in his account passes over his own important contributions in these early developments. No account brings out more clearly than his own, however, the way in which the development of radar is based on Appleton's classical range measurement on the ionosphere and Breit and Tuve's powerful tool, the radio pulse. The beginnings of radiolocation, Sir Robert points out, lay in the work of those who laboured to understand more of the things that happened in the earth's atmosphere. Its later developments, and much of its technique at all times, were due to those who sought the inner secrets of the structure of matter.

Nor was this all. Sir Robert maintains that the most important thing about the British development of radiolocation is that it happened at the right time, and the essential differences between the British effort and that in other countries is to be found in the intangible factors which assured to us at each stage in development at least an adequate margin of time for meeting the successive crises of the War. Britain was a prominent leader in ionosphere research, and those researches were State-aided and generously and lightly State-controlled, and Sir Robert considers that without the peaceful pursuits of the Radio Research Board in general and of Sir Edward Appleton and his colleagues in ionospheric research in particular, radiolocation would have come too late to have any decisive influence in the War. Further, the Radio Research Board had trained a team of young research workers encouraged to see and explore the whole gap between the Morse key and the loudspeaker, and while turning their vision and imagination generally towards application, taking neither narrow nor short views. Sir Robert again stresses the importance of the spiritual ingredients—wisdom, sound judgment and courage—in the scientific advisers, the scientific workers, and the administrative officers who staked some millions of pounds of public money and revised the air defence system of the country ; but the most significant factor was the unprecedented and unprecedentedly productive interplay between scientific and operational minds, which carried the basic technique from its first defensive application in an early warning system through more actively defensive phases to a wealth of offensive applications which had a decisive effect in every major phase of the War.

This intimate co-operation of scientific and military minds, he suggests, will remain as the real secret weapon in the British armoury. Nowhere else has there been a parallel to the practice followed from the first days of radiolocation research. This fruitful co-operation, moreover, extended to the selection and training of personnel to operate and maintain the systems, to the evolution and practising of tactical methods based on the systems, and to the whole complex of technical, tactical and logistic problems involved in introducing new scientific devices into heavily engaged operational formations.

Even that valuable tradition of constructive debate between General and junior scientific officer and the inextricable weaving of contributions from operational officer and scientific worker is not the only lesson of co-operation and team work that radiolocation has to teach. Almost equally impressive is Sir Robert's picture of the building up into a single team of the later and much more numerous recruits, not merely the cream of the physical research laboratories of the country but also chemists, physiologists, biologists, dons and schoolmasters, united by certain basic characteristics common to all branches of science. This whole combination of technical objectivity and the highest technical skill in one team, coupled with the remarkable organization for rapid production and team work on the part of industry to which Sir Stafford Cripps has paid tribute in addressing the Council of the Radio Industry, is indeed, as Sir Robert suggests, even more important and significant than the technical devices issuing from it.

Moreover, in this there was the partnership built up between the Government establishments, the universities and the industrial laboratories, and beyond that the pooling from the time of the Tizard mission in 1940 onward of British and American information over the whole field of radiolocation. The arrangements made for the interchange of information between the United States and the British Commonwealth, following on this first pooling of knowledge and ideas, were reinforced by the community of interest and understanding which at all times links the leading scientific workers in friendly fellowship as well as by the intimate contact with operational needs which the British workers, as Sir Robert shows, enjoyed from the start. In sum, the joint efforts have led to results which have not only been rightly described as the heart of our war effort, but may well prove to hold the key to success in the task of reconstruction.

Equally impressive is the picture of war investigations carried out by large groups which Prof. C. H. Lander gave in his Melchett lecture, "Team Work in Research". These investigations covered combustion work in connexion with gas turbines and jet propulsion, research and development of a model law to predict performances of flame-throwers, and research and development on petrol burners and their supply, and signalling arrangements for fog dispersal on aerodromes. Prof. Lander, moreover, points out that in his own experience in peace-time, when he was starting the survey of the coal resources of Great Britain, he had been faced with the problem of knitting together the contributions of organic, inorganic and physical chemists ; of physicists, geologists, zoologists, botanists and palæobotanists ; of mining, civil and mechanical engineers ; and of oil and fuel technologists.

Much of Prof. Lander's lecture was of technical interest, but he was at pains to stress the importance of the task of the team leader in holding the balance between the specialized advices of his team members; and he insisted that such a leader must above all possess that critical sense which is based on a wide experience and broad knowledge of scientific work. A team leader must also possess sufficient knowledge of the various sciences to enable him to follow the reasoning of the individual members of the team. Prof. Lander gave little indication as to how the organization of such a team should be built up, though his whole lecture was a challenge to narrow specialization in technical education. He recognized that the team leader requires breadth of understanding in the human as well as the technical sense, but he did not indicate so clearly as Sir Robert Watson-Watt that the members of the team should themselves possess similar qualities to some extent, particularly a capacity for the self-criticism necessary for realizing the possibility of bias and for generating toleration for the inevitable bias in others. It will be noted, however, that while Prof. Lander recognized that secrecy may be necessary, at any rate for the time, he stressed the great importance of publication, especially publication under the names of the men responsible for the particular pieces of work.

It is against the background of this experience and the lessons it enforces that we have to regard in fact future proposals for the organization of research and development, whether in industry, in the Government service or in the universities themselves. Proposals for the reorganization and recruitment of the scientific civil service, for the expansion of industrial research, and for university development must be considered from the point of view of how far they embody the relevant lessons of this war-time experience of team work and the full and free interchange of knowledge and ideas. These are not, of course, the sole criteria, but no proposals which fail to foster the outlook and the temper of mind in which team work of this kind flourishes best can well be entertained except on the basis of the most powerful and convincing reasons.

The two most impressive features of this particular aspect of radiolocation team work in development and research which are stressed not only by Sir Robert Watson-Watt, but also in the British and the United States official accounts, are indeed in regard to the interchange of information and the treatment of scientific staff. No one who has followed at all closely reports or statements on scientific and industrial research, such as that of Nuffield College, during the last two years or so, or studied the recent report of the Barlow Committee on Scientific Staff or, on the American side, those of Dr. Vannevar Bush and his advisory committees, can fail to note how well in line with precept and principles stressed in those documents practice has been. The team work on which the success of radar is firmly based is in fact a demonstration of the soundness of principles long pressed in these columns as essential for scientific advance and which must be far more widely applied in industry and in Government if our scientific resources are to meet adequately the new and immense demands of peace.

The interchange of information provides a highly instructive example. The critical importance of secrecy in regard to radar is unquestionable. None the less, this overriding demand for secrecy was not allowed to obstruct or exclude that close contact of mind and free and full discussion so essential to the fertilization of ideas, to constructive and creative thought and to scientific advance. The conditions for the stimulation of scientific thought and imaginative enterprise were secured. The instrument was limited to its purpose and was never allowed to become the master; and there is no more satisfactory feature in the Government's proposals for a scientific civil service than the statement that it views sympathetically the recommendation that secrecy restrictions should be relaxed as much as possible, and scientific workers in Government service encouraged both to publish work of their own and to discuss their work with persons outside the Service engaged on similar problems.

That is a *sine qua non* of effective team work and co-operation, whether between departments, between industry, the Government or the universities. Scientific workers have given clear indications in recent months that they recognize the importance of restoring as quickly as possible full freedom of scientific communications, and it is to be hoped that neither in Britain nor in America will they miss the implications of radar but will insist on an improvement on, and not merely a return to, pre-war conditions in this respect. Freedom to know, to utter and to argue freely according to conscience is a fundamental condition of scientific advance. Radar provides a convincing demonstration that a solution of the problem of secrecy is possible on some such lines as those suggested by the Barlow Committee—that such freedom can be responsibly exercised.

A solution of this problem is essential if we are to attract to the services of the State the ablest scientific minds of each generation and if we are to make the most effective and best use of such minds in the employment of the State, of industry or of the universities. It is of course a special aspect, as the Barlow Committee recognizes, of breaking down the isolation of the scientific worker, whether or not he is employed in the Government service. Moreover, the further measures proposed for dealing with that isolation of the scientific worker in Government departments through the encouragement of mobility and interchange of staff and the introduction of the sabbatical year and the like, which the superannuation proposals of the Government are designed to assist, are exactly the type of measure equally adapted to break down departmentalism anywhere and that compartmentalism of mind whether in teaching or research to which the specialist is ever liable. Sir Robert Watson-Watt shows the brilliant success which has attended the elimination of such isolation and compartmentalism in the development of radiolocation. That very success calls for the closest study of the technique of organization by which it has been achieved, and it may confidently be predicted that the careful study of the factors responsible for such outstanding team work, and the application of the lessons of that experience in the elaboration of our post-war research structure, in Government departments, in industry and in the universities, will pay equally rich dividends.

Radar research has provided a convincing demonstration, not merely of the possibility of highly productive team work, but also of its existence side by side with conditions which favour creative work and encourage the originality and individuality, initiative and enthusiasm which are all-important in the advance of science. Here have been found and maintained exactly those conditions, those methods of treating the scientific worker so that the utmost use is made of his inherent abilities ; and no strategy of research which ignores such tactical measures is likely to achieve success. As we face the problems of reconstruction and the acute shortage of man-power which persists and is likely to remain with us, we do well to recall the reminder of an early report from the Select Committee on National Expenditure that the main need is a better use of the available forces rather than an increase in their number. Above all it is true of scientific man-power that efficient use depends not merely on having at our disposal an adequately staffed intelligence organization provided with ample means for collecting and interpreting the relevant data on the problems to be solved and determining their priorities, but also on giving to the human factor the right attention and treatment to enlist and hold its enthusiasm and highest creative and imaginative powers.

FORESTRY PROBLEMS IN THE UNITED STATES

Behold our Green Mansions

A Book about American Forests. By Richard H. D. Boerker. Pp. xvi+313+96 plates. (Chapel Hill, N.C. : University of North Carolina Press ; London : Oxford University Press, 1945.) 24*s*. net.

THIS is a book about forests in North America : forest conservation, soil conservation, timber, flood control, wild life, grazing, scenic beauty, recreation and the use of timber. All these are subjects very much under consideration at the present time, and most of them interest the general reader and all of them are of first-rate scientific importance. The subject-matter is based entirely on American experience, and brings out the scale of operations there in comparison with those in Great Britain and with the latter's small-scale problems and comparatively small climatic fluctuations. The subject is of importance in all the continental areas in the temperate zone, and the same disquieting condition is found everywhere—depleted forests causing soil movement, and an ever-expanding demand for timber.

Man's attempt at settlement in new countries has often been accompanied by a failure to recognize the dangers of interference with natural phenomena without a very detailed scientific knowledge of the factors involved. Interference with the natural cover of vegetation has nearly always been the cause of disaster. This process is well seen in the United States where, according to the U.S. Forest Service, only seven-eighths of the original virgin forest is left. This is illustrated in the work under consideration by three diagrams of forest areas dated 1620, 1850 and 1942. While there is little difference between 1620 and 1850, the 1942 map shows these virgin forest areas as very small and detached patches. It is during this latter period that the problem of soil erosion has arisen.

We have been accustomed to think of America as a land where natural resources are so rich as to be almost inexhaustible. Mr. Boerker starts by destroying this myth regarding America's forest wealth. During the War, timber was classified as a critical war material, and the forests were called upon for a tremendous output of material essential to the prosecution of the War. This was met, but was handicapped—as he explains in an interesting preface—"by our past gross neglect of our forests". He shows how through forest fires, bad and unscientific cutting of timber, through ignorance and for quick gain, and by indiscriminate cutting down of forest lands for farming, serious inroads have been made on timber resources. However, this is the negative side of the picture ; he goes on to show what is being done through conservation and re-afforestation to remedy this deficiency. But as he says, "it is one thing to gather scientific data and lay out a plan of action ; but it is quite another thing to acquaint the forest-using public with the facts". This is what this book claims to do, and in this the author has succeeded well.

The forest is treated in its relation to wild life, water supply, holding the soil, flood control and as a live-stock range.

With regard to wild life, the author gives examples of the delicacy of balance between species, and quotes instances of disastrous control due to ignorance of inter-relationships. In fact, man's attempts—in the absence of expert knowledge—to control Nature has often been as disastrous as his destruction of it for profit. This aspect is closely bound up with the importance of the forest as a region of recreation for the people. But with the artificial management of the forests, game laws have to be tightened or liberalized in proportion to the food available.

The many factors affecting forests in regard to water supply are complex, but broadly speaking, forests conserve water and prevent rapid run-off causing erosion. Not only the trees of the forest but also the ground vegetation of flowering herbaceous plants and shrubs, mosses, liverworts, lichens are all interdependent and act as anti-erosion agents. In northern regions these also retain snow and slow down its melting and run-off. Every type of forest has its characteristic undergrowth, and the balance is often a delicate one. Soil erosion is a world-wide problem, and while much of it is due to the destruction of forest, the breaking of natural grassland is equally destructive in semi-arid regions, where the erosion may be due to sudden storms or more frequently to strong winds.

Of the destructive agents the author has much of interest to say. While fire on a large scale is not a problem in Britain, it is a real menace where hundreds of miles of unbroken forest may occur, as in America, and where much lower relative humidity is encountered than in western Europe.

Boerker gives an excellent description of such fires, which enables the reader to realize what formidable destructive agents they are. A good idea of the elaborate system of fire-watching and fire-fighting measures taken in the United States can be gathered from this book, and the reader is impressed by the well-organized scale on which these preventive measures are carried out. In spite of all this, the annual loss of timber is very great. This is well illustrated by one example—"one of the most serious of recent fires was the big Wilson fire of August 1933 in Oregon started by friction from a steel cable passing round a dry stump. Over 260,000 acres of the finest virgin forest timber was burnt. The loss to the public and to labour was computed to be in excess of $350,000,000." In this one fire alone an amount of timber was destroyed equal in total to the entire timber cut of the United States for 1932.

To make good the wastage due to human carelessness and to almost unavoidable accident, re-afforestation has to be carried out on a similar scale by both private timber companies and the State Conservation Department. These efforts are not only designed to re-forest burnt-over areas but also to return abandoned farm land to forest.

The United States have carried out a well-planned and comprehensive scheme of juvenile and adult education on the preservation and development of their forest resources, as well as setting aside extensive areas as national parks. The work begins in the schools and is carried on later by numerous societies, of which the author mentions a number of the more important. The United States and Canada form one of the greatest centres of coniferous forests in the world, and although man has greatly depleted this, wise measures of conservation and large-scale schemes of re-afforestation still make the North American continent the chief area of supplies of coniferous timber.

This book is of great interest to the general reader, for it deals in a most interesting fashion with a subject that concerns all of us. It is of equal interest to the scientific man, and appeals particularly to the botanist and the plant ecologist. A word of praise must be added for the many beautiful plates which accompany the text. Many of these were taken by the U.S. Forest Service, some by the U.S. Soil Conservation Service, and a certain number were obtained from private sources. F. J. LEWIS.

ELECTRICITY SUPPLY ORGANIZATION

Electricity—Public or Private Monopoly?
By F. Hamlyn Dennis. Pp. iv+143. (London: Victor Gollancz, Ltd., 1945.) 7*s.* 6*d.* net.

ELECTRICITY supply takes a high place in the list of major public services which are scheduled for reorganization by the Government now in power in Great Britain. Its political prominence is not a new development, as Parliament has given considerable attention to co-ordination of electricity supply ever since the War of 1914–18 revealed the deficiencies of separate power systems serving comparatively limited areas.

The book under review provides ample information regarding the various steps which led to the existing Grid supply system, but it may be useful to summarize these steps for the information of readers not intimately connected with the supply industry.

The Electricity (Supply) Act of 1919 established the Electricity Commissioners, who endeavoured to co-ordinate the British systems by establishing joint electricity authorities which grouped adjacent undertakings to form larger and more economical units. Their efforts had so little success that it proved necessary to pass the 1926 Electricity (Supply) Act and thereby establish the Grid system controlled by the Central Electricity Board.

The Grid provides for the co-operative working of all electrical generating stations in Great Britain. It has been in operation since 1930, and has been effective in improving the average thermal efficiency by some 15 per cent. All generating plant has become generally available instead of only locally, and the savings in capital costs in power stations have offset the cost of providing the Grid equipment. During the War the Grid was of inestimable value in assuring continuity of electricity supplies throughout the country. This great technical and economic success of the Grid has been an important factor in focusing attention on the vital question of ownership of undertakings.

Mr. Dennis is a whole-hearted advocate of public ownership, and he does his best to justify his preference by revealing the fact that power companies charge more for electricity than do municipalities. He also takes great care to reveal the sources of his information, and these sources are usually the best which are available to the public. He presses home his main contention by disinterring from *The Economist* of July 4, 1936, a rather sour estimate of the efficiency of power companies: "Company-owned undertakings, by and large, have shown neither outstanding commercial efficiency in the pursuit of their own interests, nor over-much zeal for those of the consumer". This thrust would have been more effective had it been illustrated by analysing the production costs of typical undertakings. In the reviewer's opinion, the absence of such analyses conduces to inefficiency.

A 'unit' of electricity costs about 1*d.* The public are notoriously careless of pence and tolerate extortionate percentage increases of cheap articles without taking much notice.

The authorized undertakings are able to continue to operate at comparatively low efficiency because they sell much of their output directly to the uncritical and uninformed public, and because they exploit the situation to a comparatively small extent.

As a first step towards real economy in electricity supply, the reviewer suggests publication of costs of electricity to the consumer in the form of league tables. These would reveal the facts in a way which would appeal to the British public, and if they did not cause the inefficient undertakers to improve, governmental action could be taken. To ensure that there will be no premature change over to civil service control, the relative efficiencies of the General Post Office telephone service and of the power companies should be examined. The reviewer suggests that such an examination would have a sobering effect on Mr. Dennis and his co-enthusiasts.

The book is recommended as being one of the most convenient and interesting sources of information on British electricity supply. C. W. MARSHALL.

THE JOHN INNES HORTICULTURAL INSTITUTION

THE John Innes Horticultural Institution is to move from Merton to a new site at Bayfordbury in Hertfordshire. The move will mean a radical change in the scale of work and the opportunities for studying the problems of horticulture. It is therefore worth while considering these prospects in relation to the past work and development of the Institution.

The foundation was due to a private bequest. When Mr. John Innes died at Merton in 1904, he left the greater part of his fortune to endow an institution to be set up at Merton "for the improvement of horticulture". In 1909, the Charity Commissioners approved a scheme for the new Institution which was to concern itself, on one hand, with the training of gardeners and, on the other hand, with "research, whether of a scientific or practical nature, into any matters having reference to the growth of trees and plants generally".

The administering Council represented universities and public bodies, including the Ministry of Agriculture. The first step it took was in the choice of a director. This step was decisive, for the choice was William Bateson. At this time Bateson was not only an outstanding personality in British science, but he was also engaged in the tremendous struggle—not yet won in his own country—to establish the new science of genetics. In British universities no facilities existed for research in genetics, and its teaching met with opposition rather than encouragement. To Bateson, therefore, the appointment meant a foothold, a first secure foothold, for genetical research in Britain. To the new foundation it meant a policy and a programme which filled a gap in the national development of science. At the same time, the terms of the foundation required, or ensured, that the fundamental methods of inquiry introduced by Bateson should be applied and taught on the spot. The Institution has therefore always held pure research and applied research equally balanced, using each to feed the other. Following this habit, it has always been able to attack its own problems in its own way, and its programme has been a self-propagating one.

The new theories and techniques had to be fitted into the larger framework of science, and, in the process, some false steps were taken, as indeed they were bound to be. The first appointment to the staff, however, was a success: E. J. Allard, a fine gardener and a wise teacher, was made curator. From the first, too, the genetic work with fruit crops met with success. M. B. Crane, who was one of the earliest products of the new training, was put in charge of this branch in 1919. The full possibilities of plant breeding, however, waited upon the second decisive step in the development of the Institution. This step was taken by Bateson following his visit to the headquarters of the *Drosophila* school in 1921. He then realized that the next great advances in genetics would demand that the study of chromosomes should go hand in hand with experimental breeding. He accordingly invited the late W. C. F. Newton to establish this second new theory and technique at Merton. Once again a serious gap in the national scheme of research was filled by Bateson's initiative. A school developed, and foreign workers played an important part in its growth. Vavilov and Sturtevant, and later Karpechenko, Belar and Müntzing made their varied contributions to the work; and the visits of Johannsen and Morgan, Lotsy, Winge and Mohr, Driesch, Baur and Goldschmidt enlivened the frequent and often lengthy arguments in the library, laboratories and fields at Merton.

BAYFORDBURY, THE NEW HOME OF THE JOHN INNES HORTICULTURAL INSTITUTION

After Bateson's sudden death in 1926, the same policies were continued by Sir Daniel Hall. But very naturally a synthesis also began to take place.

Mendelian experiment and chromosome observation were combined in the work of J. B. S. Haldane and, in a different way, in that of C. D. Darlington. The foundations of plant breeding, especially in the fruits, were changed by the discovery of polyploid series related in various ways to hybridization and recombination, as well as to fertility and vigour. At the same time, to meet the exacting needs of plant breeding, improvements in the quality and precision of glasshouse cultivation were demanded. W. J. C. Lawrence, Allard's successor, and a second of the Institution's own students, achieved these improvements, and the fruits of his success have been reaped by the industry at large.

In October 1939 Sir Daniel Hall was succeeded as director by C. D. Darlington. In spite of war conditions, K. Mather, now head of the Genetics Department, was able to introduce and perfect another new scientific method. It was based on applying the Mendelian and chromosome theories in combination with Fisher's statistical methods. It made use of parallel studies on quantitative inheritance, or continuous variation, in the fly *Drosophila* and in crop plants. The results have an undoubted practical bearing on plant breeding; and they also have the fundamental value that they finally reconcile the hard-dying conflicts of Darwinian and Mendelian theory, of biometry and genetics. During the same period, at several angles, chromosome studies have been shown in their broad and fundamental bearing on medical research, in the recognition, etiology, and X-ray treatment of cancer, and in the understanding of the development of the blood. With new methods the study of the cell is proving to be as useful in the approach to development and disease as it has been in the approach to heredity.

During the War, the scientific staff was reduced from sixteen to six, and long-term projects had of course to be replaced in part by more immediately useful trials and experiments. The practical results of this work have been made known to the grower and cultivator by leaflets, bulletins and by advisory service. These activities will doubtless have to remain after the War: it is clearly not enough for the harvest of research to be stored—or buried—in libraries. Future developments, however, will depend on the success of the major operation of transplanting the Institution and on its economic situation afterwards.

When the permanent buildings, laboratories and glasshouses were put up in 1910, it was already known from A. D. Hall's report that the site and soil were poorly suited to the purpose. Both went from bad to worse. The vicinity was clothed with suburb after the last War; the air was polluted, the sunlight cut down, the water-table lowered, the garden pests multiplied and strengthened, while miles of houses and factories cut off all avenue for expansion and all contact with the one industry that mattered. As fast as its building value went up, the horticultural value of the land went down. The workers outgrew the laboratories, the books outgrew the library, the experiments outgrew the gardens. Setting up overflow stations could merely postpone the decision. A new site had to be found.

Inquiries for new land were begun in 1938. They continued over a wide area for seven years. The quality and drainage of the soil, the atmosphere and climate, the water and electricity supply, the availability of buildings, the accessibility to town and university, all had to be taken into account. Commercial value also had to be regarded. The Institution's revenue, reduced in 1931, was still further curtailed in 1941 by the war damage in London, which was even more serious in its financial effects than the direct destruction at Merton in 1944.

The John Innes Trustees have chosen a site which meets these various requirements better than had seemed possible. They are exchanging 19 acres at Merton for 372 acres on the new site. While Merton is eight miles from the centre of London, Bayfordbury is sixteen miles away. It is one mile from Bayford Station and less than a mile from the outskirts of Hertford. Yet the district, for the last hundred years, has been unfashionable enough to have remained rural. Indeed Bayford (to quote the Greater London Plan, 1944) "is in the centre of a very extensive belt of woodland . . . one of the few really unspoilt tracts of land near London, from which it is readily accessible". The soil is based on glacial drift over chalk and varies from a light to a medium-heavy loam. The land lies on the south side of the River Lea, and rises a hundred feet above it. The slopes should give safety from frost without undue exposure to wind. Conditions so favourable as these are not easily found near London.

Bayfordbury was built in the years after 1759 by William Baker, nephew-in-law of Tonson, the publisher of Milton and Dryden. Until this year it housed the collection of Kneller's portraits of his forty-two friends or clients, members of the Kit Cat Club, which has now been acquired by the nation. The profits of "Paradise Lost" paid for a substantial building. The mansion is conveniently designed and centrally placed. It is handsomely sited between two groups of cedars of its own age. A lake near by, fed by surface drainage, affords a plentiful supply of water for irrigation. The woodlands include the collection of conifers, occupying ten acres and recorded in the four-volume work of Clinton-Baker and Jackson. This collection was established in 1838 by W. R. Baker with the advice of Loudon. Now it might well prove of value in the study and breeding of both ornamental and timber trees.

The mansion and outbuildings provide nearly twice the accommodation at present available at Merton. Some of this will be useful for domestic housing. But even with the six additional cottages it will clearly not go far towards solving the housing problem. With their dependants, the staff number, in peacetime, about 120, and under present conditions their removal as a whole to a new locality will demand new housing. The necessary building will probably not be completed for two years or more.

The question remains as to why such a sudden expansion of area is made. Can profitable use be made of so large an area for horticultural, and especially genetic, research? The original land purchased at Merton was five acres, and only piece by piece were acres added to it—so long as they could be added, and always at an increased price. Other research stations have suffered from outgrowing their land after twenty or thirty years with like consequences. The Royal Botanic Gardens, Kew, were larger and the difficulty came late but, having come, proves insuperable. With the Royal Horticultural Society's gardens at Chiswick the difficulty was overcome by removal; and the new gardens at Wisley, like those at Kew, are of similar size to Bayfordbury. Of the 372 acres in the new estate, no more than 150 acres will, it is expected, be taken up for research purposes in the next ten years. But the choice of a larger area for the John Innes land is based on the expectations of fifty years. It is also based on the view that the need for research, and the understanding of that need, are likely to grow beyond our present computations. This view takes into account two lessons of the war period. One is that horticulture has changed from an incidental luxury into a necessary part of the nation's economy. The other is that genetics has changed from an ornament of research to one of the main props of science.

In its new habitation, the John Innes Institution will undoubtedly undergo a transformation. But there seems no reason why it should forsake the character or the aim for which it has been valued. Its aim will no doubt continue to be to unite theory with practice and to combine a freedom of initiative with some coherence of purpose within the wide range of activities allowed by its foundation.

THE TEACHING OF ANALYTICAL CHEMISTRY IN GREAT BRITAIN: WITH SPECIAL REFERENCE TO MICROCHEMISTRY

By Dr. CECIL L. WILSON

For some time past it has not been possible to make any accurate estimate of how the demand for microchemical teaching in the British Isles has been met. Previously, the only guide in this direction was the list, probably not altogether comprehensive, published from time to time in *Mikrochemie* before the War. As a consequence, discussion of the teaching of microchemistry must of necessity have been based largely on estimates derived solely from personal contacts and hearsay, and any statement about it was justly open to doubt.

The only satisfactory way to clear up the position was by means of some sort of census. This was scarcely an undertaking for a private individual. The recent formation of the Microchemistry Group of the Society of Public Analysts and Other Analytical Chemists, however, provided an official body to which the information is of first importance. At the request of the Committee of this Group (under the chairmanship of Prof. H. V. A. Briscoe, Imperial College of Science and Technology, London), therefore, a questionnaire was drawn up, the answers to which would clarify the position of the teaching of modern analytical methods, and, in particular, of microchemistry. This questionnaire has been circulated to 85 centres of higher chemical education in the British Isles, comprising 43 universities, university colleges and university institutes, and 42 technical institutions. Replies have been received from 64 of the institutions —75 per cent of the total covered—made up of 32 universities and their institutes and 32 technical colleges. The information contained in the replies has been collated, and forms the basis of this report.

It was difficult to draw up a questionnaire which would cover the situation both completely and in detail. In fact, study of the replies suggests that such an achievement would have been impossible. But it must be acknowledged that most of the institutions received the questionnaire in an extremely helpful spirit, and did their best to interpret doubtful questions so as to supply the maximum of useful information. Many institutions made valuable additional comments, and it is perhaps in these that most food for thought will be found.

In spite of this co-operation, some points were missed completely, while others still remain vague. For example, as was pointed out in one reply, one question which should have been asked, and was not, concerned the number of microchemical balances possessed by each institution. Answers to this might conceivably have been useful in clearing up certain vagueness in other replies. Again, confusion in nomenclature, more particularly as between the terms 'micro' and 'semi-micro', is apparent; while some institutions probably put a much wider interpretation than was intended on a question which asked for information about *special* courses dealing with modern analytical techniques. This gives rise to doubts as to whether the teaching of any of the more modern techniques is really as advanced as is suggested by a superficial study of the replies.

As a consequence, it has been necessary, in reporting, to interpret equally broadly on occasion. But it is felt that, at least so far as microchemistry is concerned, this summary presents a much more coherent and truthful picture than has hitherto been available. Where it has been thought desirable, distinction has been made between the technical colleges and the universities, as the conditions ruling in each of these groups, and controlling their activities, are markedly different in many ways.

Modern Analytical Methods

Of the 64 institutions replying, 25 normally teach electrochemical analysis, 16 teach spectrographic analysis, and 25 teach electrometric methods. One or two of these courses of instruction have been interrupted owing to the War. In addition, 5 institutions teach the use of the polarograph, 12 colorimetry-photometry, 2 metallurgical analysis, and 10 report miscellaneous or unspecified courses.

It is probable, as already suggested, that in many cases this instruction merely forms part of an existing course in general chemistry, and is not a special course. There are, however, certain institutions the replies from which indicate clearly that in their case the courses *are* special ones dealing only with the methods specified, in a reasonably detailed fashion.

Only 3 of the institutions replying possess a special lectureship in analytical chemistry. However, 12 other institutions find it necessary to qualify the negative reply by stating either that they have a lecturer concerned solely or almost solely with this branch of work, or that such a lectureship is desirable or projected.

Microchemistry

In all, 43 of the institutions, that is, almost 70 per cent, have taught or teach microchemistry in some form or another.

The first course in microchemistry in Britain appears to have been established in 1929. Of the 20 institutions which give a date for the commencement of their course or courses, 16 started prior to the War, only 4 since. This is quite to be expected. The peak years for new courses were around 1936–38.

Estimates were given by 22 institutions of the time spent on micro work. These estimates range, rather startlingly, from 4 hours per student to 300 hours. Examining these figures rather more closely, an average value for the 22 institutions is just over 65 hours per student. Of the individual estimates, 6 lie above the 100-hour mark, and 12 above 50 hours. Rather surprisingly, these figures are distributed fairly equally between universities and technical colleges.

In Table 1, which indicates roughly the grading of the courses, those referred to as "current" are running at present. Those designated "pre-war" were in existence before the War, but have since been suspended. Thus the total of these two gives some measure of the probable *minimum* number of courses which would be in existence at present, had it not been for the War.

TABLE 1.

	Universities	Technical Colleges	Total
Special Postgraduate Courses :			
Current	4	3	7
Pre-war	1	5	6
Total	5	8	13
Special Undergraduate Courses :			
Current	2	3	5
Pre-war	1	1	2
Total	3	4	7
Routine Instruction to Undergraduates :			
Current	11	10	21
Pre-war	6	5	11
Total	17	15	32

As this shows, of 64 institutions, there should be, after the War, at least 52 potential courses in the practice of some form of micro methods—25 in universities, and 27 in technical colleges. In fact, this figure is almost certainly an under-estimate, as several institutions report projected courses, not included in Table 1, which have not yet materialized because of the War.

The outstanding point that is brought out here, however, is the impressive number of institutions—50 per cent—which have found it advisable to introduce microchemistry to some extent as routine practice for students. This is concrete proof—perhaps the first to be produced—of the appeal and usefulness of micro methods in teaching in Britain. It gives every justification for the recognition of these methods by examining bodies which control external examinations, thus enabling those institutions which teach for such examinations to do so on an equal footing with those which include microchemistry in courses for internal examinations, and with an equal claim to modernity.

Further details of the type of instruction are tabluated in Table 2 :

TABLE 2.

	Universities	Technical Colleges	Total
Quantitative Organic Analysis	13	15	28
Qualitative Inorganic Analysis	9	18	27
Quantitative Inorganic Analysis	10	11	21
Physicochemical Methods ..	8	9	17
Synthetic Organic Methods ..	7	9	16
Qualitative Organic Analysis	5	7	12
Chemical Microscopy	4	2	6

Semi-micro methods are taught, either in conjunction with, or as an alternative to, full micro methods (it is not always clear which) as shown in Table 3.

TABLE 3.

	Total
Quantitative Organic Analysis	13
Synthetic Organic Methods	7
Qualitative Inorganic Analysis	5
Quantitative Inorganic Analysis	4
Qualitative Organic Analysis	4
Physicochemical Methods	2

In the case particularly of the qualitative and synthetic methods, there seems to be considerable confusion over a distinction between the two scales of 'micro' and 'semi-micro'.

In preparing a general report such as this, it is almost impossible to give any closer indication of the type of instruction which prevails. It is felt, however, that it would be of interest to detail the instruction given at one institution, of moderate size, serving a town of average population (about 50,000–60,000). This institution, one of the more advanced in this respect, is not, however, necessarily the best. It is chosen rather as showing what can be undertaken by an institution which has only average resources of space, staff and finance, where the will to progress is present. Special courses deal with electrochemical analysis, electrometric methods of analysis, including the use of the "magic eye" apparatus, and absorptiometry. In general analytical chemistry, apparently a special postgraduate course, the following are dealt with : application of organic reagents to inorganic analysis ; chromatography ; polarography ; the electrograph ; use of luminescent, redox, adsorption and complex-forming indicators ; the high-temperature combustion furnace ; survey of the branches of microchemistry, etc. Coming to microchemical courses, these are held both as special undergraduate courses and as part of routine instruction to students. The branches covered include qualitative inorganic analysis, qualitative organic analysis, quantitative organic analysis, physicochemical measurements ; synthetic organic methods are to be introduced soon, and quantitative inorganic analysis is taught on the semi-micro scale. The special course occupies two hours per week for its duration. The special remarks section states : "We are teaching micro-methods to National Certificate Students. A special course for final students and graduates is run in the Summer Vacation. It is hoped to extend it to 'outside' people this year".

The reasons given for absence of any, or of fuller, instruction in the various institutions occur in the following order of importance : lack of time (25) ; lack of staff with the appropriate knowledge (16) ; the War (14) ; lack of space (14) ; lack of apparatus (13) ; small educational value and limited uses of microchemistry (6). Certain of the answers—lack of staff, lack of space, lack of apparatus—are in some cases qualified by "during the War", these necessities having been loaned for national use.

The last category—small educational value and limited uses—must be read with some reserve, since of the 6 institutions putting it forward, 2 already teach some microchemistry, and 2 others propose introducing some after war conditions have eased.

As already remarked, the additional comments kindly supplied by the different institutions provide much that is of interest. The more important issues which they raise are best illustrated by quotation. Two divergent views of the value of microchemical instruction provide a striking assessment when taken in conjunction : "From educational standpoint, favour Inorganic micro in Third Year". "Micro and semi-micro technique is not taught for its own sake, but merely to improve the experimental technique of the students—mostly with a view to the saving of time". On the other hand, it is stated, "Many of our research investigations demand a good working knowledge of microchemistry in all its branches". "In chemical practice one so frequently has to deal with small quantities". In other words, microchemistry has proved its usefulness, whether it is considered solely as a teaching method or as an analytical tool.

A few of the institutions which already include some microchemical teaching doubt the wisdom of introducing more ; but a considerable majority intend to increase substantially the time devoted to the subject when conditions permit.

The low regard in which analytical chemistry tends to be held is specially commented on by several writers : "Modern analytical methods should figure much more prominently in the curriculum of a Technical College than is customary at present". "*Academic* Institutions tend not to give much attention to chemical analysis. It is often quite difficult to make students do *any* accurate work".

Pleas are made for the provision of teaching *for the teacher*. "Vocational courses held at some suitable centre, for the training of teachers in the various branches of microchemical analysis, would be much appreciated". "It is desirable that a summer school for teachers should be established so that they may acquire a first-hand knowledge of the technique required. Prior to the War, such training was difficult to obtain in the British Isles".

The difficulty of the external examination is pointed out: "The chief determining factor is undoubtedly that the University of London and professional bodies generally do not yet demand a knowledge of microchemical technique in their practical examinations". "Omitted of late, since students have to complete their studies in less time than before"; that is, discarded as the first inessential for examinations!

Finally, one comment may be coupled with the difficulties of those who plead lack of apparatus: "For quite a year now we have been unable to do micro organic analysis for research purposes, on account of the balances needing attention. It has not been possible to get even one of the three balances reconditioned".

Without further comment, it may be claimed that a number of conclusions are implicit in this survey. In the first place, there is undoubtedly a general recognition among teachers of the importance of analytical chemistry in general, and microchemical methods have obviously recommended themselves strongly to teachers as a useful instructional topic. Recognition of this by the professional and other examining bodies is desirable, particularly in view of the probable post-war development. Every effort ought to be made to secure this recognition, and to make possible further development of the regard for analytical chemistry in teaching institutions.

In this connexion it is perhaps worthy of stress that the size of the institution and the importance of the area which it serves seem to bear no direct relationship to its attitude to analytical and micro methods. In other words, small institutions are as advanced in this respect as larger ones, whether one considers the apparatus available or the nature and extent of the instruction. Presumably, therefore, development in analytical and microchemical teaching may be regarded as a function of individual endeavour, and further improvement in this respect is not altogether dependent on such physical factors as available funds.

Some provision should obviously be made for refresher courses in analytical chemistry of varying scope, arranged primarily, but not necessarily solely, for the benefit of teachers. It is out of the question for Britain to regress, in the next few years, to the pre-war condition of being almost entirely dependent on Central Europe for such a prime necessity.

In conclusion, it may be claimed that a subject which is regarded by 50 per cent of the more important teaching institutions of the British Isles as worth teaching cannot in future be considered to be beneath the notice of the chemist in general.

It is impossible to thank personally all those teachers who took pains to fill up the questionnaire, and to supply valuable further information. Grateful acknowledgment of their help is therefore made here.

NEW BASIC CONCEPTS IN ELECTROCARDIOGRAPHY: THE VENTRICULAR GRADIENT

By Dr. W. F. BERG*

CLINICAL, anatomical and experimental research have all collaborated to make electrocardiography indispensable for the clinician. The nature and origin of the various irregularities of the heart rhythm can be diagnosed with accuracy. Since chest leads have been introduced, one can get detailed diagnoses of heart muscle lesions, such as result from an occlusion of the arteries supplying the heart muscle. Similarly, we are able to locate lesions within the specific nervous system of the heart known as the bundle of His and its branches. It is even possible to diagnose toxic changes so small as to escape the methods of the pathologist. An important advance has more recently been achieved by the introduction of a new basic concept by the American workers, F. N. Wilson[1] and his school. This has found almost immediate practical application.

In the state of rest the heart, in common with all muscles, consists of polarized cells: the insides of the cells carry electric charges which are neutralized by charges of opposite sign surrounding the cells. The regular excitation and relaxation causes a rhythmic sequence of waves of electric depolarization and repolarization to pass through the heart muscle. Thus, at any one moment potential differences are set up between two points of the body; these can be measured by any instrument which is sufficiently sensitive. At any one instant the heart may be likened to an electric battery, the poles of which are inserted into a conducting medium, the body; such an arrangement is characterized by the direction of a line pointing, say, from the negative to the positive pole, and by the strength of the poles. Thus the electric excitation of the heart muscle is best described by an arrow possessing both a direction and a length; this arrow is known as the instantaneous electric axis or heart vector. In order to determine this vector the following assumptions are commonly made.

In the standard procedure the current produced by the heart is recorded by an instrument of short period such as a string galvanometer or cathode ray tube, which is connected in turn to two out of three points: the left arm (*L.A.*), the right arm (*R.A.*) and the left leg (*L.L.*). Electrically the heart is considered to lie in the centre of an equilateral triangle, which is large compared with the dimensions of the heart and which is named after Einthoven. Records obtained simultaneously in two 'leads', say between the left and right arms, and the left arm and leg enable the instantaneous heart vector to be determined by the construction indicated in Fig. 1. The method is based on the consideration that the deflexion of the instrument in one lead is proportional to the projection of the heart voltage on to a straight line connecting the end points of that lead. Thus the deflexion in each lead at any one instant is the component of the vector in the direction of the lead line as marked inside the triangle. Verticals are erected at the end point of each component on a lead line. A line drawn from the centre of the triangle to the point where the verticals from two components cross constitutes the instantaneous vector. If deflexions are obtained in three leads simultaneously,

* From the Central Middlesex County Hospital, London.

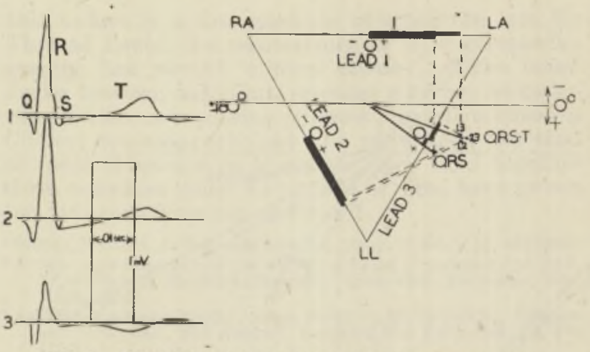

Fig. 1. PRINCIPLE OF THE HEART AXIS DETERMINATION.

(1), (2) and (3) are records obtained in the three leads. The figures in the table are the areas under the various parts of the records.

	Lead 1	Lead 2	Lead 3	
Q	− 3·2	− 6·5	− 7·0	Calibration
R	+37·5	+43·0	+10·5	
S	− 2·5	− 1·5	0·0	0·1 mV. sec. = 248
T	− 5·0	−10·5	−16·0	1 µV. sec. = 2·48
	+19·5	+12·5	+ 3·0	
	− 3·5			
QRS	+31·8	+35·0	+ 3·5	
QRS—T	+42·8	+37·0	− 9·5	Resultant
QRS/2·48	+12·6	+14·1	+ 1·4	37° 15·5 µV. sec.
QRS—T/2·48	+17·2	+14·9	− 3·8	20° 18·9 µV. sec.

three end-points are obtained for the vector; these points should coincide if the Einthoven condition is fulfilled. The heart vector so determined constitutes the projection of the vector in space on to the plane determined by the three lead points[2].

Displacements of the heart as well as pathological changes influence the directions and the lengths of the heart vectors, and considerable variations are found. A certain degree of order has been introduced by the new concept due to Wilson[1] and his collaborators, and termed by them the 'ventricular gradient' (G); this means the average electrical activity during the excitation and contraction of the heart chambers, the averaging process being carried out over time, direction and length of the instantaneous vectors. Whereas the length of the instantaneous vectors is measured, say, in micro-volts, the dimensions of the average vector is in micro-volt seconds. Average vectors may be obtained for any part of the heart-cycle which can be recognized with certainty in each lead. Thus an average *QRS* vector is sometimes utilized[3], these letters referring to the first peak part of each record (Fig. 1).

The average vectors are obtained as follows (Fig. 1). The areas under the different parts of the electrocardiogram Q, R, S and T are tabulated and added to give the total areas of *QRS* and *QRS-T* ($= G$). These totals, standardized by dividing them by the area corresponding to 1 µV. sec., constitute the components of the average vectors along the sides of the Einthoven Triangle and are here marked by heavy lines, inside the triangle for *QRS*, and outside the triangle for *QRS-T*. The resultant vectors are shown and their length and direction can be read from the diagram.

The ventricular gradient is a concept of fundamental importance in the physiology of muscle action-currents. Depolarization and repolarization of the cells in the muscle are brought about most probably by movements of the same ions across cell membranes and back again. In a homogeneous muscle fibre the total electric activity due to depolarization must be equal and opposite to that brought about by the repolarization. This is true wherever the place of the original stimulation may be, since the waves of excitation and relaxation merely follow one another with opposite signs. If now the fibre considered is not homogeneous, but for example the systole—the state of contraction before relaxation sets in—lasts longer in one part of the fibre than in another, the total electric activities of excitation and relaxation may no longer be equal and opposite: the fibre now exhibits a 'gradient' of average electric activity. Records obtained from three equidistant points of a surrounding conducting medium would allow this gradient to be determined. Again, the direction and length of the gradient is independent of the point and method of stimulation of the fibre. This conclusion was beautifully confirmed by Wilson *et al.*[1] on a dog's heart. They cut the fibres along which excitation is normally conducted, so that excitation had to spread through the mass of the heart muscle. This altered completely the character of the electrocardiogram, but the gradient was not affected. Thus, "the ventricular gradient is the fundamental quantity in electrocardiography"[3]; generally speaking, it points from the part of the heart where systole is longest to where it is shortest.

A very thorough study of the ventricular gradient and the mean *QRS* vector has been carried out by Ashman and Byer and collaborators[3] on more than five hundred persons whose hearts were considered from clinical investigations to be normal. This large amount of material allowed the different factors influencing the mean vectors to be investigated. The average value for the gradient G is 52 µV. sec., for the *QRS* vector 25 µV. sec., being slightly smaller for women than for men. There is a distinct correlation between the size of the *QRS* and the G vectors: G tends to be about twice *QRS*, although many other factors influence the relationship in any one particular instance. The value of G decreases with increasing heart-rate H, the average over a large number of persons following a straight-line relationship which may be expressed as $G = 92 - 0{\cdot}5\,H$. Acceleration of the heart-rate by amyl nitrite or by exercise causes a change corresponding to this relationship, but a change from the recumbent to the supine position causes G to decrease very much more than corresponds to the resulting acceleration of the heart. This variation of G with posture is probably connected with a displacement of the heart, which tends to assume a more vertical position in the upright body.

A great deal of consideration was given to data which would allow the position in space of the *QRS* and G vectors to be derived from their projection on to the frontal plane as determined from the records. The assumption on which these considerations were based was that in the various normal hearts investigated, the *QRS* and the G vectors in space were identical with respect to length and relative position to one another and to the heart itself, and that the differences in length and direction of these vectors as projected on to the frontal plane were due to variations in the position of the heart in the body. Various indications as to the position of the heart were utilized, such as X-ray radiographs and relationships already established between the appearance of the *QRS* complex and a rotation of the heart around its longitudinal axis. The problem is very similar to that known to X-ray crystallographers: many data are available, but it is impossible to derive the configuration directly from these data. A shrewd guess guided by these data had to be made. The longi-

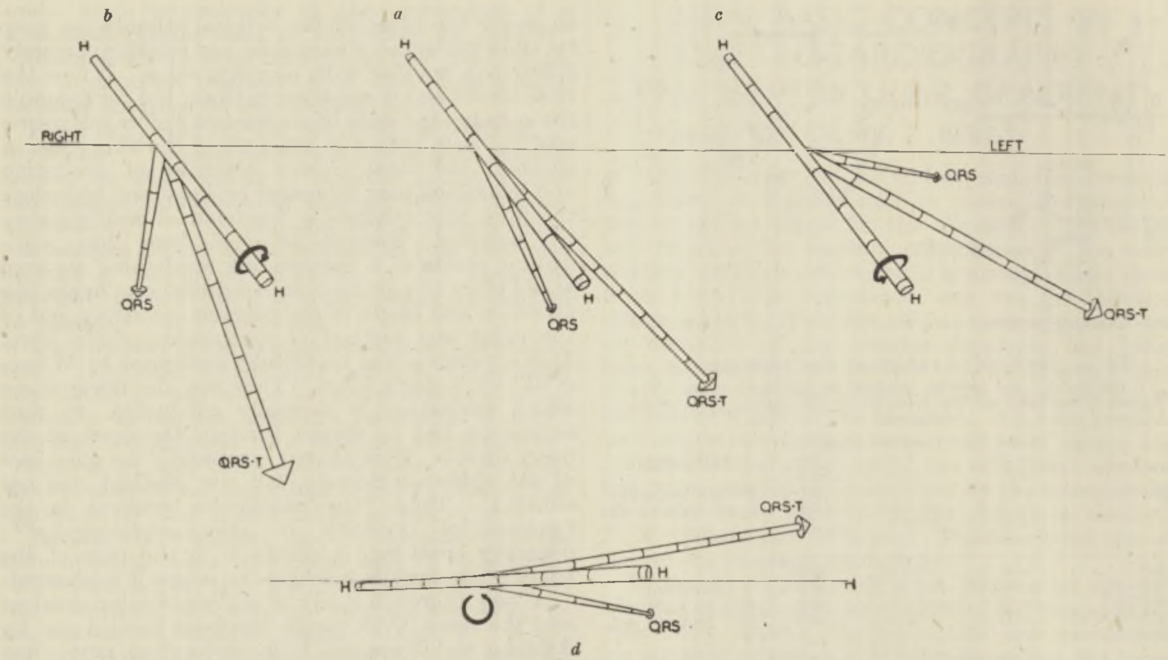

Fig. 2. VARIOUS POSITIONS OF THE HEART, CHARACTERIZED BY ITS LONGITUDINAL AXIS H—H AND THE RESULTING POSITIONS OF THE TWO AVERAGE VECTORS AS PROJECTED ON TO THE FRONTAL PLANE.
(*a*) is a heart in a normal position, (*b*) rotated clockwise around the longitudinal axis, (*c*) rotated around the same axis anti-clockwise. (*d*) is the heart as shown in (*a*) rotated around an antero-posterior axis as a result of pneumo-peritoneum.

tudinal axis of the heart, normally pointing slightly forward and to the left, the gradient and the *QRS* vector lie nearly in one plane. The gradient lies backwards from the longitudinal axis forming an angle of 60°, and *QRS* lies back still farther, making an angle of 90° with the axis. The length of the gradient is 92 µV. sec., that of *QRS* 44 µV. sec. A model of the heart with these vectors attached was projected by light on to a sheet of paper representing the frontal plane, and thus the various relationships between the measured values for length and position of the vectors could be checked up. Very good agreement was obtained between the directions of the vectors and their length as determined in the frontal plane. Typical results are indicated in Fig. 2. Here (*a*) indicates a typical normal heart, in which the anatomical heart axis is indicated by *HH*. The most common variation in human hearts is a rotation about the anatomical axis; where this is clockwise, as viewed from the apex towards the base, *QRS* appears to the right of *G* (Fig. 2*b*); where it is anti-clockwise, *QRS* lies to the left of *G* (Fig. 2*c*). Master[4] has published a thorough study of the correlation between the shape of the heart silhouette and the electro-cardiogram. Ashman and Byer[3] have evaluated his electro-cardiograms by vector analysis and added cases of their own. On the whole, the agreement is astonishingly good, and the model put forward by these authors to represent the relative positions of the vectors with respect to the heart would appear to be generally valid for a normal human heart.

Acceptance of this model thus provides a means for studying displacements of the heart using electro-cardiographic records. This method is all the more valuable where the displacement is so large that an investigation of the heart silhouette ceases to be a reliable guide. This difficulty arose in the course of an investigation by Benatt and myself[5] on the electro-cardiogram in pneumo-peritoneum. This treatment, which was introduced into Great Britain by Clifford-Jones and MacDonald[6], is now applied widely in the treatment of tuberculosis of the lung, and consists in the induction of a litre or more of air into the abdominal cavity just below the diaphragm. A considerable rise of the diaphragm then displaces the heart, which often becomes quite unrecognizable in the X-ray silhouette. The electrocardiogram was very similar to that obtained with severe heart muscle damage, but in the absence of any clinical symptoms, and since the pattern was completely reversible, it was concluded that the new pattern was due to a mere displacement of the heart. Vector analysis was applied and both *QRS* and *G* vectors were found to deviate very strongly to the left, as indicated in Fig. 2*d*. The heart therefore must carry out a similar rotation around an antero-posterior axis, together with less important movements the description of which would take up too much space here.

Thus the new concepts of average electric heart vectors, and in particular of the ventricular gradient, are beginning to play an important part in electro-cardiography. After the fundamental groundwork has been done, applications to clinical work are now forthcoming. In his latest paper Ashman[7] discusses one of the most important signs of heart disease in the electrocardiogram, the so-called deviation of the *S-T* segment from the zero line, in relation to the magnitudes of the *QRS* and *G* vectors. More and interesting work is bound to follow from this line of thought.

In conclusion, a word regarding the organization of this research may not be out of place. It is no accident that all the research summarized above is the result of team-work, and that the team included a physiologist or even a physicist. Work in the border region between medicine, physiology and physics usually requires collaboration. Research of this nature is a fine example of what the late Sir Thomas Lewis, the master pioneer in electrocardiography, has termed 'clinical science'. "The boundaries between individual sciences may not be maintained without hindering progress ; overlaps between Clinical Science, pathology and physiology are vital to medical science as a whole ; they bind together three activities which in process of time have grown too far apart from one another"[8].

[1] Wilson, McLeod, Barker and Johnston, *Amer. Heart J.*, **10**, 46 (1934).
[2] A very clear discussion of the subject is found in Ashman and Hull, "Essentials of Electrocardiography" (2nd edit., Macmillan, New York, 1941).
[3] Ashman, Byer and Bayley, *Amer. Heart J.*, **25**, 16 (1943). Ashman and Byer, *ibid.*, 36. Ashman, Gardberg and Byer, *ibid.*, **26**, 473 (1943).
[4] Master, "The Electrocardiogram and X-Ray Configuration of the Heart" (Lea and Febiger, Philadelphia, 1939).
[5] Benatt and Berg, *Amer. Heart J.*, in the press.
[6] Clifford-Jones and MacDonald, *Tubercle*, **24**, 6 (1943).
[7] Ashman, *Amer. Heart J.*, **26**, 495 (1943).
[8] Lewis, Sir Thomas, *Brit. Med. J.*, **30**, 3 (1935).

REPEATING COMPASSES

By W. E. MAY

FROM time to time paragraphs appear in the Press on the subject of compasses in aircraft. They usually take the form of a complaint of the inaccuracy of magnetic compasses in general, followed by praise of some invention which is said to surmount all difficulties. The new instrument is often improperly described as a 'gyro-compass'. It is not the purpose of this article to advertise or condemn any of these inventions, but to enable the reader to see in proper perspective the claims which they contain.

For nearly a century, inventors have striven to perfect a repeating magnetic compass, that is to say, a compass the indications of which are automatically transmitted to a point or points at some distance. Many methods of obtaining signals from an ordinary magnetic compass in order to work a repeater system have been tried. Among these may be mentioned the forms using selenium cells, intermittent positive contact between contact on the card and in the bowl, or a Wheatstone bridge principle using electric currents passed through the liquid in the bowl. All need some form of signal amplification which may be obtained by the use of valves or relays.

When we talk of a magnetic compass we are apt to think only of the ordinary instrument containing a needle which aligns itself with the direction of the lines of magnetic force ; but there is a second type which particularly lends itself to the provision of a repeating system. That is the earth inductor or rotating inductor compass, which depends on the principle that if an armature, similar to that of a small electric motor, is rotated about a vertical axis in the earth's magnetic field, it generates a current. This current can be tapped off in the ordinary way by means of a commutator and brushes, the strength and direction of the current in the external circuit being determined by the orientation of the brushes relative to magnetic north. There will be a relative brush position where no current flows in the external circuit.

Thus by various means both the needle and earth inductor types of repeating compass give a signal as soon as the bowl (or other follow-up unit such as the brush carriage) is out of step with the directional element. This signal can be made use of in two ways. In the simple form the bowl is turned by means of a Bowden wire to the position corresponding to the course desired. When the aircraft is off her course, a simple indicator shows the pilot which way to steer to get back.

In the more ambitious arrangement, the directional signal is used to control a follow-up motor which drives the bowl round until the position of 'no signal' is reached. At the same time it drives a step-by-step transmitter through gearing, and this transmitter drives the repeaters electrically so that they indicate the orientation of the bowl and consequently the course of the aircraft.

Another type of repeating compass may be styled the static inductor type. In this type an alternating electric current is passed through a coil wound on an iron alloy core bent into a triangle or other shape. This core is fixed in the aircraft with its plane horizontal. According to the course of the aircraft, the various sides of the core will be magnetized in a greater or less degree by the magnetism of the earth. The fact that the sides thus become magnets of differing strengths upsets the balance of the alternating currents in the parts of the coil wound round them, thereby causing varying currents to flow in wires which are tapped off the coil at intervals. These tappings are led to coils in the repeater where they set up a magnetic field. A magnetic needle lines itself up with this field and thus indicates the course of the aircraft.

A combination of the needle and static inductor type of compass is also sometimes used. This is similar to the static inductor type, but contains in addition an ordinary compass needle of rather high magnetic moment. The needle points to magnetic north and also serves to induce magnetism in the core of the inductor.

A type of compass which is often referred to nowadays is the gyro-compass. This compass depends on the fact that a perfectly balanced gyroscope will always tend to keep its axis pointing in a fixed direction in space. This of itself would be of little value as a direction indicator, since the earth's rotation will produce a continuous variation in the direction of the axis relative to the meridian. The gyroscope can, however, be made to act as a compass by the introduction of some form of control, so that this fixed direction in space is amended until the axis is horizontal and pointing along the meridian. In the true gyro-compass, this is effected by using the rotation of the earth to harness the force of gravity to the gyroscope.

The arrangement is perfectly satisfactory in a ship of moderate size, but in aircraft the higher speeds and greater manœuvrability produce accelerations introducing a varying false vertical and upsetting the control. All attempts to use gyro-compasses in aircraft have consequently been failures.

The gyroscope, as distinct from the gyro-compass, has, however, a use in aircraft. We have not been able to produce a gyroscope so well made that it will give a perfect performance with its axis maintaining a fixed direction in space indefinitely, but we can make one which will maintain its direction for a matter of minutes. It will be appreciated that having no gravity control, this gyroscope will be unaffected by the movement of the aircraft. If now we link any form of repeating magnetic compass to this gyroscope, so that the latter is controlled by the former, the gyroscope will tend to line itself up with the magnetic compass ; but as its rate of precession is much less than the rate of oscillation of the compass, it will actually line itself up to the mean direction of that instrument. In this way, by using a magnetic compass to control a gyroscope and the gyroscope to control repeaters we get a combination, known as a 'gyro-magnetic compass', which smoothes out most of the erratic oscillation of the ordinary compass.

Another application of the gyroscope is sometimes used. In those static inductor compasses where the core is magnetized by a compass needle, it is convenient to use a double-axis needle, that is, one which is mounted on a vertical axis instead of being free to dip as in the ordinary compass. This method of mounting introduces difficulties, because if accelerations cause the axle to leave the vertical, the vertical force of the earth pulls down on the north end of the needle, thereby deflecting it from north and causing an error. By introducing a gyroscope into the instrument it is possible to use the gyroscope to stabilize it so that the axle of the needle will always remain truly vertical.

When speaking of gyro-magnetic compasses it must be clearly understood that they are fundamentally magnetic compasses and not gyro-compasses. Although they have the advantage of smoothing out oscillations, they still point to the magnetic and not to the true north. The master compass must be fitted in a position as remote as possible from magnetic disturbance. The aircraft must be 'swung' to adjust the compass in the ordinary way, and rather more than ordinary care is required to do this effectively. Finally, a deviation table must be obtained and the deviations applied to *all* repeaters when using them.

The statement that the gyro-magnetic compass indicates the magnetic rather than the true north must be qualified. In some systems a variation-setting corrector or other device is provided. This is a link in the repeater system which enables the repeaters to be put out of step with the master in a convenient manner. If the variation is kept set on this device, the repeaters will show a heading differing from true by the deviation. If the variation plus deviation is kept set, the repeaters can be made to indicate true north, but it will be noted that this does not mean that the swinging of the aircraft for compass adjustment can be dispensed with.

We can now summarize the several points to be considered when judging the relative advantages of the various systems. They are : (1) A needle compass is liable to be affected by accelerations and movements of the aircraft, that is, by swirl error, northerly turning error, etc. (2) All types of magnetic compasses, whether they be needle or inductor or a combination of both, indicate the direction of the magnetic field at the compass position, and not necessarily the magnetic meridian. It follows that they all have deviations which must be allowed for or corrected. (3) Repeating compasses can be placed in better positions from the magnetic point of view than those positions from which the aircraft is controlled. (4) In repeaters other than those driven on the step-by-step principle, the needle is apt to be made to oscillate by shocks and accelerations. The repeaters, however, are self-synchronous so do not need lining up when the compass is switched on. (5) Inductor compasses are less sensitive than needle compasses. (6) Gravity controlled gyro-compasses cannot be used in aircraft. (7) Gyro-magnetic compasses require adjusting like any other magnetic compasses, but smooth out swirl and northerly turning errors. (8) The introduction of a gyro introduces an additional electrical complication.

OBITUARIES

Mr. C. S. Middlemiss, C.I.E., F.R.S.

WITH the death on June 11, 1945, at Tunbridge Wells, at the age of eighty-five, of Mr. Charles Stewart Middlemiss, Indian geology has lost its doyen, one who will long be regarded as one of the great figures of Indian geology. Middlemiss was the son of Robert Middlemiss of Hull, where he was born on November 22, 1859. He was educated at Caistor and St. John's College, Cambridge, taking his B.A. degree in 1881. He joined the Geological Survey of India on September 20, 1883, when H. B. Medlicott was still head of the Department.

During his service, Middlemiss did field work in the Himalaya, the Salt Range, and Hazara, all in north-western India ; in Coimbatore, Salem and the Vizagapatan Hill Tracts in the Madras Presidency ; in the Southern Shan States and Karenni in Burma ; in Central India, Rajputana and North Bombay (Idar) ; and finally in Kashmir. He also investigated the earthquakes of Bengal (1885), Kangra (1905), and Calcutta (1906). During spells at headquarters he was curator of the Geological Museum (1898–99), and in charge of the headquarters office (1907–8). He was promoted deputy superintendent in 1889 and superintendent in 1895. He officiated as director for two periods, during 1914–15 and in 1916. In 1903 he paid a visit to Ceylon on deputation.

Middlemiss should have retired from the Geological Survey of India on reaching the age of fifty-five in 1914, but on account of the War his service was extended so that he did not leave the Department until April 1, 1917, after being gazetted C.I.E. in 1916. As a result of this extension, Middlemiss holds the record for length of service in the Geological Survey, amounting to 33 years 6 months and 11 days (beating Medlicott by five months and eight days). Having created this record, Middlemiss then entered the service of the Maharaja of Kashmir, with the title of superintendent, Mineral Survey, Jammu and Kashmir, from which he did not retire until his seventy-first year in 1930, after a total service in India of more than forty-six years.

Of other scientific activities, we may record that Middlemiss became an ordinary and life member of the Asiatic Society of Bengal in 1884, and a fellow in 1912, being at the time of his death the senior member of the Society by four years and also the senior fellow. He became a fellow of the Geological Society of London in 1900, and was awarded the Lyell Medal in 1914. Middlemiss was elected a fellow of the Royal Society in 1921. He was president of the Geological Section of the Fourth Indian Science Congress at Bangalore in 1917 and president of the Ninth Indian Science Congress at Madras in 1922. He was also president of the Mining and Geological Institute of India in 1928.

Middlemiss married Martha Frances Wheeler, daughter of Major-General Wheeler, of the Bengal Staff Corps. They had five sons and one daughter, of whom two sons died early in India, and two sons lost their lives in the War of 1914–18, in Gallipoli and France respectively. On retiring from India, Middlemiss settled down at Crowborough in Sussex, where he became a centre of local activities. Mrs. Middlemiss died in 1931.

Middlemiss, as first known to my contemporaries and me, was already in the forties—partially bald with an aureole of grey hair, bright blue eyes, pleasant

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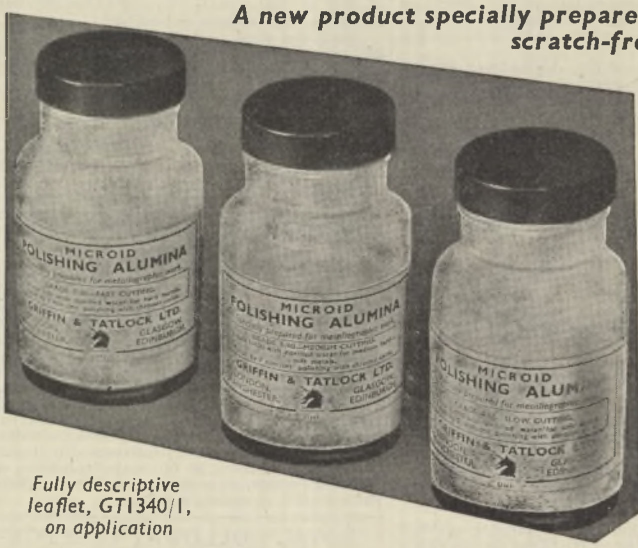

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A. W. SUTTON,
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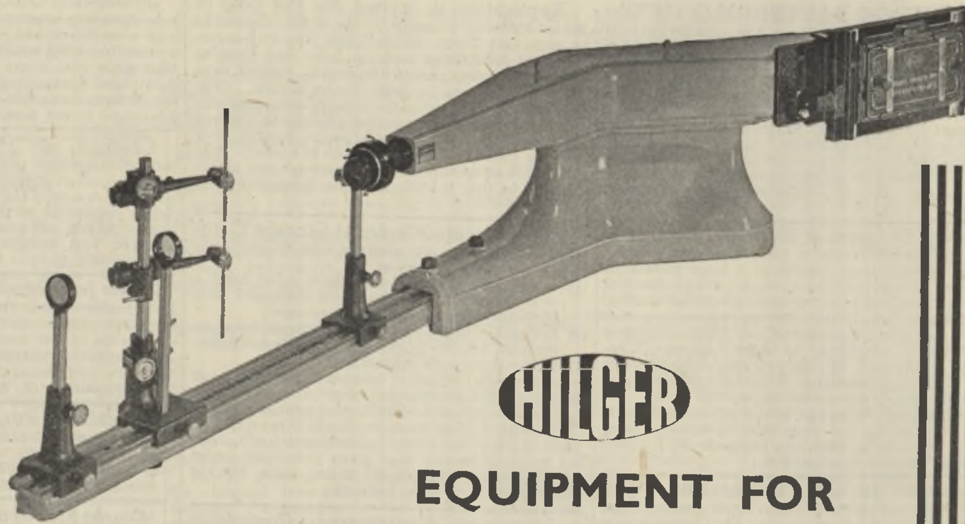

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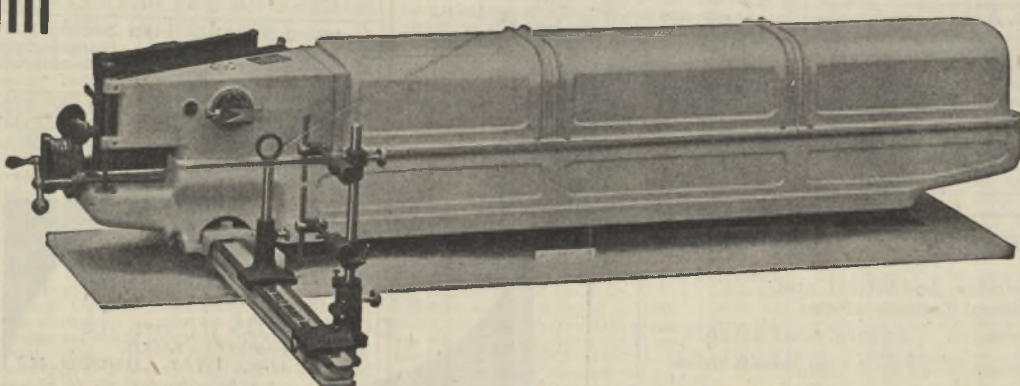

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friendly expression, very sturdily built, and above medium height. He had an extraordinarily youthful mind and was always ready for fun.

This youthful mind was also an experimental one, so that Middlemiss was willing to try anything, and especially anything new. He developed thus a multitude of interests outside geology, the principal of which were perhaps music and sketching in water colours; but he was also interested in verse, in Esperanto, in chess, rowing and lawn tennis. In Esperanto he kept the Calcutta Esperanto Society alive, acting as its honorary secretary for some years. In music he devised a new system of notation, not being satisfied with the existing system. To his junior officers he was very helpful, both in the field and at headquarters, and because of his friendly nature he was always accessible.

Middlemiss was essentially a field man, believing in the direct appeal to the rocks by means of the hammer. He was able to illustrate his notes with his skilful pencil and brush, often making use also of the *camera lucida* in order to ensure correct outlines in panoramic views; and as in addition he had an accurate but eloquent pen, he has been able to present the results of his studies in a large number of papers, four of which rank as memoirs, almost all of which contain inspired passages, and all of which amply repay study.

His field work may be divided into three spells, the first of some ten years in north-western India (Garhwal, Kumaon, the Salt Range, and Hazara), the second of some twenty-two years in Peninsular India (with many interruptions), and the third of some twenty-two years in Kashmir and Jammu, the latter overlapping his middle period.

Middlemiss's most important work was probably that done in his first spell, represented by several short papers and two fine memoirs. In the earlier memoir (*Mem. Geol. Surv. India*, **24**, pt. 2; 1890) he published his classic studies of the Siwalik zones of the Sub-Himalaya, and discussed the origin of the Himalaya ranges, adopting Osmond Fisher's views and showing himself to be an isostasist before the word 'isostasy' had reached him. In his second memoir (*Mem. Geol. Surv. India*, **26**; 1896), Middlemiss describes the geology of four parallel zones of disturbance or elongated blocks of formations, belonging to the Hindu Kush system of ranges striking north-east, contemporaneous in age with the Himalayan system of ranges striking north-west. As in Garhwal and Kumaon, he shows that as one moves outwards from mountain to plains across these zones each successive outer zone is separated from the preceding inner zone by a major thrust-plane, so that the inner older zone overrides the younger outer zone.

In his brief spell in the Salt Range, Middlemiss started the controversy not yet ended, as the recent columns of *Nature* have shown, concerning the age of the Saline series. For Middlemiss cast doubt upon the view that the Salt Marl was Cambrian or pre-Cambrian, as seemed likely in view of the position of this series at the foot of the Salt Range scarp. This he did by demonstrating that everywhere the Salt Marl showed discordant relations, often of an apparently intrusive nature, to the physically overlying rocks (*Rec. Geol. Surv. India*, **24**, 19; 1891), and to explain these phenomena he propounds his hypothesis of the quasi-intrusive nature of the Salt Marl (in late Tertiary times).

In his latest contribution, written in his eighty-fifth year (see the symposium arranged by Prof. B. Sahni, *Proc. Nat. Acad. Sci. India*, **14**, Sect. B, p. 267; 1944), Middlemiss claims that his theory of the quasi-intrusive nature of the Salt Marl is in harmony with modern requirements "even though acceptance of the possible guess . . . that an igneous magma may have been ultimately responsible, is too much to expect".

We must now refer to Middlemiss's middle period of work, that in Peninsular India. Here his earlier work was on the magnesite and corundum deposits of the Salem and Coimbatore districts, followed by mapping in the Vizagapatan Hill Tracts, a country of longitudinal strips of acid gneisses, of the charnockite series, and of the khondalite series. Here he found interesting hybrid rocks containing sapphirine (until then only known in Greenland), spinel, cordierite and sillimanite, formed at the intrusive contact of an ultra-basic member of the charnockite series with the sedimentary khondalite series (see *Rec. Geol. Surv. India*, **31**, 38; 1904; and **36**, 1; 1906). He also found nepheline-syenites (miaskite) similar to the rocks of the Urals and Sivamalai in southern India. Later he held charge of the Central India and Bombay party of the Geological Survey of India and produced a detailed memoir on the geology of Idar State (*Mem. Geol. Surv. India*, **44**, pt. 1; 1921).

We come now to Middlemiss's third period—Kashmir with Jammu. Here his first task was to study a recently discovered occurrence of Gondwana plants (*Gangamopteris*) in their stratigraphical relationships. In crossing the Pir Panjal Range by the Golabgarh Pass, he found a supremely important section, with not only *Gangamopteris* but also *Glossopteris* beds overlain in due course by a marine limestone containing *Protoretepora ampla* Lonsd. Middlemiss had thereby succeeded in correlating the great freshwater Gondwana formation of Peninsular India with the richly fossiliferous marine sedimentary systems of the Himalayan area—two widely distinct geological provinces not hitherto found in juxtaposition. The age of the lowest Gondwana beds was shown to be Permo-Carboniferous (Artinskian). His work in Kashmir did not then cease, for he had found incidentally that the previous survey of Kashmir had been made on too small a scale, so that the whole of the geology needed revision. Consequently he set out to make detailed surveys of selected areas and thereby laid successfully the foundations of a new geology of Kashmir, foundations upon which H. S. Bion began to build until his premature death in 1915; foundations upon which Mr. D. N. Wadia built so effectively later that he was awarded by the Geological Society of London in 1943 the same medal as had been bestowed on Middlemiss in 1914, the Lyell Medal.

On joining the Kashmir service in 1917, Middlemiss had to concentrate upon the study of the mineral resources of Jammu and Kashmir. This he did to such effect that he produced no less than ten reports published as *Reports of the Mineral Survey of Jammu and Kashmir*, following two papers published in the *Records of the Geological Survey of India*. Two of these reports deserve mention here. One is his report on the "Bauxite Deposits of Jammu Province" (*Min. Surv. Rep.*, 1; 1928). These deposits are found in association with the Riasi dome of the Great Limestone. The bauxite is of unusual character, being a monohydrate instead of a trihydrate. It is accordingly unusually high in alumina (70–80 per cent instead of 50–60 per cent usual in the lateritic bauxites of the Peninsula); it is also unusually low in iron oxide and of high density and hardness. The quantity is considerable, and one day it will be used, perhaps, with the aid of electric power generated from the high-grade Nummulitic coals that overlie it stratigraphically, or from a projected hydro-electric installation on the Chinat River.

The second paper to be mentioned is on the "Possible Occurrence of Petroleum in Jammu Province" (*Rec. Geol. Surv. India*, **49**, 191; 1919), in which he demonstrates the existence of a structure (the Nar-Budhan dome) suitable for the storage of oil, and existing in rocks identical with those of the existing oilfields near Rawalpindi in the Punjab. This dome has not yet been tested. During the course of this latter survey, Middlemiss succeeded in measuring the angle of the thrust-plane or reversed fault (the Great Boundary Fault of the Himalaya) between the Siwalik and Murree zones of formations near Kotli. The angle was found to be only 12°–15°, a much lower figure than had been previously assumed by all who constructed geological sections across the Himalaya, but an angle in accordance with the modern views of *nappe* structure.

This notice is already too long to permit more than a passing reference to Middlemiss's important memoir on "The Kangra Earthquake of April 4, 1906" (*Mem. Geol. Surv. India*, **38**, 1; 1910). In this disastrous earthquake more than 20,000 persons lost their lives. Middlemiss shows that there were two epicentral tracts or foci, a principal one in the Kangra Valley of intensity 10 on the Rossi-Forel scale, and a subordinate one in the Dehra Dun of intensity 8. These two foci were situated at the two places where the Sub-Himalayan zone of Tertiary formations embays in a north-easterly direction into the Lower Himalayan zone, and separated by the bulge or bastion of Lower Himalayan formations upon which Simla stands. The earthquake represents, in Middlemiss's view, an attempt to reduce these embayments.

L. L. FERMOR.

WE regret to announce the following deaths:

Prof. F. Akerblom, formerly professor of meteorology in the University of Uppsala, on July 24.

Mr. C. E. Fairburn, chief mechanical and electrical engineer of the London, Midland and Scottish Railway, on October 12, aged fifty-eight.

Mr. G. S. Fawcett, managing director of The Tintometer, Ltd., on November 8.

Dr. R. D. Gillespie, the well-known psychiatrist, on October 30, aged forty-eight.

Prof. V. E. Henderson, professor of pharmacology in the University of Toronto, on August 6, aged sixty-eight.

Dr. H. K. Sen, professor of applied chemistry in the University College of Science, Calcutta, during 1920–36, director of the Lac Research Institute, Namkum, during 1936–44, lately director of industries, Bihar, on June 3, aged fifty-seven.

Prof. C. E. Wright, professor of gunnery and mathematics in the Military College of Science, Woolwich, on October 30, aged fifty-nine.

NEWS and VIEWS

Royal Society Medal Awards

THE King has approved the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: Prof. J. D. Bernal, professor of physics at Birkbeck College, University of London, for his work on the structure of proteins and other substances by X-ray methods, and for the solution of many other problems requiring a physical approach; Dr. E. J. Salisbury, director of the Royal Botanic Gardens, Kew, for his notable contributions to plant ecology and to the study of the British flora generally.

The following awards of medals have been made by the President and Council of the Royal Society: Copley Medal to Dr. O. T. Avery, emeritus member of the Rockefeller Institute, New York, for his success in introducing chemical methods in the study of immunity against infective diseases; Davy Medal to Prof. Roger Adams, head of the Department of Chemistry, University of Illinois, for his extensive researches in the field of organic chemistry and his recent work in the alkaloid field; Hughes Medal to Prof. B. F. J. Schonland, Carnegie–Price professor of geophysics and director of the Bernard Price Institute of Geophysics in the University of the Witwatersrand, for his distinguished work on atmospheric electricity and of his other physical researches.

Paludrine: a New Anti-malarial Drug

PALUDRINE, or 4888 as it was first called, the new drug for malaria, which was announced at the annual meeting of the Liverpool School of Tropical Medicine on November 5, was discovered in the laboratories of I.C.I. at Blackley, Manchester. The chemical work was directed by Dr. F. H. S. Curd and Dr. F. L. Rose, and the biological work by Dr. D. G. Davey. The substance has two outstanding points of scientific interest. First, it marks a complete departure in chemical structure from the known antimalarial drugs; it is not a quinoline like quinine and pamaquin, and it is not an acridine like mepacrine—an account of it, together with its constitution, will be given in papers which will appear shortly in the *Annals of Tropical Medicine and Parasitology*. Secondly, in avian malaria it has a powerful action not only on the blood forms of the parasite but also on the so-called exoerythrocytic forms. The latter are now known to occur in almost every type of avian malaria, and it is the working hypothesis of the I.C.I. group of workers, as it is of some others, that these forms also exist in human malaria although they have never been demonstrated microscopically.

According to this hypothesis, the two major problems of malarial chemotherapy, namely, complete protection against benign tertian malaria by the prophylactic use of drugs, and a radical cure of benign tertian malaria, will be solved by the discovery of drugs with an action on exoerythrocytic forms. Paludrine has such an action on these forms in avian malaria, and there is some evidence, admittedly very incomplete, that unlike quinine and mepacrine, it acts upon the as yet undemonstrated exoerythrocytic forms of *Plasmodium vivax* and consequently that it gives a better protective action. The investigation is still proceeding.

The workers at the Liverpool School of Tropical Medicine, under the direction of Prof. B. G. Maegraith and Dr. A. R. D. Adams, R.A.M.C. officers at Colchester and Woolwich, and Major-General Covell in India, are studying the effect of paludrine on the relapse-rate of benign tertian malaria, while in Australia a team of research workers in the Australian Army, led by Brigadier N. H. Fairley, is making an intensive study of its prophylactic action. The work of Brigadier Fairley is noteworthy for the great use which is made of volunteers, and the consequent rigorous control which is kept over all aspects of the experiments.

The full significance of all the work, which has been done under the auspices of the Medical Research Council, has still to be assessed, but paludrine appears to be a notable advance in the chemotherapy of malaria. The Liverpool workers, who were the first to treat human cases with the new substance, are impressed by the latitude allowed the clinician in treatment, for doses fifteen or twenty times the size of those necessary to control clinical symptoms can be given with impunity, while Brigadier Fairley is impressed by the remarkable suppressive action which the drug possesses. Unlike mepacrine, paludrine is not coloured and does not stain the skin. It is also a simpler substance, chemically, and it should be easier to manufacture. The two qualities, potential cheapness and freedom from undesirable effects at therapeutic doses, are themselves sufficient to make paludrine an important new drug.

Government Support for Research Associations in Britain

Announcing in an address to the Conference of Industrial Research Associations on November 6 that grants to such associations would form a permanent part of the activities of the Department of Scientific and Industrial Research, Mr. Herbert Morrison, Lord President of the Council, declared that we need research workers to-day as much as in 1940, and that the Government will do everything possible to encourage British industry to use scientific research. It is essential that some of the money gained to industry by relief from taxation in the new Budget should be invested in research. Large concerns, he hoped, would establish or extend their own research departments, but smaller concerns should give their full support to existing research associations, for no single section of industry can do without this essential scientific partnership and remain virile. Moreover, Government support of industrial research must be backed by readiness to use its results, and firms which cannot maintain fully equipped research staffs of their own should employ at least some trained scientific workers who can co-operate with the appropriate research association and help in the interpretation and application of its work.

Expenditure on research should be regarded as an essential cost, and dealing with the finance of research associations, Mr. Morrison said that with larger incomes the research associations would be able to carry out more of the expensive development work. The Government has therefore decided that in suitable cases it will make single grants to finance capital expenditure for such special purposes as buildings and re-equipment, the purchase of particularly expensive apparatus or the provision of semi-scale plant. Until a research association attains an appropriate scale, the present system of a block grant and an additional grant will continue. Eventually, the additional grant will cease, but a new block grant will be made, to continue indefinitely so long as the Department of Scientific and Industrial Research is satisfied with the activities of the association. The associations, Mr. Morrison said, can rely on the Government to proceed as rapidly as possible with the release and training of promising research workers, and all possible assistance will be given for rebuilding or extending laboratories. Sir Edward Appleton, referring to the importance of first-class research workers, pointed out that a monastic life is not stimulating to the young scientific worker, and there should be the closest contact between the research associations themselves, and with the universities and other research establishments.

Air Speed Record by Jet Propelled Aircraft

Group Captain H. J. Wilson, R.A.F., piloting a Gloster Meteor aircraft powered with two Rolls Derwent gas turbine engines, regained the speed record for Great Britain on November 7, flying over a course in the Thames estuary off Herne Bay. The officially recognized speed, being the average of four flights over the course in opposite directions, was 606·2 miles an hour. Mr. Eric Greenwood, the chief test pilot of the Gloster Aircraft Co., also flew a similar course, on another machine of the same type, averaging 603 miles per hour. The previous speed record was held for Germany by Fritz Wendel. This was set up on April 27, 1939, when he flew a Messerschmidt Bs.109R monoplane at 469·2 miles per hour.

The development of the Gloster machine is the result of research and experiment principally by Air Commodore F. Whittle in conjunction with Messrs. Power Jets, Ltd. The final design and construction of the aircraft and the engine were the responsibility of the Gloster Aircraft Co. and Messrs. Rolls Royce respectively. The attainment of such speeds is due to developments that are perhaps less obvious than the actual result. The production of a gas turbine having a thrust at the jet that gives, at 600 m.p.h., a horse-power of from two to three times greater than anything reached by the conventional aero engine is the most important factor. The use of jet propulsion allows this power to be turned into useful thrust more certainly than the usual airscrew method of propulsion could have accomplished. The problems of control of the aircraft at speeds approaching the speed of sound were unique and have been overcome by the aircraft designer. The machine was designed for lower speeds with earlier and less powerful engines, and it is a tribute to his foresight that it has been able to stand up to the increased stresses with a minimum of local strengthening involving no radical redesigning. The actual record-breaking aircraft was a production type of the standard R.A.F. Meteor that is now in service, and has been used in operations both over Germany and for shooting down flying bombs over Great Britain. Special preparation of the machine and the development of the general flying technique for the attempt has been under the supervision of Group Captain Wilson at Manston Aerodrome.

International Council for the Exploration of the Sea

At a meeting held in Copenhagen during October 15–19, attended by delegates and experts from Great Britain, France, Norway, Denmark, Sweden, Finland, Holland and Iceland, the International Council for the Exploration of the Sea was formally reconstituted for a five-year period, as from July 22, 1945. Though the last five-year period ended in 1941, the Council was kept in being throughout the War thanks to the efforts of its president, Dr. Johan Hjort, aided by financial contributions from several Continental countries, including substantial additional subsidies from Denmark. At the recent meeting Dr. Hjort (Norway) was re-elected president, and the following four vice-presidents were appointed to constitute, with the president, the Bureau or Executive Committee: Mr. A. T. A. Dobson (Great Britain), Prof. Martin Knudsen (Denmark), Dr. K. A. Andersson (Sweden) and M. Pierre Tissier (France). Dr. H. Blegvad (Denmark) was appointed general secretary in succession to the late Capt. Nellemose, who fell a victim to the Nazis. The scientific work of the Council is organized by a number of area committees, which draw up co-operative programmes of research that are reviewed by the Consultative Committee. The great majority of these committees were re-established at the recent meeting and agreement reached as to the lines of work to be pursued for the ensuing year. Dr. E. S. Russell (Great Britain) was reappointed chairman of the Consultative Committee.

The Council, which was formally founded in 1902 and, through the courtesy of the Danish Government, has its headquarters near Copenhagen, has now survived two wars and has proved itself one of the most successful organizations set up to co-ordinate scientific research on an international basis. It concerns itself primarily with the investigation of fishery problems, together with the cognate problems of marine biology and hydrography. It has published a long series of scientific reports and valuable annual summaries of fishery statistics and hydrographical data. Its journal, suspended during the War, will, it is hoped, reappear early next year. The recent meeting was well attended, especially by Scandinavian members. The British delegates were Mr. A. T. A. Dobson and Mr. J. E. de Watteville, the fisheries secretaries for England and Scotland, respectively, and the British delegation included Sir John Edgell, lately hydrographer to the Navy.

Nicolas Lemery (1645–1715)

Among the students of medicine and pharmacy who did good work during what has been called "the dawn of scientific chemistry" was the Frenchman Nicolas Lemery, the tercentenary of whose birth falls on November 17. He was born at Rouen, and as a youth he spent some years with Glazer at the Jardin du Roi in Paris, but found his master much imbued with the dreams of the alchemists. Proceeding to the University of Montpelier, he spent three years studying medicine, pharmacy and natural history, and then after travelling through various parts of France took up his residence in Paris. By his lectures he gained a wide reputation which was much enhanced by the publication in 1675 of his "Cours de Chymie", which in eighty years went through thirteen editions and was translated into Latin, German, Italian, Spanish and English. Scarcely had he sprung into fame than, through being a Calvinist, he found himself threatened by persecution and, like many of his countrymen, fled to England. Embracing Catholicism, however, he was enabled to return to France and resume his lecturing, and in 1699 was elected a member of the Royal Academy of Sciences. Among his other writings were his "Pharmacopée universelle" and his "Traité universel des drogues simple", both published in 1697. "Chemistry," he said, "is a science of observation, it can only be based on what is palpable and demonstrative." Thomas Thomson wrote of him that he was "The first Frenchman who completely stripped chemistry of its mysticism, and presented it to the world in all its native simplicity". Lemery died in Paris on June 19, 1715, leaving a son, Louis (1677–1743), who held important medical appointments in the French capital and published several books.

Karel Vrba (1845–1922)

Prominent among men of science in Bohemia towards the end of last century was Karel Vrba. Born at Klatovy in west Bohemia on November 10, 1845, he studied science at Prague and graduated in 1868, first becoming assistant to the professor of mineralogy, Dr. V. von Zepharovich, and later *docent* in petrography. Then he was appointed professor of mineralogy at Czernowitz in Bukovina, returning to Prague in the same capacity in 1881 when the Czech University was reinstated. At this time there was a complete overhauling of the old collection of minerals, to which Vrba constantly added more to make it as complete and representative as possible. He gave the first detailed descriptions (sometimes as long monographs) of twenty-nine minerals, mostly occurring locally though a few came from abroad, including one from Bolivia. The accounts of stephanite (1895) and the beryls of Pisek (1888) are regarded as Czech classics in science.

For teaching purposes, Vrba constructed special crystal models that were produced in tens of thousands and were used in all parts of the world, although their origin was not always attributed to him. He was prominent in the movement that led to the foundation of the Czech Academy of Science in 1890. Since 1869 there had been a Natural Science Club in Prague, and Vrba attended the lectures and joined in the biological and geological excursions. Nevertheless there was a need for a more august body for the discussion and publication of original researches. The Academy soon became the leading Czech scientific institution. Vrba retired in 1912 and lived through the First World War to see the early years of the Czechoslovak Republic, though he was too infirm to take an active part in the rapid expansion of scientific activities that occurred after 1918. Besides other foreign connexions, he was an honorary member of the Leningrad and Odessa scientific societies.

Announcements

The following have been elected honorary members of the Institution of Civil Engineers: Field Marshal the Hon. Sir Harold Alexander and Sir Edward Appleton.

Sir Lawrence Bragg is visiting Portugal under the auspices of the British Council to lecture on "Some Problems of the Metallic State" and on matters connected with X-rays. He will lecture in Lisbon, Oporto and probably also Coimbra.

Sir George Stapledon is to retire from the post of director of the Grassland Improvement Station on December 31. Sir George undertook to organize and direct the work of the Station as a war-time task, and now wishes to be relieved of these responsibilities.

An exhibition is being arranged at the Curtis Museum, Alton, Hants, during January 11, 12 and 14, 1946, to commemorate the bicentenary of William Curtis (1746–99), founder of *Curtis's Botanical Magazine*, who was born at Alton.

LETTERS TO THE EDITORS

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

Conditions for the Vernal Increase in the Phytoplankton and a Supposed Lag in the Process

In his recent discussion of the fertility of ocean waters, Harvey[1] mentions that "A phenomenon which seems to lack explanation is the time at which phytoplankton start to increase rapidly at the beginning of the year", for by mid-winter all the known nutrient salts have been regenerated and, in spite of the bright light of spring, the steep increase in the phytoplankton, as shown by the decrease in phosphate, becomes apparent in the English Channel normally only between March and April, and even much later elsewhere. He mentions the well-known effect of turbulence in carrying the cells down into regions of low illumination, and suggests that there are unrecognized factors controlling the inception of growth in some areas. Sverdrup[2] also states: "This conditioning of the water may well be a factor in the initial outburst of phytoplankton growth when other conditions are optimum"; thus he also alludes to an unknown factor.

In 1923 I obtained decisive evidence that light alone is necessary for the full development of the phytoplankton up to complete exhaustion of the phosphate supply[3]. This was done by taking water from the surface of the English Channel about 15 km. out to sea on December 18, 1922, January 16, February 12 and March 8, 1923. These samples were exposed side by side in a south window from March 24 after storing in the dark. It took thirty days to exhaust the phosphate in the December sample, slightly less in the January one and only about five days for the February and March samples. The explanation offered was that the spring samples contained a larger number of cells. "In winter, however, the much smaller numbers present can apparently be doubled or quadrupled with but little effect upon the amount of phosphate as ascertained by analysis."

A culture of the diatom *Nitzschia closterium* W.Sm. showed that half a milligram of phosphorus produced 10^9 diatoms, so this number must be present per cubic metre before any diminution in phosphate can possibly be detected, as 0·5 mgm./m.^{3} is the limit of sensitivity. The lag in production follows as a mathematical necessity, since in winter the number of plankton cells is relatively much reduced. Using a north window culture of the diatom, it was ascertained that a fourfold increase required sixteen days, March 27–April 13. Thus one cell would, after eight successive doublings, become 256 and the process would require 64 days, and similarly for any other rate of increase.

Where vertical mixing is reduced one may find the spring outburst well under way even by February 21, as in the middle of the Channel in 1928; the surface water contained only 5 mgm./m.^{3} of phosphorus[4], though near the Eddystone and off Ushant there was more than double as much, as also in mid-Channel from 5 metres down. The stability of the water column is thus of fundamental importance, and as already shown[5] the thermal stability of sea water is much greater than that of fresh water, which has maximum density at 4° C. as against – 2° C. for sea water. For the same temperature difference, resistance to mixing increases as the temperature rises. Oceanographers appear to have overlooked these two factors.

Dr. Harvey kindly showed me his proofs in 1943 during my temporary return to Plymouth, and I regret that I did not then direct his attention to the early work. Dr. Harvey still considers that "there is a reasonable *suspicion* that something else besides light, turbulence and grazing plays a part".

W. R. G. Atkins.

Department of General Physiology,
Marine Biological Laboratory,
Plymouth.
Sept. 29.

[1] Harvey, H. W., "Recent Advances in the Chemistry and Biology of Sea Water" (Cambridge, 1945).

[2] Sverdrup, H. U., Johnson, M. W., and Fleming, R. H., "The Oceans" (New York, 1942).

[3] Atkins, W. R. G., *J. Mar. Biol. Assoc.*, 13, 119 (1923).

[4] Poole, H. H., and Atkins, W. R. G., *J. Mar. Biol. Assoc.*, 16, 297 (1929).

[5] Atkins, W. R. G., *J. Mar. Biol. Assoc.*, 13, 693 (1925); and *J. Conseil Internat. Expl. de la Mer*, 1, 99 (1926).

Energy of the Hg—C Bond and the Heat of Atomization of Carbon

It has not yet been possible to make a final choice, from spectroscopic and vapour pressure data, between the two alternative values of 124·3 and 170·6 kilocalories/gram atom for the heat of atomization of carbon ($\Delta H_{291°K.}$ for the change $C_{diamond} \rightarrow C_{gas}$)[1], though the most recent treatment favours the higher value[2], and this also makes easier the correlation of some kinetic and thermochemical data[3].

An argument in support of the higher value may be got from the energy of the Hg—C link. The heats of combustion of mercury dimethyl, diethyl and diphenyl in their standard states at constant pressure are 432, 735 and 1,565 k.cal./gm. mol. respectively[4]. These values may be analysed with the help of the following data: heats of atomization (k.cal./gm. atom) C 124·3; H 51·7[5]; Hg 14·6[6]; associated bond energy terms (k.cal./gm. mol. C—C 58·6[7]; C=C 100[8]; C—H 87·3[7]; benzene nucleus resonance energy 39 k.cal./gm. mol.[9]; latent heats for the phase changes (standard state to gas) $HgMe_2$ 8, $HgEt_2$ 9, $Hg(C_6H_5)_2$ 23 k.cal./gm. mol.[10]. The energies so obtained for the Hg—C bond are: from the dimethyl 1·5, from the diethyl 6·5, and from the diphenyl 3·5: mean 4 k.cal./gm. mol. Even though the energy needed to break the first C—Hg bond is probably greater by about 30 per cent than the mean value for the two bonds[11], 4 k.cal./gm. mol. is an unprecedentedly low value for a chemical bond, and is of the order of the van der Waals attractions.

If we use the higher value 170·6 for the heat of atomization of carbon (with the corresponding changes in the C—H, C—C, and C=C values) the Hg—C energy is increased by $(170 \cdot 6 - 124 \cdot 3)/4 = 11 \cdot 5$, and becomes 15·5 (energy necessary to break the first C—Hg bond probably about 20 k.cal./gm. mol.). This seems much more probable; it is still very low, but of the same order as the P—P and As—As bonds (18·9 and 15·1[12]).

That the energy of the Hg—C link is very small is supported by many other facts. For example, the spontaneous decomposition of the dialkyls and (on heating) the cyanide to mercury and hydrocarbon or cyanogen ; the abnormally low force constant derived from Krishnamurti's Raman spectrum of mercuric cyanide[13] ; this is $1{\cdot}16 \times 10^5$ dynes/cm., probably the lowest yet found for any chemical link (we are indebted to Dr. L. A. Woodward for this calculation). Mercury can also be displaced from its alkyls by a great variety of metals (lithium, sodium, beryllium, magnesium, zinc, cadmium, thallium, tin, antimony, bismuth, tellurium). The common idea of the great stability of the mercury alkyls is derived from their indifference to air and water, which is mainly due to the small affinity of mercury for oxygen. But the value for Hg—C derived from the lower heat of atomization of carbon is so extremely minute that the higher value of 170·6 k.cal./gm. atom seems far more probable.

N. V. Sidgwick.

Lincoln College,
Oxford.

H. D. Springall.

Chemistry Department,
University, Manchester.

[1] See Skinner, H. A., *Trans. Faraday Soc.*, **41** (1945, in the press). The two values for the $\Delta H_{291°K}$ for the diamond atomization are derived from the two alternative values for DZ(CO) 9·10 eV. and 11·11 eV. The fact that the use of the new conversion factors now raises the lower value of DZ(CO) to 9·14 eV. does not affect the treatment given here.

[2] Gaydon, A. G., and Penney, W. G., *Proc. Roy. Soc.*, A, **183**, 374 (1945).

[3] Baughan, E. C., *Nature*, **147**, 542 (1941).

[4] Berthelot, M., *C.R. Acad. Sci.*, **129**, 918 (1899).

[5] Pauling, L., "Nature of the Chemical Bond" (Ithaca 2nd Ed., 1940), 54.

[6] Bichowsky, F. R., and Rossini, F. D., "Thermochemistry of Chemical Substances" (New York, 1936), 69.

[7] Pauling, *op. cit.*, 53.

[8] Pauling, *op. cit.*, 131.

[9] Pauling, *op. cit.*, 136.

[10] Latent heat of fusion for the diphenyl from melting point by Walden's rule (*Z. Elektrochem.*, **14**, 715; 1908). Latent heats of evaporation (at 25°) by assuming a Trouton constant of 21.

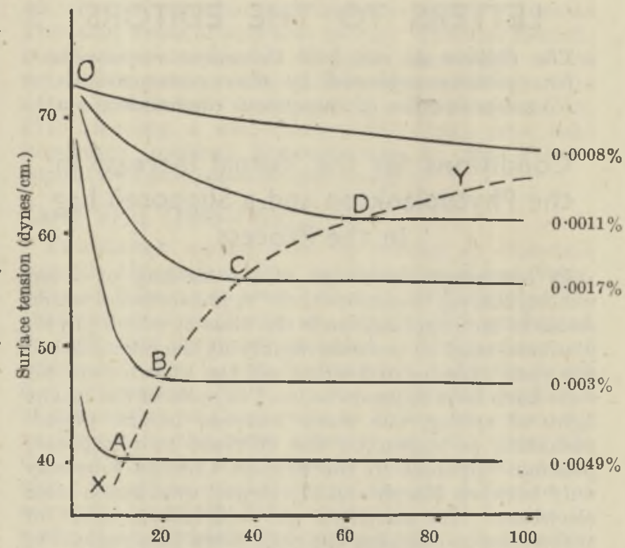
[11] Horn, E., Polanyi, M., and Sattler, H., *Z. phys. Chem.*, B, **17**, 220 (1932). Wieland, K., *Z. phys. Chem.*, B, **42**, 422 (1939). Butler, E. T., and Polanyi, M., *Trans. Faraday Soc.*, **39**, 19 (1943).

[12] Pauling, ref. 7 ; but see Skinner, ref. 1.

[13] Krishnamurti, P., *Ind. J. Phys.*, **5**, 633 (1930).

Time Factor in Service Tension Measurement

In recent years various authors[1] have applied static methods to the study of the slow changes which occur in the surface tension of aqueous solutions of some long-chain compounds ; and in general the possibility that the accumulation of solute on the surface by diffusion from bulk solution might be responsible for the drift in tension is dismissed on the grounds that the periods of time involved may be as much as 10^9 times greater than those anticipated on classical diffusion theory. My recent quantitative studies of the adsorption process[2] using vibrating jets of aqueous alcohol solutions have confirmed that diffusion to the surface is complete within 10^{-4} to 10^{-1} sec. over the available range of chain-length and concentration, and similar results have been obtained with aqueous solutions of short-chain carboxylic acids. It seems clear that changes in tension over periods of hours, or even days, which occur in solutions of appreciable concentration (and which are usually smaller than the initial fall from the pure water value which occurs during development of the surface layer) are the result of rearrangements in the equilibrium adsorbed layer rather than of diffusion[1].



Relation between surface age and surface tension at 20° C. for aqueous solutions of decoic acid at various concentrations.

However, where intermediate time intervals are concerned, I have found that changes in tension due to both diffusion and rearrangement can be observed using the same experimental technique, and in some cases can be clearly distinguished. The time required for the establishment of a surface layer by diffusion diminishes with increasing chain-length, but is extended as the polar nature of the end group, and the dilution of the adsorbate, increase. Suitable combination of these properties can give rise to systems in which the forces of diffusion will operate over periods of time overlapping those employed in the 'slow drift' experiments. The accompanying graph shows the variation in surface tension with time observed for aqueous solutions of decoic acid at several concentrations. The results were obtained by a modified drop-weight method, which consisted essentially in the rapid formation of a drop of the solution of predetermined volume on a calibrated orifice, and measuring the time required for the tension to fall to a value equivalent to the drop weight (indicated by the falling away of the drop). Full details of this work will be published elsewhere.

That the curves *OA*, *OB*, *OC* and *OD* represent the development of the surface layer under diffusion forces is supported by the fact that the form of the curves, and the times involved, are of the order forecast by the general time-adsorption velocity equation deduced from the behaviour of shorter chain systems where diffusion alone can operate[3]. Beyond the points *A*, *B*, *C*, *D* the tension falls very slowly, and readjustments in the established surface layer might well be responsible. It appears unlikely that the two factors can overlap, and extrapolation of the appropriate section of the time-tension curve to zero time assists in identifying the type of change occurring.

In view of the existence of such systems, it is not possible to determine which factor is responsible for the change of surface tension by reference to the order of time alone, and it appears that the terminology, and in particular the expression 'time to reach equilibrium' in common use in these studies, requires some amplification. It is suggested that the use of both the terms 'dynamic surface' and 'dynamic surface tension' be restricted to those surfaces to which solute is in the process of diffusing. When this process is complete, the surface can conveniently be said to have reached dynamic or diffusion equilibrium. All older surfaces would then be termed static, and would reach static equilibrium only after rearrangements in the surface film were complete. The broken line XY in the graph thus traces the variation of diffusion equilibrium with concentration, and represents the boundary between static and dynamic tensions. Methods of measuring surface tension are classified by common usage as static or dynamic, and it is of interest from the above results that static (as well as dynamic) methods are capable of yielding both static and dynamic tensions.

C. C. ADDISON.

Harris Institute Technical College,
Preston.
July 30.

[1] See Alexander, A. E., *Trans. Faraday Soc.*, 37, 15 (1941), and references therein.

[2] Addison, C. C., *J. Chem. Soc.*, 252, *et seq.* (1944); *Phil. Mag.*, 36, 73 (1945).

[3] Addison, C. C., *J. Chem. Soc.*, 354 (1945).

3 : 4-Benzpyrene from Coal Tar

THE extraction of the carcinogenic hydrocarbon 3 : 4-benzpyrene from coal tar, whether by the original method of Cook, Hewett and Hieger[1] (using repeated fractional distillation, extraction with solvents, formation of picrates, and crystallizations) or by Winterstein's modification[2] (involving chromatography), is generally considered too laborious, and the yields obtained too low, to serve as a practical measure for routine supplies. Hence the use of synthetic 3 : 4-benzpyrene for most experimental needs. When it was found[3], however, by a spectrographic method of estimation, that tar might contain as much as 1·5 per cent of benzpyrene, a re-investigation of the methods of isolating the hydrocarbon from tar seemed desirable.

Advantage was taken of the fact that sulphonation of benzpyrene does not readily occur with sulphuric acid alone in the cold, yet the hydrocarbon disappears completely from a solution on shaking with sulphuric acid. The expectation that the benzpyrene would be recoverable from the sulphuric acid washings (by dilution with water and re-extraction with an organic solvent) was confirmed; moreover, a quantitative test with pure benzpyrene yielded almost 100 per cent recovery. Its applicability as a means of isolating the hydrocarbon from tar seemed promising, since most other constituents of tar are either sulphonated by treatment with sulphuric acid in the cold, or else are left unextracted (the latter being the case, for example, with chrysene, and partly with pyrene).

Though the method was not practicable when applied directly to whole tar, owing to the very large amounts of sulphonated material obtained, it proved effective when tried on one of the crude distillation fractions of tar, obtained at 200–240° C. at a pressure of 0·1 mm. mercury (Hyvac and mercury pump), the fraction representing about 10 per cent of the original tar, and containing 2·4 per cent of benzpyrene (as estimated spectrographically).

10 gm. of this material in 100 ml. benzene was added to excess of petroleum ether, filtered, and the filtrate treated (at about 3° C.) with four successive lots of concentrated sulphuric acid. The pooled acid extracts were diluted with water, and extracted twice with benzene. The benzene extract was washed with dilute alkali, dried with anhydrous sodium sulphate, mixed with twice its volume of petroleum ether, and passed through a column of alumina (B.D.H.). The column was then developed with a benzene-petroleum ether mixture (1 : 2), and the early (non-crystallizable) eluates were discarded; the later eluates were collected, evaporated and several times recrystallized (from methanol and from petroleum ether). This yielded 75 mgm of a pale yellow crystalline product, possessing the characteristic fluorescence spectrum of 3 : 4-benzpyrene, and the following m.p. values:

Crystalline product from tar	m.p. 171–173° C.
Synthetic sample for comparison	m.p. 175–176·5° C.
Mixed m.p. 171·5–173·5° C.	

The yield of 75 mgm. of almost pure benzpyrene from 10 gm. of a crude distillate of tar, by a relatively simple procedure, seems sufficiently promising for application of the method on a large scale as a practical means for supplying this important hydrocarbon.

I. BERENBLUM.

Oxford University Research Centre
of the British Empire Cancer Campaign,
Sir William Dunn School of Pathology,
University of Oxford.
Aug. 1.

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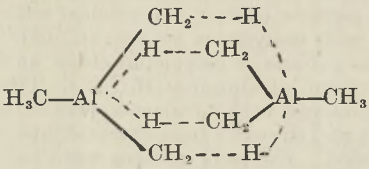
Aluminium Trimethyl

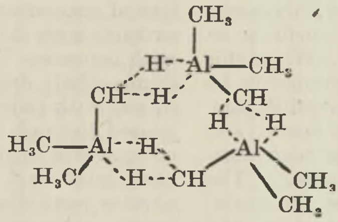
IN a recent letter, Burawoy[1] remarked that the ethane-like structure ascribed by us[2] to the dimeric form of aluminium trimethyl from electron diffraction investigations, and supported by Brockway and Davidson[3], is most unlikely. He proposed an alternative.

This method of examination does not enable us to deduce structures for such complicated molecules. They must be invented and tried; and for such a case, especially when not many orders of diffraction can be observed, it is impossible to say that any one satisfactory solution is unique. We have therefore tried Burawoy's model, and a number of others which we devised on various hypotheses about the type of binding without regard to their probability, for it is clear that the binding, whatever it is, must be new in some degree. We entertained the possibility that the degree of polymerization is more than two[4].

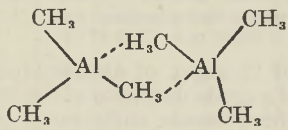
Burawoy's model proves unsatisfactory in both the qualitative and the quantitative fit of the simplified theoretical scattering curve with the observed scattering. We have, however, found three other more or less satisfactory models: I is a cage-type structure for the dimer; II is a ring structure for the trimer; III is a ring structure for the dimer with the ring not perpendicular to the plane of the other atoms. I is very good, II is quite good, III is fair. It may be recalled, also, that Brockway and Davidson rejected one of the ring models for the dimer (the sixth which they tried) more because it seemed improbable than because its scattering curve is bad. At present the experimental evidence available does not suffice for a definite choice between these possibilities to be made.



Model I
Al-C = 2·01; C-H = 1·09; Al..Al = 3·34; Al..C (ring) = 3·23 A.; ∠C-Al-C (ring) = 138°; ∠C-Al-C = 111°; C..H, Al..H not specified.



Model II
Al-C = 2·05; C-H = 1·09; Al..C (bridge) = 2·05; Al..H = 1·85; C..H = 1·30 A.; ∠ s tetrahedral.



Model III
Al..Al = 3·20; Al-C = 2·05; Al..CH_3 = 2·59 A.; ∠C-Al-C tetrahedral throughout.

The structures which appear to do least violence to current theory are I and III. These could arise if the association were due primarily to polar character in the Al-CH_3 bonds (the methyl groups being negative). The attraction may be increased by some polarization of the methyl groups by the aluminium atoms which they approach.

A fuller account of the calculations and of the theoretical considerations will be given elsewhere.

H. A. Skinner.
L. E. Sutton.
Physical Chemistry Departments,
Universities of Manchester and Oxford.

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Concentration of Solutions of Salts of Penicillin

Penicillin as a chemotherapeutic agent is usually employed in the form of its sodium or calcium salt: a concentrated solution of one of these salts is used for parenteral injection or for local application. For the latter form of treatment penicillin in solid form is often used (usually the calcium salt). Owing to the instability of solutions of these salts of penicillin it is necessary to prepare and store the salts in the solid form and to dissolve in the appropriate volume of water or saline shortly before required.

In order to obtain salts of penicillin in the solid form, evaporation *in vacuo* of the concentrated solutions at low temperature is necessary, and the lyophilic drying process, in which evaporation takes place from the frozen state, has been the method of choice. The lyophilic drying process is, however, very slow, especially with the apparatus usually available in the laboratory, and it is therefore desirable to concentrate the solution as much as possible before drying.

This concentration may be achieved by extraction of the free penicillin at pH 2 with organic solvents, the salt being formed from the extract by treatment with the appropriate alkali and a smaller volume (for example, one tenth) of water[1,2,3]. This method of concentration may be repeated if necessary, yielding very highly concentrated solutions of the salt.

At alternative method of concentration which has advantages over that outlined above has been developed as the result of an observation made during the preparation of penicillin in these laboratories. Thus, it was noticed that frozen solutions of the sodium salt of penicillin when allowed to thaw at room temperature gave fractions varying in composition (for example, in pigmentation)[3]. The process has now been examined in more detail, and the 'drip-thaw' method, as used by McFarlane for fractionation of blood plasma[4], has been found suitable for concentrating solutions of the salts of penicillin. Preliminary experiments showed that penicillin potency could be correlated with the degree of pigmentation, and the volume of the respective fractions was determined by observing, as thawing proceeded, the progressive decrease in the colour of the drops of fluid. Satisfactory results were finally obtained by fractionating into three fractions.

Thus, in a typical experiment, a solution of the sodium salt of penicillin (400 c.c.) was frozen at −25° C. and the bottle containing the frozen solution was inverted and allowed to 'drip thaw' at room temperature. Three fractions were collected and there was a progressive variation in penicillin content, pigmentation and alkalinity. Assay tests showed that about 90 per cent of the penicillin content of the original solution was concentrated in the first fraction, which was highly coloured and about half the original volume; the second fraction, which was only pale yellow in colour, contained most of the small amount of penicillin remaining, while the third fraction (colourless and about one fifth of the original volume) contained less than 1 per cent of the penicillin content of the original solution.

By this process solutions of the sodium salt of penicillin with a potency, for example, of about 3,000 units per ml. may be fractionated to yield a first fraction with a potency of 5,000 units or more per ml., that is, to a potency suitable for parenteral injection.

Since the bulk of the penicillin content of the original solution is concentrated in the first fraction, the volume of solution for lyophilic drying is reduced to about a half. The fractional thawing may be repeated on the first fraction, for example, thus still further reducing the volume of solution for lyophilic drying. In one or two instances the lyophilic drying process has been omitted, and solutions of the sodium salt of penicillin have been concentrated to a high potency by the above method, and have been stored for several weeks in the frozen state without appreciable loss of potency.

Assay tests on the fractions have shown that, as would be expected, there is practically no loss of penicillin; the process is easily carried out, requiring little attention, may readily be accomplished under aseptic conditions, and is, in fact, ideal for the concentration of solutions of unstable substances such as the salts of penicillin.

The method is suitable for the concentration of solutions of the calcium salt of penicillin, and it may also be of value for the concentration of solutions of other antibiotics or of antibacterial substances.

We wish to thank Dr. C. P. Stewart, of the Blood Transfusion Service, Royal Infirmary, Edinburgh, for providing facilities for the freezing of the solutions of penicillin used in this work.

S. W. CHALLINOR.
JEAN MACNAUGHTAN.

Department of Bacteriology and the
Wilkie Surgical Research Laboratory,
University of Edinburgh.
Dec. 17, 1943.

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Sexual Differentiation of the Gonad and the Sexualization of the Germ Cells in Teleosts

IN the Amphibia and Amniota, the original bisexuality of the gonad is evident from the dual origin of its two main constituents—the *cortex* from the peritoneal wall, and the *medulla* from the interrenal blastema[1]. Sexualization of the germ cells, which are originally indifferent, results from the action of one or other of the sexual differentiators which are produced in these areas, *medullarin* inducing maleness and *cortexin* femaleness (Witschi).

With this in view, several authors (Essenberg, Dildine, Dantschakoff, Lepori) have tried to identify cortical and medullary regions in the gonads of Teleosts. My own observations on several species do not support such a double origin, and a critical examination of the literature leads me to believe that in the Teleosts generally (as judged from the species studied to date) the somatic substratum of the gonad has a simple origin from the peritoneal wall.

In the Teleosts, as in the Cyclostomes[2], the germ cells do not at first exhibit male and female characteristics, which appear later in development. The primordial germ cells or *protogonia* (Beccari) multiply for a certain number of generations, giving rise to cells which I call *deutogonia*, becoming separated from each other or temporarily united into small groups. These are always sexually undifferentiated. The female cells first become recognizable oocytes during the maturative prophase and during the processes of growth and deutoplasmogenesis ; the male cells first disclose themselves as such when they multiply to form encysted groups of secondary spermatogonia. The two sexes are thus first distinguishable by the growth and suspension of division on the part of the female cells, and the continued multiplication within cysts of the male elements. Between these two extremes every degree of intermediate condition is to be found, giving cells in a state of *intermediate sexuality*.

Growth, deutoplasmogenesis and meiotic prophase may be initiated in cells which are derived, after a series of generations, from the early protogonia, but they may also set in immediately in the first generation of deutogonia, a condition which we have referred to as *abbreviated oogenesis*[3].

We see therefore that the development of the germ cells is characterized by an initial state of indeterminacy, which applies also to the gonad as a whole. This is particularly evident in the eel, and I think is the primitive condition in the Teleosts[4]. In the eel we can trace, from an initial indifferent condition, the progressive sexual orientation of the gonad with an increasing predominance of the germ cells of either male or female type. Parallel with this there is a regression of the heterologous sex elements and the accentuation of the male or female structure of the gonad. In the male these changes are recognizable in the development of the vas deferens and in the cordonal arrangement of the spermatogonia, and in the female in the lamellar arrangement of the oocytes.

The initial state of the gonad, as described above, is one in which the two opposing tendencies are balanced and can be defined as *intersexuality*. According to Goldschmidt[5], the essential difference between intersexuality and hermaphroditism lies in the temporal succession of two opposing tendencies in the first and the co-existence of both in the second. In my opinion, intersexuality is rather characterized by the incompatibility between the two tendencies, and hermaphroditism by their mutual tolerance[6]. This difference is probably due to the diffusible or non-diffusible nature of the sex differentiators.

Among the Teleosts we have a typical example of hermaphroditism in *Sparus auratus*[7]. Here, in the same gonad, the protogonia localized in the marginal ventral portion become differentiated in the male sense, while those distributed along the median and partly along the lateral walls of the central cavity differentiate in the female sense. In this case differentiation of each germ cell proceeds directly in one direction or the other with no intermediate condition of intersexuality. In *Sparus* there is constant *protandry*, that is, the male germ cells mature before the female.

In the Sparidæ there are other species (for example, *Diplodus* spp.) in which the testicular and ovarian areas likewise appear in the same gonad, but only one of them reaches maturity. Here, therefore, we see the transition from hermaphroditism, which must be considered as the primitive condition, to gonochorism.

With *Sparus auratus*, as in all cases of hermaphroditism, there is a genetically determined balance between the two opposing sex potencies. The differentiation in the same individual of male and female gonocytes cannot be interpreted as the direct effect of hereditary factors, but must be regarded as determined by the surrounding somatic tissue. The spatial separation of the protogonia destined to form sperm and ova lead us to believe that the somatic tissues of the gonad are chemodifferentiated into regions producing either male- or female-inducing substances.

Even in the eel, where there is no spatial separation of prospective male and female protogonia, we are led to the same general conclusion. The ultimate sexualization, which takes the form of an increasing predominance of one type of germ cell over the other, must be induced by local influences in the surrounding somatic tissue of the gonad[8].

In the Amphibia this is still more obvious. The protogonia become oogonia if they remain in the cortex of the gonad. If, however, they migrate into the medulla, they become spermatogonia. If migration is incomplete or delayed, the result is a condition of intermediate sexualization[9].

It would thus appear that in the vertebrates generally the germ cells are originally indifferent and later become sexualized under the influence of the somatic substratum of the gonad. This conclusion seems at first sight paradoxical and at variance with the widely held belief in the continuity of the germ plasm. It seems that the sex of the germ cells is not determined by genetic factors passed directly from the zygote through a series of germinal cell generations. But in species with genotypic sex determination, the sex-determining influence appears to pass first to the somatic tissues, which in turn induce the sexualization of the germ cells. In species in which there is a balanced genotypic sexuality (intersexuality), sexualization of the germ cells is likewise probably due to influences originating within the organism or from the external environment and acting always through the somatic substratum of the gonad.

UMBERTO D'ANCONA.

Institute of Zoology and
Comparative Anatomy,
University of Padua.

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Use of Dibenzylphosphoryl Chloride for Phosphorylations

ABOUT ten years ago, one of us (A. D.), at the suggestion of Dr. P. Eggleton, began experiments on the synthesis of some biologically important phosphorous compounds at the Physiology Department of the University of Edinburgh. In the course of these experiments, the chloride of dibenzylphosphoric acid was prepared and its usefulness proved in preliminary experiments. This work had to be broken off and could not be resumed until recently.

In the meantime, L. Zervas[1] has introduced the silver salt of dibenzylphosphoric acid as a phosphorylating agent; he considers the chloride too unstable for convenient use in phosphorylations.

We find that the chloride, prepared according to our original procedure from the potassium salt of dibenzylphosphoric acid with thionyl chloride in chloroform, is sufficiently stable for preparative use in phosphorylations. Guanidine dibenzylphosphoric acid can easily be prepared by shaking the chloride with a 25 per cent guanidine solution. Within a few minutes the oily chloride disappears and a solid is precipitated. After filtration and washing with water, the crude product is recrystallized from alcohol-ether; m.p. 166·5–167·5° C.; yield 80 per cent. By hydrogenation with a palladium catalyst, guanidinophosphoric acid is obtained. We have prepared a number of substituted amino- and guanidino-phosphoric acids and are at the present time occupied with experiments on the phosphorylation of hydroxy-compounds.

When treated with a cold dilute potassium hydroxide solution, dibenzylphosphoryl chloride yields the tetrabenzylester of pyrophosphoric acid in good yield; m.p. 59–60° C. The substance is insoluble in water, soluble in alcohol and ether and decomposes with warm alkali to form dibenzylphosphoric acid. Our attempts to prepare tribenzylpyrophosphoric acid by partial saponification or hydrogenation of the tetrabenzylester have hitherto been unsuccessful.

A. DEUTSCH.
O. FERNÖ.

Research Department,
A.-B. Leo, Hälsingborg,
Sweden.
June 29.

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Air Photography in the Far East

THE recent article[1] by Wing-Commdr. Hamshaw Thomas is very timely. I have recently been attached to H.Q., S.E.A.C., so I have had considerable opportunity of seeing the part played by air photography in that region. When the time comes for the full story to be told, it will be found that many of the applications are likely to be those described in the recent article. My present purpose, however, is to put on record a plea for the continuation of R.A.F. air survey in the tropics as well as in England. The need in the Far East is even greater than in Great Britain, because many of the tracts of country are almost inaccessible. One need scarcely say that the governments concerned, for example, India, Ceylon, Malay and Burma, are fully aware of the great value of air survey, but too often decisions are made in Great Britain by people who are not familiar with the needs elsewhere. Here one may refer to the aerial surveys carried out for the forest service in Burma, for example, Irrawaddy and Lower Tenassarim, between the two Wars, though for present-day purposes these were on a small scale. There has also been great improvement in technique since these surveys were carried out, and much of the work must require repetition.

One or more units of the R.A.F. ought to be maintained in the Far East and their work made available to the resident scientific men and government departments. In this connexion also it is to be hoped that the vast collection of photographs now accumulated in the Far East will not be destroyed but made available in the near future to men of science for study. Finally, there is not only the question of the continuance of air survey, but there is also the problem of service photographic research. It is highly desirable that this should be continued, not only in Great Britain but also in the tropics. Conditions for photography are obviously completely different in the tropics, and we have by no means fully mastered them. They cannot properly be overcome by simulating tropical conditions in Britain, and it is most important that a photographic research unit should be set up and maintained in either India or Ceylon. This unit could operate as an out-station of the main research centre in Britain. During the course of their investigations, if there is proper co-ordination between them and local scientific men and local needs, much useful work could be done. This type of peace-time co-ordination is already in evidence at the army photographic research centre in Wiltshire. It is to be hoped that the R.A.F. will follow suit.

V. J. CHAPMAN.

Botany School,
Cambridge.

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ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

ANNUAL CONFERENCE

THE twentieth Conference of the Association of Special Libraries and Information Bureaux, held in the Portland Hall, Polytechnic Extension Building, London, during September 15–16, drew the largest attendance of recent years, and the new *venue* provided more of the opportunities for informal discussion and contacts which were such a useful feature of the residential conferences arranged before the War. Even at the conversazione at the Royal Institute of British Architects on the Friday which preceded the formal opening it was evident that this was appreciated; and there was, further, a clear desire for a conference to be held in a northern and industrial centre which afterwards found expression at the annual general meeting and in the discussion which followed Mr. E. N. Simon's paper, "Some Problems of the Special Librarian in Industry". The liveliness of the discussion on that paper, like that on Mr. E. J. Carter's paper on "The Planning and Equipment of Research Libraries and Information Bureaux", indicated that the time available was all too inadequate. Indeed, the general impression was gained that these two sessions, with that at which Miss M. Bateman presented her paper, "Some General Desk Reference Books", the discussion on the book shortage over which Mr. L. J. F. Brimble presided, and some opportunity for informal discussion of the ideas thrown out by Prof. J. D. Bernal in his opening address, would have provided more than enough, in addition to the formal business, to satisfy the majority of those attending.

In contrast to the usual practice, the Conference opened with the annual general meeting at which the report of the year's work was presented. Membership has risen to 530, and the subscriptions increased to £1,500. Grants of £300 from the British Council and £1,000 from the Department of Scientific and Industrial Research were received during the year, and the income and expenditure account shows a surplus for the year of £241.

Only two Library Training Courses were held during the year, and the second of these did not end until July 1945. The first issue of the *Journal of Documentation* appeared in July 1945 and non-member subscribers to the ASLIB Book List now number 424, including 230 copies distributed through the British Council. Preliminary steps have been taken towards the compilation of a "Directory of Medical Libraries and Sources of Information", and a new edition of the "Select List of Standard British Scientific and Technical Books" is also in preparation. The Publications Committee has also been responsible for editing a guide to "British Sources of Information", commissioned by the British Council for the use of libraries overseas. ASLIB has also collaborated with the Library Association and the National Central Library in compiling a list of American periodicals missing in transit or through enemy action during recent years. This is the first step in a scheme by which it is hoped that some replacements may be obtainable through co-operation with American libraries, even when the issues in question are out of print.

Following the annual meeting, Prof. J. D. Bernal gave a challenging address on "Information Service as an Essential in the Progress of Science". Dealing primarily with the user's side of library service in relation to research, Prof. Bernal made a strong plea for closer co-operation between the librarian and the research worker and for a fuller understanding of each other's needs and problems. The modern information service should endeavour first to secure that the right information in the right form was sent out to the right people, and, secondly, to arrange that facts of diverse origin which might bear on any particular topic should be correlated for the study of that topic. The very fact that the productive capacity for scientific information increased so greatly, while the absorptive capacity did not increase, accentuated the importance of these distributive and integrative aspects of library service, and Prof. Bernal suggested that in the future the librarian should be master of the material itself and be in a position to present it in forms different from those in which he receives it. It is the librarian's job not merely to accept material as sent to him, but also to demand that the material be presented in the appropriate forms for passing on. This implies a much closer relation between the librarian and the research worker as well as between the function of the librarian and that of the publisher, and Prof. Bernal referred to the way in which war-time experience of the dangers of departmentalism in information service had emphasized the unity of the whole question of scientific communications. It had become clear that, so far as information service for furthering research was concerned, a thorough recasting of the whole system was required, and the present period of rehabilitation offered a unique opportunity for a new start.

The primary unit in scientific communications was the individual scientific paper dealing comprehensively with one topic, and in Prof. Bernal's opinion the scientific journal had ceased to be a really satisfactory means of distributing scientific information. He suggested that the individual scientific paper was the proper basis for distribution as well as for publication. Under the proposed scheme the papers, after being passed for publication by referees, would be forwarded by scientific societies to a national centre which would act as clearing house. The papers would be published in three lengths: in full, possibly as microfilm; in the main, printed; and in summary or abstract. Prof. Bernal visualized a unified abstract service. For indexing, the title of the paper would be sufficient for most purposes. The scientific societies would retain their editorial functions, but it was particularly important that the scheme should be on an international basis from the start, and librarians who were able to appreciate the need for order and uniformity in the presentation and distribution of information should stress to scientific societies and governments the folly of independent action.

At the afternoon session when Sir Frederic Kenyon presided over a symposium on "Links with the U.S.A.", there were some striking omissions. Miss Taylor read a paper by Dr. R. H. Heindel on "The American Library in London" and indicated that this was likely to be retained in some form or other. The arrangement by which H.M. Stationery Office will act as a sales agent for the publications of the U.S. Government Printing Office was also mentioned as likely to operate in the near future, and the paper was supplemented by a list of some guides to American publications. Mr. R. H. Hill read a joint paper with Mr. E. G. Tayler describing the Bureau of American Bibliography established at the National Central Library on January 1, 1938, and the collaboration of the National Central Library with the Committee on International Relations of the American Library Association in the distribution of American books and periodicals to men serving in the British Forces at home and overseas. Mr. W. C. Dalgoutte described the British Information Services in New York and the work of its four divisions—information, including the library, which is the main link between the organization and American libraries; press and radio; general, including speakers and circulation; and films; and he referred to the growing demand for information on Britain's financial and economic position. In a paper on the work of the American and British Commonwealth Association, Major W. E. Sinnett referred to plans for an Anglo-American Library of Reference which were in abeyance with the formation of the American Library under Dr. Heindel, and to the foundation of an Anglo-American Institute of Cultural Relations and Study. Mr. L. R. McColvin outlined cultural relations with the United States organized by the Library Association, and a paper by E. S. Cavanaugh on the work of the Special Libraries Association was read by Miss Ditmas in which the proposal for an Educational and Cultural Organisation of the United Nations was welcomed and reference made to Mr. Archibald MacLeish's plan for inter-library loans on an international basis to help the devastated libraries in Europe.

A paper on exchanges of staff and students between British and American universities, by Mr. R. A. Johnson, appeared singularly out of date. Taken from an article published in October 1944, it omitted all reference to the more recent arrangements such as that between the University of Manchester and the University of Virginia. Among papers presented in person were those of Mrs. Beatrice Warde describing the operations of the "Books Across the Sea" societies and of E. A. Ford on the "Educational Work of the English Speaking Union", but in an overloaded symposium there was little reference to the scientific field and none at all either to the work of the Scientific Offices in Washington or in London or to the important proposals in the recent report of Dr. Vannevar Bush.

By way of contrast, almost the whole of the following session was given over to lively discussion of Mr. E. N. Simon's paper. Possibly Mr. Simon overstressed the need for education inside a company—his own experience on this point was not generally corroborated—but there can be no question as to the importance of more propaganda on the part of ASLIB. The Association has sometimes tended to preach too much to the converted, and Dr. W. H. Brindley's suggestion for more joint or conjoint meetings of ASLIB with the scientific societies and professional associations should be followed up. Mr. Simon himself indicated that the primary task of the information officer is to direct his clients to reading, not to read for them, and in fact the technique of good showmanship is an important part of the equipment of a first-class works librarian as of the public librarian. Mr. Simon gave frank expression to a number of problems, internal and external, with which most librarians are confronted, and succeeded in conveying a point of view that is not always recognized. Not every librarian appreciates the harm that is done by automatic reminders or recalls, whether or not the borrowed volume is actually required for use elsewhere, though, of course, every librarian knows that in the absence of a reminder system the book may never come back, whether it is in use or not. The question of co-operative translations Mr. Simon discussed at some length and also the functions of ASLIB, and if all his strictures could not be maintained the plea for a northern conference received strong support. Such a conference should do much to remove the main burden of Mr. Simon's strictures on the Association—that its discussions are conducted in too general terms, insufficiently related to specific problems; and if at the same time the suggestion that active steps should be taken to enlighten chambers of commerce, sales managers associations, bankers, municipal officials and others as to the importance and value of information services is adopted the steady growth of the industrial membership of ASLIB may in itself supply whatever further impetus is required for the movement urged by Mr. Simon.

Mr. Edward Carter's paper on the planning and equipment of research libraries and information bureaux at the Sunday morning session, over which Mr. S. W. Gibson presided, alone would have given value to the Conference for the industrialist, but once again the session was overloaded by bringing in Mr. C. E. A. Bedwell's paper on "Hospital Library Accommodation", which not only curtailed the discussion but was clearly regarded by the majority of those present as extraneous, if indeed it fell properly within the sphere of ASLIB at all. Mr. Carter emphasized the importance of flexibility of plan and freedom to expand and suggested accordingly that the least possible amount of equipment should be fixed. Increase in size inevitably compels changes in the qualitative elements of a library's organizations, including the main plan elements, doorways and walls as well as equipment, and changes should be allowed for, even if they cannot be calculated in detail. Moreover, provision for expansion should cover not merely straightforward increase in holdings but also increase or intensification of service. Usually this will mean more staff for whom workplace must be found, and this is often difficult except at the expense of reader-space even if the sound principle is observed—not, however, mentioned by Mr. Carter—that only those members of the library's staff actually responsible for service to readers should be located in the reading-room itself.

Without dealing in detail with library planning, Mr. Carter indicated his objections to the university type with reader's bays and emphasized the desirability of the librarian's own room being situated where he will be in close contact with both readers and staff. On lighting and acoustics he made many important practical observations, and his comment that it is as important to prevent noisy conditions in rooms where staff are at work on tasks demanding concentration as in reading rooms will be appreciated. He pointed out that a sustained background noise of traffic or machinery is generally not troublesome and can even be helpful in muffling foreground disturbances such as conversation, a squeaky pen and so on. Readers prefer, he finds, to sit facing rather than alongside each other unless the space between adjacent readers is very generous. Something more than minimum seating comfort is one of the amenities which any but the poorest research body should afford, and all shelving should be adjustable. Mr. Carter's whole paper is packed with observations, notes on minimum standards, and data for calculations for accommodation and design which should be valuable even to the experienced works librarian, and further comments on a number of his points are to be found in S. Rowland Pierce's "Some Notes on the Planning of Research Libraries", who expresses the opinion that where doors are not provided to the bookshelves there should be no books between twelve or eighteen inches of the floor.

There is room for more discussions of the type that followed Miss M. Bateman's paper on "Some General Desk Reference Books" at the afternoon session on September 16, though the speakers betrayed a tendency to think in terms of specific reference books rather than those of a general, all-round usefulness. This session was followed by a discussion on the great book shortage, over which Mr. L. J. F. Brimble presided. This was opened by a paper by Miss E. M. R. Ditmas who, after recapitulating the causes of the shortage, referred to its effects in education and research and its bearing on Empire intercommunications and the re-establishment of cultural relations with Europe. In regard to research, Miss Ditmas quoted figures supplied by the research department of a large firm carrying on research of vital national importance, showing how the position has steadily deteriorated since 1942 and the dependence on American rather than on British books—a dependence which, with the termination of Lend-Lease, may have serious repercussions on industrial and scientific development if books are regarded as articles of luxury or merely a commodity of trade. The immediate demand for British publications is far in advance of the normal pre-war demand, while stocks are at their lowest. The discrepancy between supply and demand grows monthly, but the remedy must take account of labour in both the paper-making and the printing and bookbinding industries as well as transport and materials.

In the lively discussion which followed, Miss Ditmas's remarks in regard to the effect of the book shortage on research was stressed by Dr. V. E. Parke and other speakers, including the chairman, who expressed the opinion that books needed for research and for the universities were more important than those needed for schools, where the numbers run into hundreds of thousands of volumes. Reference was made to the possible help of the American Library in arranging facilities for inspecting American books which could not be obtained on approval, and the chairman endorsed a deserved tribute paid by Prof. R. S. Hutton to the services of Messrs. H. K. Lewis and Co., Ltd., and other leading booksellers in procuring American literature. Mr. H. L. Jackson, of Messrs. H. K. Lewis and Co., Ltd., thought that Miss Ditmas had given a very good account of the position and that the shortage was most acute in the educational field. Confirming that the labour position rather than the paper shortage* was the most acute difficulty, he suggested that it would be better to send a deputation with a resolution rather than submit a resolution only from the Conference. After further discussion a resolution was approved suggesting that the Council of the Association of Special Libraries and Information Bureaux should take definite action along such lines, either by a deputation to the Ministry of Labour or other Ministry or by way of resolution.

* Since this discussion was held, a fifteen per cent increase in paper allocation has been announced.

CHEMICAL COMPOSITION OF MARINE ORGANISMS

THE data on the chemical composition of marine organisms are widely scattered; hence Prof. A. P. Vinogradov's paper on "La composition chimique élémentaire des organismes marins" (*Trav. Lab. Biogéochimique, Acad. Sci. URSS.*, Pt. 1, 1937, Pt. 2, 1941, Pt. 3, 1944) is a valuable contribution to our knowledge of the elemental chemical composition of marine plants and animals; it is in Russian. Essentially it represents a compilation of many thousands of elemental analyses of marine organisms, and the bibliography alone, printed in double columns in close type, occupies 44 pages. The data presented are accompanied by extensive critical discussion and comments. Part 1 embraces Algæ, Bacteria, Protozoa, Porifera and Cœlenterata; Part 2, the remaining Invertebrata and a part of a chapter on the chemical composition of respiratory pigments; and this chapter is carried over to Part 3, which also contains additional notes on the composition of Invertebrata, composition of Pisces, composition of skeletal parts of animals, a general summary and special chapters dealing with the problems of geology and evolution from the biogeochemical point of view.

Although the collection of analyses appears to be enormous, its usefulness in its present form is somewhat limited, mainly because the analyses are usually confined to certain chemical elements found in certain parts of organisms (soft parts, skeleton, ash, etc.), and there is no attempt made to evaluate the composition of complete organisms. This means that any attempt to give a generalized view of the chemical composition of individual species is bound to be rather vague, and any comparison between them very difficult. This fault certainly does not lie with the author, whose perseverance in collecting these data is truly remarkable. In spite of these difficulties the author makes an attempt to trace the relation existing between the composition of organisms and the composition of the ocean and to find out the major changes in chemical composition of organisms during geological time.

From the point of view of geology, or rather of biogeochemistry, as this branch of science is now called in the U.S.S.R., an especially important question is that of the concentration of certain chemical elements by marine organisms, which often leads to the deposition of rocks of biogenic origin, such as limestone, diatomite, manganese and iron ores and petroleum. "Marine organisms, concentrating certain elements and dispersing others during the process of their living activity, are performing complex and varied geochemical functions. Their chemical elemental composition, as shown by thousands of analyses, does not appear to be a simple reflection of the chemical composition of the surrounding medium. The varying chemical composition of the organism is determined by their physiological character, which in its turn is produced by lengthy interaction between each organism and its medium. On closer investigation we can discover that the chemical composition of the organism reflects its genetic history." According to the author, each species of organism is characterized by its own chemical composition, which has remained more or less constant throughout geological time, and only new species show a marked change in composition.

S. I. TOMKEIEFF.

FORTHCOMING EVENTS

Monday, November 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. F. C. Bawden: "Virus Diseases of Plants", 1. "Symptoms of Virus Diseases" (Cantor Lectures).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. C. P. Skrine: "Persia and Afghanistan" (Kodachrome films and commentary).

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Birmingham Chamber of Commerce, 95 New Street, Birmingham 2), at 6.15 p.m. —Discussion on the Radio Industry Council Report on "Post-War European Broadcasting" (to be opened by Mr. A. H. Cooper).

Tuesday, November 20

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. G. Macdonald: "Tropical Hygiene and the Overseas Empire".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "Recent Research Work in the Davy Faraday Laboratory" (i) "Atomic Movements in Crystals".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. A. S. Parkes: "Some Problems of Reproductive Physiology".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY, MEDICAL GROUP (at the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Discussion on "Equipment for Medical Photography" (to be opened by Dr. A. C. Roxburgh and Mr. J. E. Andrews).

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 6 p.m.—Dr. W. F. Berg: "How it Works in Photography", 2. "Latent-Image Theory without Tears".

Wednesday, November 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Henry Berry: "The Thames Conservancy".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. R. Brinkley: "A Method of Increasing the Range of V.H.F. Communication Systems by Multi-Carrier Amplitude Modulation".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. M. Fishenden and Dr. O. Saunders: "Heat Transmission" (Second paper in the Industrial 'Waste Heat' Recovery Series).

SOCIETY OF CHEMICAL INDUSTRY (at the Royal Institution, Albemarle Street, London, W.1), at 6.15 p.m.—Sir Harold Hartley, F.R.S.: The first H. E. Armstrong Memorial Lecture (members of the Plastics Group are particularly invited).

INSTITUTE OF WELDING, WOLVERHAMPTON BRANCH (at the Victoria Hotel, Wolverhampton), at 7 p.m.—Mr. T. E. Calverley: "Electrical Technique in Resistance Welding".

Thursday, November 22

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. M. Meek and Mr. C. E. R. Bruce: "Some Recent Theories of the Electrical Discharge".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "The Anatomy and Functions of the Brain in Lower Vertebrates" (iv) "Mammals".

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY COLLEGE OF NORTH WALES CHEMICAL SOCIETY) (in the Department of Chemistry, University College, Bangor), at 5.30 p.m.—Prof. J. W. Cook, F.R.S.: "Colchicine, its Chemistry and some Biological Effects".

Friday, November 23

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. J. D. Bernal, F.R.S.: "Lessons of the War for Scientists".

BEDSON CLUB (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. G. F. Marrian, F.R.S.: "Some Aspects of the Biochemistry of the Corpus Luteum Hormone" (Sixty-first Bedson Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Dr. J. M. Meek: "The Influence of Irradiation on the Measurement of Impulse Voltage with Sphere-Gaps".

INSTITUTION of MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Miss Verena Holmes: "The Place of Women in Post-War Engineering".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY) (at University College, Cardiff), at 6.30 p.m.—Prof. J. W. Cook, F.R.S.: "Colchicine, its Chemistry and some Biological Effects".

ASSOCIATION OF SCIENTIFIC WORKERS (at the Onward Hall, 207 Deansgate, Manchester), at 7 p.m.—Dr. W. A. Wooster: "Science To-day in the U.S.S.R.".

BRITISH ASSOCIATION OF CHEMISTS, ST. HELENS SECTION (at the Y.M.C.A. Buildings, St. Helens), at 7.30 p.m.—Dr. N. Thorley: "Chemical Analysis by X-Rays".

Saturday, November 24

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. A. C. Hartley: "Operation PLUTO" (Annual Lecture).

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