THE PROMOTION OF THE SCIENCES IN THE COMMONWEALTH

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THE PROMOTION OF THE SCIENCES IN THE COMMONWEALTH

INTRODUCTION

THERE was little scientific activity within the Commonwealth outside the United Kingdom until the first universities in the other member countries were formed about the middle of the nineteenth century, and it was at about that time that scientific research in them may be said to have started.

Since the exchange of ideas is essential to such activity, unofficial collaboration between Commonwealth scientists was common from the first, and was made natural and easy since the early professors in Commonwealth universities usually came from United Kingdom universities, with which they maintained close contact. The learned societies of the United Kingdom (whose contribution to the promotion of research and the development of science were already immense) also played, and still play, an important part in disseminating knowledge and maintaining friendly links between scientists throughout the Commonwealth.

The organisation of systematic scientific research on a national scale, with Governments assuming responsibility and supplying funds, developed later, starting in connection with primary production and medicine and then, to meet the urgent needs of the two world wars, continuing into secondary industry and defence. Today most Commonwealth countries have national organisations for promoting and financing scientific research, which is recognised as necessary both to economic and social development and to defence.

As the *corpus* of knowledge and the institutions concerned with it have both increased rapidly in recent years, the informal links between scientists have been supplemented in a formal framework of institutes, bureaux, conferences and liaison offices which have been established to assist the exchange of ideas between the national organisations throughout the Commonwealth. Collaboration is also fostered by various official and unofficial schemes for the interchange of scientists between Commonwealth countries, and *ad hoc* conferences held from time to time on such subjects as health, education, metallurgy, standards, nuclear energy. All these links and rallying points add to the prestige and effectiveness of British science as a whole and thus to the economic strength of the Commonwealth and help individual Commonwealth scientists and technicians to contribute more effectively to the solution of world problems.

This paper describes first the influence of the learned societies, then the evolution and structure of the various national research organisations in the independent countries of the Commonwealth, and the Federation of Rhodesia and Nyasaland and the different, but analogous, standards organisations, outlines the growth and nature of the framework within which the process of intra-Commonwealth collaboration is conducted, and finally describes briefly research for the UK dependencies. [For a fuller account of research in and on behalf of the UK dependencies see RF.P.4035 of November 1958, *Research and the United Kingdom Dependencies.*]

LEARNED SOCIETIES

The learned societies of the United Kingdom have had a profound and lasting influence upon the development of scientific research not only in the United Kingdom itself but throughout the Commonwealth. Fellows of the Royal Society of London, for instance, have always been drawn from the whole Commonwealth. This is true of other learned societies in the United Kingdom. The journals of these societies are open for publication of scientific work of Commonwealth scientists, who also freely participate in their meetings. Many have local sections in other Commonwealth countries and local correspondents who encourage links with United Kingdom scientists. An outstanding example of Commonwealth scientific collaboration is provided by the Royal Society Empire Scientific Conference of 1946, which was attended by representatives from all Commonwealth countries.

Although today most research operations are conducted under other auspices, the learned societies have retained their traditional function of facilitating the speedy communication of scientific knowledge and the application of new discoveries.

There are at present over 200 learned societies in the United Kingdom. The chief of them are unique and without exact counterparts anywhere else in the Commonwealth, although similar societies have been, and are being, established in some other Commonwealth countries. This section refers briefly to the four main learned societies in the United Kingdom and the more important of those in other Commonwealth countries.

United Kingdom

The four chief learned societies in the United Kingdom are the Royal Society of London, the Royal Society of Arts, the Royal Institution and the British Association for the Advancement of Science.

The Royal Society of London: This is the oldest of these, having been founded in 1660 'for improving natural knowledge by experiment'. It originated in the informal discussions occasionally held in London as early as 1640 by a small group of men interested in the idea of the New Philosophy which had been put forward by Francis Bacon (1561–1626). In 1660 the members resolved to constitute themselves a scientific society. This project received the approval of King Charles II and his permission to use the title the 'Royal Society'. The charter of incorporation was received from King Charles in 1662 and a second charter issued in 1663 extended the privileges of the society.

The society consisted of two groups of members: those actively engaged in the advancement of some branch of 'natural knowledge', and others whose interests lay in history, literature, art, archæology or exploration. For two centuries men of science were in a minority though the growth of the society's scientific reputation was based upon their learning and enthusiasm.

From 1820 onwards the administration of the society's affairs passed increasingly into the hands of the scientist members. Since the beginning of the present century the Fellows have all, with the exception of a few who have been specially elected, been men of science, and the society's aims and policies have been directed wholly to the advancement of scientific research.

The society has from its foundation been consulted by the United Kingdom Government on scientific projects of national importance and has also itself made representations to the Government from time to time on scientific matters.

The Royal Society nominates seven members of the board of visitors of the Royal Greenwich Observatory at Herstmonceux and has two representatives on the Meteorological Committee and eleven representatives on the Joint Permanent Eclipse Committee. The president and council, acting on behalf of

the Committee of the Privy Council for Scientific and Industrial Research, have been responsible for supervising the scientific policy of the National Physical Laboratory since its establishment in 1900 on the recommendation of the Royal Society. The society also has custody of the standard copies of the imperial standard yard and pound.

The officers of the society are the president, the treasurer, principal secretaries and foreign secretary. While the president and foreign secretary hold their offices for five years, the treasurer and other secretaries retain theirs for ten. The officers and the council for the ensuing year are elected by the Fellows at each annual anniversary meeting held on Saint Andrew's Day (30th November).

The affairs of the society are managed by the council, which comprises twenty-one members including all the officers. The council is assisted by a number of committees, which advise on the use of the society's research funds and the organisation of research. With the aid of nine boards, the council also administer the annual grants voted by Parliament to finance scientific investigations, publications and certain UK participation in international scientific meetings. The minutes of the council, which has met at regular intervals since its first meeting at Gresham College in 1663, record the complete history of the society.

The ordinary meetings of the society, to which papers are submitted by its Fellows, are held weekly during the session, which lasts from November to June. The selection of papers for publication in either the *Philosophical Transactions* or *Proceedings* is made by the Committee of Papers, which consists of the council aided by advisory committees.

The highest honour bestowed by the society is the Copley medal, for which scientists of all nationalities are eligible, and which is awarded to 'the living author of such philosophical research, either published or communicated to the society, as may appear to the council to be deserving of that honour'. Two Royal medals are awarded annually for the two most important contributions to science published in the Commonwealth not more than ten years nor less than one year before the date of the award. The Davy medal, founded in memory of Sir Humphry Davy, is given for the most important discovery in chemistry made in Europe or North America.

The Rumford medal is awarded biennially for the most important discoveries in heat or light made during the preceding two years. The Darwin medal is also awarded every two years, the Sylvester once in three years and the Buchanan in every fifth year.

Admission to Fellowships is restricted to 25 a year, elected in March.

During the International Geophysical Year 1957–58, the Royal Society, acting through the British National Committee, co-ordinated the research effort of UK Government departments, universities and other institutions.

In July 1960 the society celebrated the tercentenary of its foundation.

The Royal Society of Arts: Founded in 1754, this is, after the Royal Society and the Society of Antiquaries (founded in 1707 for the study of antiquity and the history of former times), the next oldest learned society in the United Kingdom.

Its objects and scope are indicated in its full title—The Royal Society for the Encouragement of Arts, Manufactures and Commerce.

William Shipley, its founder, was an obscure drawing master living in Northampton, with only the slightest footing in London, who based his project for the society on two basic ideas—the awarding of prizes, and the raising of funds for them from public-spirited people.

The most numerous section in the early prize competition was that concerned with overseas development. In this group there were in 1764, for example, 123 classes of competition for the encouragement of new products in the American and West Indian colonies. For home agriculture there were 92 classes of awards,

covering new crops, new methods of cultivation and new implements. Other sections were concerned with the production of minerals and chemicals, and with the technical and æsthetic improvement of certain industries, particularly the manufacture of textiles, and, finally, some 100 awards were offered for drawing, engraving, sculpture and architecture.

Up to 1766, no less than £16,625 had been expended in prizes. Such encouragement resulted in the reafforestation of large areas of land; it was the means of introducing several new crops, such as the swede and the mangel-wurzel, to the United Kingdom and to the colonies, and of the development of new agricultural implements such as improved ploughs, drills, harrows, chaff-cutters and root-cutters; it fostered the skill of draughtsmanship and stimulated the invention of many mechanical devices, materially contributing to the progress of the Industrial Revolution.

For about a century, prize competitions continued to be the main function of the society, but during the latter half of the nineteenth century they began to lose their predominance in favour of other activities, such as exhibitions and lectures. Awards continued to be made, however, from time to time and this traditional method has not entirely lost its usefulness.

In 1936 the society created the Faculty of Royal Designers for Industry, membership of which is recognised as the highest honour available to British industrial designers.

The society not only originated many species of exhibition; it can claim to have originated the whole genus.

In 1760 it organised the first public exhibition held in Great Britain—an exhibition of contemporary paintings which led to the foundation of the Royal Academy in 1768. In 1761 it organised an exhibition of machinery—the first industrial exhibition. In the next century, although the idea originated in France, the society was prime mover in the organisation of the first international exhibition actually to take place—the Great Exhibition of 1851.

The Exhibition of British Art in Industry, organised by the society in 1935 in conjunction with the Royal Academy, besides having many other important results, such as the founding of the Faculty of Royal Designers for Industry, established the principle of reserving to the promoters complete control over the selection of goods for exhibition. 'A Design at Work' Exhibition, sponsored in 1948 by the society in conjunction with the Council of Industrial Design, was the first collective exhibition of the work of Royal Designers for Industry.

The society's commercial examinations were started in 1854 in connection with the adult educational institutions, and have maintained two principles, viz., that they should be held at local centres and in single subjects. They are taken widely throughout the Commonwealth. Though covering a wide range of subjects, including technology, drawing and music, the bias has been towards commerce.

The Royal Institution: The Royal Institution was founded in 1799, on the initiative of Benjamin Thompson, Count Rumford, an American soldier, statesman, philanthropist and scientist, who had come to England during the War of Independence and returned after a long period in the service of the Elector of Bavaria. His proposal to form 'by subscription in the Metropolis of the British Empire a Public Institution for diffusing the knowledge facilitating the general introduction of useful mechanical inventions and improvements, and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life' was launched with the support of the Society for Bettering the Condition and Increasing the Comforts of the Poor.

The institution was formally constituted on 7th March, 1799. Rumford himself framed its constitution, and solicited a royal charter from King George III. In 1810 the constitution was amended by an Act of Parliament which extended

the scope of its activities to include the promotion of chemical science by experiments and lectures for improving arts and manufactures and the 'diffusion and extension of useful knowledge in general', and substituted a body of subscription-paying members for the hereditary proprietors who had sponsored its establishment. Eminent men have held office and served on committees of managers and visitors. There are four professors respectively of natural philosophy, astronomy, chemistry and physiology.

In 1801 Rumford engaged as lecturer in chemistry a young Cornishman named Humphry Davy, who was elected resident professor a few years later at the age of twenty-three. It was by his experiments at the institution that Davy discovered the new elements of sodium and potassium, and the science of electrochemistry was based on his brilliant research into the chemical action of electricity. He also invented the arc light and the electric furnace, but it was the development of the miner's safety lamp, based on the principle that neither flame nor explosion pass along the narrow metallic tubes formed by metal gauze, which brought him the greatest fame. Davy was also a gifted lecturer and early established the scientific reputation of the institution.

The character and traditions of the Royal Institution were maintained and enlarged by Davy's assistant and successor, Michael Faraday. During the 46 years in which he was associated with the institution, Faraday made a series of experimental discoveries. The greatest achievement of his early work in chemistry was the discovery of benzene, on the practical application of which the dyestuffs and other industries based on coal-tar derivatives were founded. During his electrical research, Faraday derived a continuous electrical current by induction from a magnet and in his principles of electricity he recognised the electro-magnetic theory of light. His invention of the dynamo made possible the development of electro-engineering.

The trend of modern scientific research towards planned investigations by the co-ordinated activity of teams of workers has not destroyed the individualistic approach of the workers more recently associated with the institution. Outstanding among their activities are the light-scattering experiments and investigations of diamagnetism and the magnetic properties of crystals by Tyndall, Dewar's work on the liquefaction of gases, Lord Rayleigh's separation of the inert gas argon from atmospheric nitrogen, the lectures of Lord Rutherford and Sir J. J. Thompson on their Cambridge research in atomic physics and the work of Sir William Bragg, in collaboration with his son Sir Laurence Bragg, on the analysis of crystal structure by means of X-rays.

The thermos flask in wide use today originated in the vacuum vessels used by Dewar to preserve liquefied gases at a low temperature.

A house adjoining the institute was presented with an endowment by Dr. Ludwig Mond in 1896 to found the Davy Faraday Research Laboratory which is today supported by several industrial firms. This gift extended the research facilities of the institution's laboratories both to accommodate a large number of independent research workers, and enable experimental work requiring the co-operation of a team of investigators to be undertaken in the institution.

The custom of holding regular Friday evening discourses at which every important scientific advance has been described was inaugurated by Faraday in 1826.

In addition to afternoon lectures which are open to the public as well as to members, courses of lectures for school children have regularly been given at the institution after Christmas since their inception by Faraday in 1826. The lectures, which are illustrated with a number of simple experiments, attract enthusiastic audiences every year.

The British Association for the Advancement of Science: The British Association was founded in 1831 'to give a stronger impulse and a more systematic direction

to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers; to obtain more general attention for the objects of science and the removal of any disadvantages of a public kind which impede its progress'.

Throughout its history, the British Association has numbered among its supporters the most eminent scientists. It was, for instance, one of the principal platforms for the discussion of Darwin's views on evolution.

Its annual meetings, which are today its best known activity, have been held successively in all the more important towns in the British Isles. The only interruptions in the series took place during the two world wars. Several meetings have been held in other Commonwealth countries. The first such occasion was at Montreal, Canada, in 1884. Since then Canada has been visited three times, South Africa twice and Australia once. In this way 'those who cultivate science in different parts of the British Empire' have been given the opportunities for contact promised by the founders.

In 1936 the British Science Guild, whose objects were similar, was incorporated in the association, and in 1938 a Division for the Social and International Relations of Science was formed to focus attention on the application of science to the public benefit and to stress its international character.

The sections of the association cover the whole range of pure and applied science other than medical science. Collaboration with other scientific organisations both in other Commonwealth, and in foreign, countries has always been an important function of the British Association, and it has an organised relationship with over 150 scientific bodies and learned societies.

Other Commonwealth Countries

Canada: The senior learned society in Canada is the Royal Society of Canada, which is concerned with the liberal arts as well as with the natural sciences and has a French-speaking section. This society owes its origin mainly to the imagination and initiative of the Marquess of Lorne (later Ninth Duke of Argyll), who was Governor-General of Canada from 1878 to 1883. With his encouragement a group of Canadians, meeting at Montreal in December 1881, prepared a provisional constitution which was later ratified at the first general meeting of the society in May 1882. In 1883 the Royal Society of Canada was incorporated by an Act of the Dominion Parliament; and in the same year Parliament began the practice of making an annual grant to assist the society in financing its publication programme and its activities generally. This grant, originally $C 5,000, has been gradually increased to $C 17,000, and, together with members' fees ($C 15 each), is the main source of revenue. The society was at first organised in four sections, concerned respectively with French literature and allied subjects; English literature and allied subjects; mathematical, physical and chemical sciences; and geological and biological sciences. The sections, under the by-laws of 1955, are: I Humanités et Sciences Sociales; II Humanities and Social Sciences; III Mathematical, Chemical and Physical Sciences; IV Geological and Allied Sciences; V Biological Sciences. The original members were nominated by the Governor-General in 1882 since when Fellows have been elected by vote by the members of the sections concerned. In 1960 there were 520 Fellows and six Honorary Fellows.

In French-speaking Canada there is the Association Canadienne-Française pour l'Avancement des Sciences (ACFAS) which is similar to the British Association in its purposes. In addition, there are societies dealing with special subjects, e.g., astronomy, chemistry, physics, and some of the provinces have their own scientific societies.

Australia: On 16th February, 1954, H.M. the Queen, during the course of her

Commonwealth Tour, received at Government House, Canberra, members of the council of the newly formed Australian Academy of Science, and handed to them a Royal Charter incorporating the academy. It is supported financially by the Federal Government. Its membership consists, in the first instance, of Fellows of the Royal Society of London resident in Australia and of a small group of other scientists selected by the first members because of their outstanding scientific distinction. The general pattern of the academy is that of the Royal Society of London and it is likely to become recognised as the senior scientific body in Australia. The Academy of Science took over the appropriate functions of the Australian National Research Council when that body was dissolved in August 1955.

There is an Australian and New Zealand Association for the Advancement of Science (ANZAAS) which meets periodically (at present at intervals of about eighteen months) at some centre in either Australia or New Zealand for about a week for discussion of research and the exchange of ideas and makes small grants to individuals. Its general pattern follows that of the British Association quite closely. Reports of its meetings appear as special issues of the *Australian Journal of Science*, now published by ANZAAS instead of the former Australian National Research Council.

There are also societies promoting general scientific interests in each State, in some cases called Royal Societies; and some States have specialist societies as well.

New Zealand: New Zealand is served by some 50 scientific societies, among the more important being the Royal Society of New Zealand with 9 branches, the New Zealand Association of Scientists (3 branches), the New Zealand Institute of Chemistry (6 branches), the New Zealand Institution of Engineers, the New Zealand Institute of Agricultural Science, the New Zealand Society of Soil Science, New Zealand Weed Control Conference, New Zealand Grassland Association, and the New Zealand Society of Animal Production. These and other organisations are responsible for issuing some 70 scientific periodicals.

South Africa: The Royal Society of South Africa was founded in July 1877, under the title of the South African Philosophical Society and published its first *Transactions* in 1878. The society received a Royal Charter of Edward VII on 25th January, 1908, since when it has been known as the Royal Society of South Africa. Under its new name, the society continued its old traditions. The only basic change was the creation of a new level—Fellows of the Royal Society of South Africa (FRSS Afr.)—a distinction reserved for persons who had rendered conspicuous service in the field of scientific research. Under the Charter, the number of such Fellows may not exceed one hundred and not more than five members may be elected to Fellowship in any one year. The Fellowship still remains the only academic award attainable in the field of science as a whole in South Africa. When, shortly after the beginning of the nineteenth century, a formal invitation to the British Association to meet in South Africa was declined on the grounds that its rules permitted it to accept such an invitation only from a body officially styled an 'Association for the Advancement of Sciences', the Philosophical Society rose to the occasion and the South African Association for the Advancement of Science was founded in 1902 from among the members of the Philosophical Society. The first president of the Philosophical Society, Sir David Gill, was elected the first president of the association, while of the 24 members of its original council, more than half were members of the society. The headquarters of the new association remained at Cape Town until 1918, when the growing needs for such a body centred in the Transvaal led to its transfer to Johannesburg. The only Afrikaans learned society is the South African Academy for Science and Art (*Die Suid-Afrikaanse*

Akademie vir Wetenskap en Kuns) established in 1909 and incorporated by Act of Parliament in 1921. It is divided into two faculties, respectively of language, literature and arts, and of natural science and technology. The Associated Scientific and Technical Societies of South Africa was founded in 1920 to promote the interests of scientific, professional and technical societies in South Africa and to represent corporatively the views of such societies.

India: The oldest learned society in India is the Asiatic Society of Bengal, originally the Asiatick Society, founded by Sir William Jones in Calcutta in 1784. From its activities has sprung most subsequent scientific activity in India, but it also embraces literature, history, archæology and philology besides the natural sciences. The Indian Science Congress Association, which held its first meeting in 1914, is similar in nature to the British Association. At its annual meetings the progress of science in various directions is discussed. The National Institute of Sciences of India, established in 1935, is the nearest equivalent in India to the Royal Society of London. It is at present located at Mathura Road, New Delhi, and has become the main national academy of science. It has sent representatives to the Royal Society of London to discuss plans for the co-operation of the scientific societies of India and of the United Kingdom. There are several other institutes of science and also specialist societies, e.g., for geology (founded 1906), mathematics (1907), botany (1921), chemistry (1924), physics (1934), soil science (1934) and physiology (1934).

Pakistan: The Pakistan Association for the Advancement of Science, which was established in December 1947, has been actively pursuing a programme of scientific development throughout the country.

The association is responsible for the organisation of the annual Pakistan Science Conference, to which a number of eminent foreign scientists are invited. The proceedings are published regularly. The first conference was held in 1949.

The association also promotes scientific research by the award of suitable research fellowships and overseas scholarships. At present four Pakistan scholars are studying in foreign universities under the Aga Khan Overseas Scholarships. The association exchanges scientific literature with foreign scientific associations, and has represented Pakistan at meetings of foreign scientific associations and at international scientific conferences.

The Pakistan Academy of Sciences was inaugurated on the 16th February, 1954. It is the main national organisation devoted to advancing the realms of knowledge. Its aims and objects include promotion of research, publication of scientific journals and memoirs, establishment of scientific libraries, laboratories and institutions, and the awards and grants of fellowships, scholarships, prizes and medals for scientific research.

The work of the Pakistan Academy of Sciences is distinct from that of the Association for the Advancement of Science, in that it has a small limited membership of senior scientists and is mainly concerned with research, whereas the association is a larger body of scientific workers disseminating scientific knowledge through holding conferences, symposia and public lectures.

The academy is financially supported by modest grants from the Government and donations from philanthropic individuals. During the short period of its existence the academy has sent a number of scholars to overseas universities for advanced scientific training. In its efforts to establish an up-to-date library the academy approached the Asia Foundation and secured a grant of $25,000 for the purchase of books.

It plans to build its permanent headquarters at Karachi with branch offices at Lahore and Dacca.

Specialist societies include those promoting biology, chemistry, statistics and geography.

Ceylon: Ceylon has an Association for the Advancement of Science.

Rhodesia and Nyasaland: The Rhodesia Scientific Association was founded in 1899, with the object of promoting the study and advancement of science, with special reference to Rhodesia, and for the purpose of facilitating the acquirement and dissemination of useful knowledge. It contributed largely to the establishment of the National Museum, Bulawayo, and its main interests include the preservation of ancient ruins, the study of geology and meteorology, flora and fauna, indigenous peoples and technical education in Rhodesia. The proceedings of the association have been published annually since its inception.

RESEARCH ORGANISATIONS

Most Governments of the Commonwealth now have national scientific research organisations, while others are planning to establish them. The actual form they take varies from country to country according to environment and for reasons of history, but in many cases the inspiration as well as the pattern of organisation has derived from the older-established practices of the United Kingdom.

UNITED KINGDOM

The scientific research carried on in the United Kingdom would be generally acknowledged to be of greater scope and importance than any as yet in progress elsewhere within the Commonwealth, but it is not the purpose of this paper to describe its organisation in detail. [For a fuller account the reader is referred to R.4688, *The Promotion of the Sciences in the United Kingdom.*] The brief notes on it which follow indicate the sort of State institutions for promoting it which have arisen, in order to serve as an indication of the way in which these have been followed in other Commonwealth countries.

Most of the 'pure' or 'fundamental' research is conducted in universities, which also play an essential part in promoting the sciences by maintaining a steady supply of trained scientists.

The first State-supported institution in Britain was the Royal Observatory, founded in 1675 to assist navigation. The Geological Survey of Great Britain, the first national institution of its kind in the world, originated in 1835. In 1842 the Department of the Government Chemist was founded, and in 1854 the Meteorological Office. In 1900 a National Physical Laboratory was established under the control of the Royal Society with a modest grant from the Treasury; in 1918 administrative responsibility passed to the Department of Scientific and Industrial Research (see below), but the direction of the scientific programme remains with the Royal Society. In 1911, the Development Commission, which had been appointed in 1909 to 'aid and develop agriculture and rural industries by promoting scientific research', was used to establish a scheme which led to most of the present-day agricultural research institutes. In 1913 a Medical Research Committee was appointed to administer the research funds provided under the National Health Insurance Act of that year. In 1920 this became the Medical Research Council with a grant provided directly by Parliament. A Department of Scientific and Industrial Research (DSIR) was established as a separate department in 1916 and the Agricultural Research Council was formed in 1931. An Overseas Research Council was established in 1959 (see p. 67).

These councils are the general responsibility of the Lord President of the Council and Minister for Science, who is also responsible for nuclear energy. The Office of the Minister for Science is organised into two divisions, a general division and an atomic energy division. An Atomic Energy Authority, with an executive board, was set up under the Atomic Energy Act, 1954, to control the UK Atomic Energy establishments. [For a detailed account see RF.P.4192, *Nuclear Energy in Britain.*]

All Government departments rely to some extent on one or other of these councils for scientific advice, but a few have supplementary organisations of their own, notably the Ministries of Aviation and Agriculture, the Admiralty and the Air Ministry.

Another Government-sponsored organisation which has counterparts in Canada and India is the National Research Development Corporation (NRDC), set up in 1948 by the Board of Trade to develop inventions resulting from research in Government and other public laboratories. It may also initiate research.

According to estimates based on the preliminary results of a survey conducted by DSIR, Britain spent during the year 1958 about £450 million on research and development, of which £300 million was spent by private industry.

CANADA

In science, as in many other aspects of its national life, Canada is influenced on the one hand by the physical proximity of the United States and on the other by its strong personal and historical ties with the United Kingdom. The scientific connections between Canada and the rest of the Commonwealth, especially the United Kingdom, started through the migration of men of science to Canadian universities. An outstanding example was Lord Rutherford, who, coming to the United Kingdom from New Zealand, did much of his pioneer work on nuclear energy while on the staff of McGill University in Canada. This migratory tendency increased greatly during and after the second world war. A substantial number of Canadian students have been trained in the United Kingdom, assisted by various scholarships and schemes for the interchange of scientists, while research students from other Commonwealth countries go to Canada under the Post-Doctorate Fellowship Scheme of the Canadian National Research Council.

While the National Research Council is now regarded as the central national research organisation, it is not by any means the only one. Research is carried on also by the federal departments of agriculture, fisheries, mines and technical surveys, northern affairs and national resources, national health and welfare and other federal bodies such as Atomic Energy of Canada Ltd., the Defence Research Board and the Board of Grain Commissioners. Provincial governments also carry on research projects, largely on projects of local importance, and the universities conduct considerable fundamental research.

Agriculture

The first major research organisation in Canada was founded to investigate agricultural problems: in 1886, a system of experimental farms was established in the Canada Department of Agriculture. Most of the research is still conducted by the federal department, in co-operation with other agencies. Important research is also conducted by provincial departments of agriculture, provincial universities, and colleges of agriculture.

The Research Branch of the Canada Department of Agriculture was formed in 1959 by amalgamation of Experimental Farms Service and Science Service. The branch has 62 experimental farms and other research centres, from Newfoundland to the Yukon, including some where work is conducted on forest insects and tree diseases. Ten of the centres are research institutes, where studies are conducted on biological control of insects and weeds, dairy technology, farm animals, genetics and plant breeding, insects, insect diseases, microbiology, pesticides, plants, and soils. Associated with the experimental farms are over 200 stations where experiments are conducted under conditions not found on the experimental farm sites. The headquarters of the branch is on the Central Experimental Farm, Ottawa.

The research branch serves a wide variety of agricultural and forest enterprises under diverse climatic and soil conditions. Specialists in various scientific disciplines (such as animal breeding, botany, chemistry, entomology, microbiology, plant breeding, plant pathology and soil science) co-operate in studying problems of national and regional concern. These include: developing better breeds of livestock, better varieties of field, orchard and garden plants and better farm machines; control of insects, mites and plant diseases; processing of fruits, vegetables, cereals, milk, wool and honey; classification of soils and

study of soil needs in relation to fertilisers, crop rotations, drainage and irrigation; and improving ranges and pastures.

Mines and Geology

The federal Department of Mines and Technical Surveys came into being on 20th January, 1950, in the reorganisation of the former Department of Mines and Resources. The department has five branches—Surveys and Mapping Branch, Geological Survey of Canada, Mines Branch, Dominion Observatories, and Geographical Branch. The department's functions also include the administration of the Emergency Gold Mining Assistance Act and of the Explosives Act.

The Surveys and Mapping Branch provides the base maps required for use in the development of Canada's natural resources, produces and distributes all Canadian aids to navigation, is responsible for legal surveys of federal lands and provides a national system of levelling and precision surveys for use as geodetic control by federal, provincial and private agencies.

The primary function of the Geological Survey of Canada is to obtain information on the geology of Canada that will be of assistance in the search for and development of mineral deposits. The results of its activities also provide a basis for the appraisal and conservation of Canada's mineral resources generally, including water supplies, for soil surveys, and for the solution of geological problems that frequently arise in construction projects.

Investigations undertaken in the laboratories of the Mines Branch cover a wide range of technical projects of importance to the advance of fundamental research; to the processing of ores, industrial minerals and fuels on a commercial scale; and to the theory and practice of physical metallurgy. The branch serves Canada's mineral industry through tests, investigations and research on all types of Canadian ores and minerals.

The Dominion Observatories, in addition to studies in positional astronomy and stellar physics, undertake research in seismology, terrestrial magnetism and gravity. The main units of the branch are at Ottawa, but the Dominion Astrophysical Observatory is located at Victoria, and a newly constructed radio telescope is at Penticton, British Columbia.

The function of the Geographical Branch is to organise and make available all the geographical data on Canada that might be of use in promoting the country's economic, commercial and social welfare. The work is of two kinds —the compilation of geographical material of national significance, and geographical surveys in the field. Land surface conditions, types of vegetation and the structure of towns and cities are typical subjects of investigation.

Forestry

Research in forestry and forest products is conducted by the Forestry Branch of the Department of Northern Affairs and National Resources, several provincial governments, the Pulp and Paper Research Institute of Canada, four universities with faculties in forestry, and a number of the larger industrial companies. In addition, the Forest Biology Division of the Research Branch, Department of Agriculture, conducts research in forest entomology and forest pathology.

The Forest Research Division of the federal Forestry Branch conducts research related to silviculture, forest management, forest fire protection and forest inventory methods at six district offices and five forest experimental areas situated at strategic locations throughout Canada. Many studies are conducted on provincial Crown lands and private lands in co-operation with the provincial governments and the industry. Two forest products laboratories are

maintained, one at Ottawa and the other at Vancouver, to conduct basic and applied research aimed at improvements in the use of wood and the reduction of waste. The Pulp and Paper Research Institute of Canada is responsible for research relating to paper pulps and paper, and a laboratory has been provided for its use by the Federal Government.

Fisheries

For fisheries research there is a Fisheries Research Board (set up in 1937 to succeed a Biological Board, established in 1912, which succeeded a Board of Management dating back to 1898). The present board consists of a full-time paid chairman assisted by not more than eighteen other members, a majority of whom must be scientists. Members are appointed by the Minister of Fisheries and serve without remuneration but are paid expenses for attending meetings and doing other work for the board. The board is financed from Federal Government funds but, on occasion, carries out studies or experiments for other Federal Government agencies or international commissions from funds supplied by those agencies or commissions. Provincial governments, notably those of Quebec and Ontario, carry out some independent fisheries research but co-operate closely with the Fisheries Research Board.

The board operates seven main scientific stations, three units and two groups. Biological stations are situated at St. John's, Newfoundland; St. Andrews, New Brunswick; London, Ontario; Nanaimo, British Columbia; with an arctic unit in Montreal, Quebec. Technological stations are at Halifax, Nova Scotia; Grande Rivière, Quebec; Vancouver, British Columbia; with smaller units in St. John's, Newfoundland, and London, Ontario. An oceanographic group operates from Halifax, Nova Scotia, and another from Nanaimo, British Columbia.

The chairman is assisted in his executive functions by an executive committee composed of members of the board. Advisory committees study the programmes of the various stations, units and groups, and report to the board at its annual meeting in January of each year in Ottawa.

Under the Act setting it up the board 'has the conduct and control of investigations of practical and economic problems connected with marine and freshwater fisheries, flora and fauna, and such other work as may be assigned to it by the Minister'.

National Research Council

In 1917, the National Research Council of Canada was set up as an advisory body of eleven, subject to a cabinet committee known as the Privy Council Committee on Scientific and Industrial Research. The council's first project was to examine the state of Canada's scientific resources. The survey indicated that industrial research was virtually non-existent in Canada and that the supply of research workers was inadequate. The universities were absorbed in undergraduate work, the teaching staffs had little or no time for research, and graduate scholarships were lacking. Most Canadian students went abroad for postgraduate training and many did not return. The council accordingly made provision for the planning and integration of research work, the organisation of co-operative investigations, postgraduate training of scientists, and assistance to research by means of grants-in-aid to university professors. This outline formed the basis of the council's work until 1924. By this time about thirty associate committees, composed of experts in various fields, whose services were given free, were guiding a number of co-operative research projects on many of which graduate students were employed. The council had also decided that its obligations to industry could not be fulfilled until it had its own laboratory

facilities. It accordingly started laboratory work on a small scale and planned for greater operations.

In 1932, the council opened its central laboratory in Ottawa, and large-scale research began. The new laboratory housed four divisions: Physics and Engineering, Biology and Agriculture, Chemistry, and Research Information. There was little expansion during the thirties, but in 1936 it was possible to establish a Division of Mechanical Engineering, and in 1939 a new 130-acre site was acquired near Ottawa. This site has since been added to and now comprises 400 acres on which stands the greater part of the council's laboratory accommodation.

During the early years of the new laboratory a nucleus of highly trained specialists was engaged. When the second world war broke out this nucleus proved to be very valuable. The very large demands of war-time necessitated a tenfold expansion, which was achieved by building new staff around the original nucleus.

During the war twenty-one additional laboratories were established from Halifax to Vancouver. Temporary laboratories for cold weather were set up at suitable points. An Explosives Experimental Establishment, organised for wartime work at Valcartier in Quebec, is still in existence as part of a Service organisation. The council equipped large laboratories in Montreal for the Atomic Energy Project and then created the permanent establishment at Chalk River. The council also built radar laboratories near Ottawa, and cold weather stations at Winnipeg for testing jet engines, naval research stations on both coasts and, on the new site at Ottawa, a permanent group of nine buildings with the necessary wind tunnels and other equipment for aeronautical and engineering research. Shortly after the war, the council transferred responsibility for Service research to the new Defence Research Board (see p. 15), which also took over Service laboratories at Valcartier, Halifax, Ottawa and other points. The Chalk River establishment, which had now acquired industrial importance, was set up in 1952 as a Crown company with the title Atomic Energy of Canada Ltd.

In 1946, a Division of Medical Research was established. This division has no laboratories and its function is the administration of the council's grants in aid of medical research. The division was a development from the Associate Committee on Medical Research which accomplished excellent work during the war.

In 1947, the council established a Division of Building Research to study broad problems of construction and to act as the research wing of the Government's Central Mortgage and Housing Corporation. In 1947, radio research, which had engaged only a handful of staff in 1939, was associated with the electrical engineering laboratories to form the Radio and Electrical Engineering Division.

In 1948, the Prairie Regional Laboratory, which was an outgrowth of the Division of Applied Biology, was set up on the campus of the University of Saskatchewan in Saskatoon. The council also set up the Atlantic Regional Laboratory on the campus of Dalhousie University in Halifax in 1952. In the same year the Division of Chemistry was divided into two divisions, Pure and Applied Chemistry. In 1955 the Division of Physics was similarly divided into Pure and Applied Physics.

The greater proportion of the work in the laboratories is of an applied nature, but in view of the importance of basic research, a considerable amount of this type of work is continually being done, particularly in physics, chemistry and biology. The programme of basic research assists in the development of a supply of top ranking scientists, many of whom move from the council's laboratories to universities and to industry.

As mentioned above, the council was concerned at the beginning with the stimulation of research and the need for scientists and engineers, and this is still one of the council's chief functions. One important method for increasing the supply of scientists has been the stimulation of research at the universities through grants in aid of research and scholarships. During the year 1958/59 the council spent $C 5·5 million in these operations.

The council staff numbers 2,426, of whom 517 are scientists. In addition, 138 Post-Doctorate Fellows from a large number of countries make use of the laboratories.

Defence Research Board

Four basic responsibilities set the pattern for the operations carried out by the scientific staff of the Defence Research Board, an integral part of Canada's Department of National Defence and established in 1947.

These obligations comprise: the provision of sound scientific advice to the Minister of National Defence, the Chiefs of Staff and to the Armed Forces; meeting the research needs of the Armed Forces; contributing to the collective security of Canada and the western world through fundamental and applied research programmes; and encouraging research of defence interest within the universities and through other agencies.

Policy and operational direction emanate from the Defence Research Board, which comprises a chairman, vice-chairman, five *ex officio* members and a number of appointed members, usually numbering seven.

The chairman, who sits on the Chiefs of Staff Committee with the same status as a Chief of Staff, and the vice-chairman are full-time salaried members. The *ex officio* members comprise the Chiefs of Staff for the Navy, the Army and the Air Force, the Deputy Minister of National Defence and the President of the National Research Council. The appointed members include a representative of the Department of Defence Production, outstanding university scientists and leading Canadian industrialists. All serve normally for three-year terms. The chairman possesses many of the financial and other powers of a Deputy Minister and reports directly to the Minister of National Defence.

Executive responsibility for carrying out the programme rests with the chairman who is assisted by several senior scientific officers and a senior administrative officer through a management committee.

Eight headquarters directorates represent the numerous active scientific fields of Canadian defence research and an additional two concern personnel and general services. The Board's eight research laboratories, located across the country, are headed by chief superintendents or superintendents, depending on their size. The smallest, which also provides research facilities for visiting scientists, is the responsibility of an officer-in-charge.

Two senior scientific staff members are associated with the Canadian Joint Staffs in London and Washington and are known as Defence Research Members. Supported by their staffs, they facilitate the passage of scientific information between the board and appropriate research and development agencies in the two countries concerned.

Each of the three Chiefs of Staff is also provided with a scientific adviser who 'lives' with the Service concerned, working directly with that Service and the board. The incumbents are senior scientists who have risen to their posts through the various echelons within the defence research organisation.

Since 1947, the board has invested about $C 90 million in physical assets, comprising well-equipped, permanent scientific laboratories. Of its total staff of 2,800, 600 are professional scientists or engineers and 800 provide technical support.

The Defence Research Board activities have contributed usefully not only to Canada's defence programme, but also to defence science in general within the NATO alliance and particularly in conjunction with the programmes of the United Kingdom and the United States.

Nuclear Energy

At first, research and development work in nuclear energy was undertaken jointly by Canada and the United Kingdom at Chalk River, Ontario. But, in 1946, this war-time partnership ceased with the setting up in Britain of the Atomic Energy Research Establishment at Harwell, and, in 1947, the Canadian National Research Council (NRC) assumed sole responsibility for the Chalk River project. In 1952, control passed from the NRC to a new Crown company —Atomic Energy of Canada Ltd. Under an Act passed by the Canadian Parliament in June 1954 to amend the Atomic Energy Control Act, 1952, the organisation was again changed. The name of the Crown company controlling the Chalk River project was changed to Nuclear Research Ltd., and a holding company, called Atomic Energy of Canada Ltd., was formed to hold the stock both of Nuclear Research Ltd., and of Eldorado Mining and Refining Ltd., the Crown company which, among other things, buys uranium ores and concentrates produced by private companies in Canada.

Canada's atomic energy establishment, located in Ontario on the Ottawa River five miles from the village of Chalk River, about 130 miles from Ottawa, is engaged in four main activities:

(1) development of economic atomic power;

(2) fundamental research;

(3) operation of nuclear reactors and separation of nuclear fuels (plutonium and uranium 233);

(4) production of radio-active isotopes and associated equipment such as therapy units for cancer treatment.

In 1946, an Atomic Energy Control Act was passed in Canada 'to make provision for the control and supervision of the development, application and use of atomic energy'. Under this Act the Atomic Energy Control Board was created, with two main powers: (1) to regulate the production and application of materials relating to atomic energy, particularly fissionable materials; and (2) to make and administer security regulations required by the Canadian atomic energy programme.

Provincial Research Foundations and Councils

A number of Canadian provinces have research organisations, supported largely by the provincial government and conducting research on provincial problems. Each maintains an information service for the benefit of industry within the province and these services work in close co-operation with the Technical Information Service of the National Research Council and with scientific branches of Federal Government departments.

The Research Council of Alberta, Edmonton, has been in existence since 1921. Its investigations cover a wide field including biological cycles, soil conditions, uses for coal, problems connected with the oil and natural gas resources, utilisation of tar sands, and studies of the development of hailstorms. The Research Council has its own building on the university campus.

The British Columbia Research Council, Vancouver, was established in 1954 to co-ordinate provincial research, initiate industrial research, and assist in developing research by means of scholarships and grants-in-aid. It does research work in co-operation with an industry, or for specific firms, on a payment basis,

or on the council's own initiative. It has many interesting projects, particularly in fisheries, forestry, agriculture and mining and the secondary industries. It has had very rapid growth and is now established in its own laboratories at the University of British Columbia.

The Nova Scotia Research Foundation, Halifax, was established in 1946. It has no laboratories and its task is the stimulation of research in facilities already established in the province. It also arranges for research to be done elsewhere if necessary. It has arranged and financed surveys on minerals and other raw materials for industry and collected primary data on mining, soils, lumber, seaweed utilisation and land use in Nova Scotia. Its library and information service are at the disposal of industry anywhere in the province.

The Ontario Research Foundation, Toronto, was established in 1928 for the improvement of manufacturing and other industry and the development of the natural resources of Ontario. This is a non-profit scientific organisation which undertakes research on a fee basis with the object of assisting public and industry in technological matters. Since it is established in a heavily industrialised province, its facilities are kept busy. It provides a number of scholarships and grants in aid of research at universities in Ontario.

The Saskatchewan Research Council, Saskatoon, was set up in 1947 to foster a programme of scientific and industrial research. Among its problems are the geology of Saskatchewan, beneficiation of uranium and other ores, antibiotics in milk supplies, building foundations suitable for Saskatchewan soils. Saskatchewan is primarily an agricultural province but industry is developing and the council will be able to make good use of its laboratories, opened at the University of Saskatchewan in 1958.

AUSTRALIA

The first scientific researches associated with Australia were the botanical studies of Banks and the early explorers following the landing at Botany Bay by Captain Cook in April 1770, and the subsequent settlement in 1778. It was not until the last half of the nineteenth century that continuous scientific research may be said to have started, with the foundation of the Universities of Sydney, Melbourne, Adelaide, and Tasmania. Although the universities were primarily concerned with teaching, research schools were formed and during this period Australia made a substantial contribution to scientific knowledge in chemistry, physics, mathematics, geology and botany. In most cases the development of the State agricultural departments followed.

It was during this early period that learned societies were first established in Australia; the Royal Societies, the Linnean Society of New South Wales, and the Australian Association for the Advancement of Science, which later became the Australian and New Zealand Association for the Advancement of Science, being amongst the first formed. The professional societies were not founded until much later.

In 1916, 15 years after federation, the Federal Government, following the pattern set in Britain by the establishment of the Department of Scientific and Industrial Research, formed an advisory council to consider the needs for a similar scientific body in Australia. The council recommended the establishment of a permanent Institute of Science and Industry, which was eventually formed in 1921. The institute was later to develop into the Council for Scientific and Industrial Research and then the Commonwealth Scientific and Industrial Research Organisation.

The Australian National Research Council was also formed in 1921. This body, comprising the Australian Fellows of the Australian and New Zealand Association for the Advancement of Science, was the senior society devoted to the advancement of science in Australia. However, the council was not con-

stituted in a way to meet the rapid scientific growth which has taken place since the end of the second world war, and in 1952 it was replaced by the Australian Academy of Science. The academy, which received its Royal Charter in 1954, has as its broad objectives the promotion of science in Australia and the establishment and maintenance of relations with overseas scientists.

Before the second world war, research into problems peculiar to Australia was confined principally to agriculture. Since 1940, problems involving the physical sciences associated with defence and the developing secondary industries, have absorbed a large proportion of the national research effort. However, secondary industries themselves have only begun to make a material contribution to Australian scientific endeavour over the last ten years. Previously, Australian industry had not thought it economic to conduct its own research—reliance was largely placed on overseas technical knowledge. A more recent and important development has been the formation of research associations financed by contributions from both Federal Government and private industry.

There is then, in Australia, a framework of scientific institutions broadly similar to that found in other countries. This can be considered under four headings, namely, the universities, departments and instrumentalities of the State governments, Federal instrumentalities, and private industrial research. There are, in addition, a number of research institutes principally concerned with biological or medical research which are attached to either the universities or major public hospitals.

Universities

There are nine Australian universities. They are, in order of their foundation, the universities of Sydney, Melbourne, Adelaide, Tasmania (Hobart), Queensland (Brisbane), Western Australia (Perth), the Australian National University (Canberra), University of New South Wales (Sydney), and the University of New England (Armidale, New South Wales). There is also at Canberra a University College, at present associated with the University of Melbourne, though due to receive independent status in 1960. In addition, the University of New South Wales has established a University College at Newcastle, NSW. In Victoria, legislation has recently been passed to establish a second university in that State. The new university is to be named after Sir John Monash, one of Australia's most distinguished university men. He was a graduate of the University of Melbourne in Arts, Law, Engineering, and served for a time as Deputy-Chancellor. He was one of the outstanding Australian soldiers during the first world war, but his greatest contribution was made in the period following that war, when he was chairman of the State Electricity Commission of Victoria and responsible for the development of the huge brown coal resources of the State and their employment for power generation and industrial use.

The Australian National University, which was established in 1946, is devoted entirely to postgraduate research in the medical, physical and social sciences and Pacific studies. The university's primary function is to encourage and provide facilities for postgraduate research both generally and in relation to subjects of importance to Australia. The former Federal Observatory at Mt. Stromlo, Australian Capital Territory, which carries out co-operative studies with the two State observatories at Sydney and Perth, is now part of this university.

The University of New South Wales, originally established as a technological university, was intended to meet the growing demand for research associated with industrial development in New South Wales and to train graduates for industry. However, it is now being extended to include the humanities and medicine amongst its faculties.

The University of New England is primarily a rural university awarding degrees in agricultural economics, rural science, and arts. Science was taught at the Canberra University College for the first time in 1959.

Without exception, all university science faculties have associated postgraduate schools. Details of graduate and postgraduate courses available are set out in the *Commonwealth Universities Year Book* and in the university handbooks.

The development of research schools has been encouraged in the post-war years and in all Australian universities it is now possible for graduates to study for a doctorate research degree. In 1958, there were approximately 1,975 bachelor degrees awarded in the sciences, medical and other associated faculties. In the same year 215 higher degrees were granted.

Australia, along with many other countries, requires additional professional scientists, many of whom need postgraduate training, to undertake the task of fully developing the country's natural resources and to handle the increased technological problems of modern industry. To provide this manpower, teaching and research facilities of the universities must be expanded over the next few years. This general problem was one aspect recently investigated by a committee, under the chairmanship of Sir Keith Murray, appointed by the Federal Government to inquire into the needs and responsibilities of Australian universities.

State Government Establishments

The scientific activities undertaken by the States of Australia are mainly confined to individual development problems. In the first 150 years of Australian development the two major economic factors controlling the country's growth were the establishment of the wool industry and the mining industry. It is understandable, then, that the States' Agricultural and Mines Departments were established early in order to assist in the problems of both industries. Soil conservation authorities, rivers and water supply departments and similar bodies, which are associated with agricultural development, have been established in recent years in some States. Other departments are concerned with forestry and fisheries. Development work in engineering, especially in power production, has also presented many problems requiring scientific examination.

The research carried out by the State Departments of Agriculture is mainly concerned with the elucidation of problems peculiar to a particular environment. They also accept responsibility for agricultural extension services. The work of these departments has contributed greatly to Australia's agricultural development.

The mines departments of the individual States are also principally concerned with local development—geological surveys and extraction processes for particular ores. An outstanding example is the work on uranium prospecting and treatment undertaken by the South Australian Mines Department.

Federal Establishments

In the last thirty years the major development in Australian science has been the entry of the Federal Government into most forms of scientific inquiry. The best-known Government research organisations are: the Commonwealth[1] Scientific and Industrial Research Organisation (CSIRO); the Australian Defence Scientific Service of the Department of Supply; the Australian Atomic Energy Commission; and the Bureau of Mineral Resources, Geology and Geophysics

[1]In titles of organisations within Australia the word Commonwealth refers to the Commonwealth of Australia.

of the Department of National Development. Many other federal departments conduct important research activities. The Department of Health has a number of laboratories including acoustics laboratories, the Bureau of Dental Standards, X-ray and Radium Laboratories, and the Commonwealth Serum Laboratories. The Postmaster General's Department also has large and well-equipped laboratories. The Snowy Mountains Hydro-electric Authority, which is responsible for the development of a hydro-electric scheme in the Australian Alps, has established a scientific research team to investigate engineering problems peculiar to that region. Research by the Department of External Affairs is concerned with physical and biological phenomena of Heard Island, Macquarie Island, and the Antarctic continent.

The Commonwealth Scientific and Industrial Research Organisation is governed by an executive of nine members appointed by the Federal Government, who are responsible to a minister. The executive is assisted by an advisory council comprising the chairmen of State advisory committees and other persons co-opted because of their scientific knowledge. Members of the executive are also members of the council. The powers and functions of the organisation include the initiation and carrying out of research in connection with, or for the promotion of, primary and secondary industries in Australia or any territory of Australia, or in connection with any matter referred to the organisation by the minister; the training of research workers, the making of grants in aid of pure scientific research, the testing and standardisation of scientific apparatus and instruments, and the carrying out of scientific investigations connected with standardisation; the collection and dissemination of information relating to scientific and technical matters; acting as a means of liaison with other countries in scientific research, the establishment of industrial research studentships and fellowships and the establishment of industrial research associations in various industries.

As the organisation's investigations cover the whole federation and as many investigations—particularly those concerning the agricultural and pastoral industries—necessitate experimental work in the field, a number of branch laboratories and field stations have been established in various parts of Australia.

The head office of the organisation is in Melbourne and associated with it are the central library, Agricultural Research Liaison Section, Industrial Research Liaison Section, Editorial and Publications Section, Film Unit, and Publishing and Translation groups. The organisation also maintains Australian Scientific Liaison Offices in London and Washington.

The group laboratories comprise: The National Standards Laboratory, consisting of the following divisions—Metrology, Physics, Electrotechnology; Chemical Research Laboratories comprising the divisions of—Chemical Physics, Mineral Chemistry, Physical Chemistry, and the following sections: Cement and Ceramics, Chemical Engineering, Foundry Sands, Organic Chemistry; Wool Research Laboratories comprising the divisions of—Protein Chemistry, Textile Physics, Textile Industry.

The independent divisions are as follows: Plant Industry; Entomology; Animal Health and Production; Biochemistry and General Nutrition; Soils; Forest Products; Food Preservation and Transport; Fisheries and Oceanography; Radiophysics; Tribophysics; Building Research; Mathematical Statistics; Meteorological Physics; Land Research and Regional Survey; Tropical Pastures.

The following are independent sections: Irrigation Research Stations; Fodder Conservation; Ore-Dressing Investigations; Mineragraphic Investigations; Dairy Research; Coal Research; Physical Metallurgy; Wildlife Survey; Animal Genetics; Agricultural Research Liaison; Engineering; Industrial Research

Liaison; Soil Mechanics; Upper Atmosphere; Wheat Research Unit; Editorial and Publications.

In addition, regional centres (co-operative research units staffed with officers from the appropriate specialist divisions) to study the problems of a particular region, have been established in Tasmania and Western Australia.

The chiefs of these divisions and the officers in charge of the sections have a large degree of autonomy in the planning of the research programme. They are responsible directly to the executive.

The total staff is approximately 4,000, of whom some 1,400 are professional scientists. The annual budget is of the order of £A8 million; the greater part of this finance is provided by the Federal Government. However, support is also given by agricultural and pastoral organisations and by industry.

The CSIRO is also associated with a number of autonomous research associations, e.g., the Leather Research Association, the Bread Research Institute, the Wine Research Institute, and the Coal Research Association. These are financed by private industry but receive grants from the Federal Government.

Two research tools of major significance in the scientific world currently being developed by CSIRO are the 210-ft.-diameter radio telescope being constructed at Parkes, New South Wales, for the Division of Radiophysics, and the phytotron being constructed for the Division of Plant Industry at Canberra. The surface accuracy of the radio telescope and the precision with which it can be directed will make it one of the most advanced instruments of its kind in the world. Designs and specifications for the telescope were prepared by a United Kingdom firm of consulting engineers, and electrical control gear supplied by the UK firm of Associated Electrical Industries Ltd. The phytotron, to consist of a number of cabinets each capable of operating over a very wide range of climatic conditions, will greatly facilitate plant research being undertaken in Australia.

The Australian Defence Scientific Service of the Department of Supply is responsible for all scientific and technical research associated with Australia's defence requirements. The service has three main laboratories—the Weapons Research Establishment at Salisbury and Woomera, South Australia, the Aeronautical Research Laboratories at Fisherman's Bend, Victoria, and the Defence Standards Laboratories at Maribyrnong, Victoria; this laboratory also has branches at Alexandria, New South Wales, and Finsbury, South Australia.

The work of the three laboratories includes research into high-speed aerodynamics, electronics, long-range guided weapons, rocket propulsion, the chemistry and physics of special materials and problems of instrumentation.

The service employs some 550 scientists. Much of the work, especially that of the Weapons Research Establishment, is carried out in co-operation with United Kingdom establishments.

The Australian Atomic Energy Commission was established in 1953. The commission undertakes and encourages the exploration, mining and treatment of uranium and associated ores, and supervises the sale of these minerals in the Commonwealth. In these functions it co-operates with other Commonwealth and State authorities. The commission is also responsible for the development and operation of nuclear energy producing equipment and for scientific research in nuclear science. It arranges for the training of research workers in nuclear science and each year awards a number of research scholarships. It also co-operates with the universities. An organisation known as the Australian Institute of Nuclear Science and Engineering has been formed jointly by the commission and the universities to permit training and research in nuclear science and technology. The institute has its headquarters at the Commission's main laboratory at Lucas Heights, New South Wales. The commission has established at this laboratory an experimental reactor known as the HIFAR

reactor (see R.3928 *Nuclear Development and Co-operation in the Commonwealth*). The dissemination of information on nuclear science by publication and through an advisory service is also a function of the commission.

The Bureau of Mineral Resources, Geology and Geophysics is concerned with investigations related to the search for metalliferous and radioactive ores, coal, oil and water both in Australia and its territories. In this it works in close collaboration with the Mines Departments of the States, and the Administration of the Territories.

In addition, the bureau is responsible for magnetic and gravity surveys, and engineering and military geophysics. In connection with this work it maintains several geophysical observatories.

Industry

Only recently have private industrial concerns in Australia started to invest in scientific research. A notable exception is the sugar industry, which has maintained private research laboratories since before the second world war.

A survey by the Institution of Engineers, Australia, of research by Australian industry in 1955, revealed it to be less in Australia than in Britain, America or Canada. The 104 firms covered by the survey had an annual value of production of £A500 million and spent £A1·7 million per annum on scientific research. The ratio of research expenditure to turnover was 0·3 per cent. Corresponding figures for British industry were 3·1 per cent (1955) and American industry 2·0 per cent (1955).

Most of the large industries employ scientifically trained staff for routine control of processes, but some of the larger companies have active research departments. In many instances the research programme consists of 'trouble-shooting' for production activities or the conversion to Australian conditions of processes developed by companies overseas. However, in several industrial laboratories—covering the chemical, pharmaceutical, sugar, paper, mining, and steel industries—original investigations of high calibre and fundamental in nature are being carried out. There is every reason to believe that the post-war development in industrial research will continue.

In addition to the research associations which receive Government assistance, a number of privately financed laboratories have been formed—Coal Research Limited, the National Gas Association of Australia, and the Sugar Research Institute.

Scientific Publications

Although Australian scientists publish widely in overseas journals, many publications are produced by Australian scientific bodies, e.g., the State Departments of Agriculture, CSIRO, the universities, the Australian Atomic Energy Commission, and learned professional societies. In addition, a series of Australian scientific journals is published by CSIRO in collaboration with the Australian Academy of Science, the universities and professional institutes. These journals are the *Australian Journal of Physics*, the *Australian Journal of Chemistry*, the *Australian Journal of Biological Science*, the *Australian Journal of Applied Science*, the *Australian Journal of Agricultural Research*, the *Australian Journal of Marine and Freshwater Research*, the *Australian Journal of Botany*, and the *Australian Journal of Zoology*.

NEW ZEALAND

New Zealand was the first Commonwealth country to open (in 1928) a scientific liaison service in London, and links between New Zealand and United Kingdom science are particularly strong. The most important step forward in

organising New Zealand's scientific research, namely, the formation of the Department of Scientific and Industrial Research (DSIR) in October 1926, was largely the result of a report by the then secretary of the United Kingdom DSIR, Sir Frank Heath.

Before the foundation of the DSIR, scientific research was carried on in a number of scattered institutions and in the colleges of the University of New Zealand. The responsibility for most of this work now rests on DSIR, governed by a Council of Scientific and Industrial Research, which is itself responsible to a Minister of the Crown.

Other Government organisations carrying out research are the Department of Agriculture, the New Zealand Forest Service, the Fisheries Branch of the Marine Department, the Central Laboratory of the Ministry of Works, and the Medical Research Council of the Health Department.

Research work into the problems of particular industries is carried out by co-operative research associations which are organised on a similar basis to those in the United Kingdom.

Research of a more fundamental nature is carried out in the science faculties of the four universities and in the two agricultural colleges.

Other organisations carrying out research are the New Zealand Dairy Board and the Cawthron Institute, both of which receive a subsidy from the Government, and the larger museums.

The oldest scientific institutions in New Zealand are the New Zealand Geological Survey and the Dominion Laboratory. The former was established in 1865, and, to help with the expansion of its chemical activities, the Colonial Laboratory came into existence in the same year, its name being changed to Dominion Laboratory in 1908. Both these institutions are now part of DSIR.

The Universities

The University of New Zealand was founded by the New Zealand University Acts of 1870, 1874 and 1875, and consists of four University Institutions, each of which, besides providing the usual university courses, specialises in certain branches of study.

The University of Otago, Dunedin, founded in 1869, has medical and dental schools and schools of mining and metallurgical engineering, home science, and physical education. The University of Canterbury, Christchurch, founded in 1873, has a school of engineering (mechanical, electrical, chemical, and civil), and a school of fine arts. The University of Auckland, founded in 1882, has schools of architecture, fine arts, and engineering (mechanical, electrical, and civil), and a postgraduate school of obstetrics and gynæcology. The Victoria University of Wellington, founded in 1897, specialises in law and has schools of political science and public administration and of social science. Associated with the University of New Zealand, though separately governed, are two agricultural colleges specialising in higher agricultural education—Massey Agricultural College, near Palmerston North (North Island), and Canterbury Agricultural College at Lincoln, near Christchurch (South Island). Encouragement in the development of higher agricultural education is given through Government grants to these colleges, and various research projects undertaken by them are aided by expert assistance and grants from the DSIR.

Department of Scientific and Industrial Research

When the department was set up in 1926 its nucleus was formed by the laboratories and scientific services transferred from other State departments. These were the Dominion Laboratory and Dominion Observatory from the Internal Affairs Department, the New Zealand Geological Survey from the

Mines Department, the Meteorological Office from the Marine Department, and the Apia Observatory from the External Affairs Department.

With the separation of Soil Survey from New Zealand Geological Survey (in 1936) and the formation of the Plant Diseases, Grasslands, Agronomy, Botany, and Entomology Divisions of the Plant Research Bureau, nearly all the main branches of the department became recognisable with those of today. The present largest unit—the Dominion Physical Laboratory—did not come into existence until 1939, and owed its rapid expansion to the war needs of the country.

Since the war several new divisions have been established.

The Fats Research Laboratory, which had been a section of the Dominion Laboratory, was set up as a separate branch in 1946 to conduct research of a fundamental nature on fats of animal, vegetable, and marine origin.

The Auckland Industrial Development Laboratories were established in 1947 to provide a research service to industry in the Auckland area.

In 1948, the Fruit Research Division was formed to co-ordinate the work being done on fruit research in the department and in collaboration with the Cawthron Institute.

The Applied Mathematics Laboratory was formed in 1949 to take the place of the Biometrics Section.

In 1951, the Geophysics Division was set up to co-ordinate the geophysical work being done at the Seismological, Geophysical, Magnetic, and Oceanographic Observatories, and by the Geophysical Survey.

In 1958, a Division of Nuclear Sciences was formed and in 1959 its functions were taken over by the Institute of Nuclear Sciences.

In 1958, the New Zealand Oceanographic Institute, previously a section of the Geophysics Division, became a separate branch, while, in 1959, an Antarctic Division was formed to co-ordinate the research work being done in the Ross Dependency.

Broadly speaking, the DSIR undertakes research for the benefit of the primary and secondary industries of New Zealand and carries out surveys related to the utilisation of the country's natural resources. Although most of the research is of an applied nature, the solution of many problems, particularly in the field of agriculture, require fundamental research to provide the necessary background information.

At the present time the department comprises the following units:

Unit	*Location of Chief Centre*
Animal Ecology Section	Wellington
Antarctic Division	Wellington
Applied Mathematics Laboratory	Wellington
Auckland Industrial Development Laboratories	Auckland
Botany Division	Lincoln
Crop Research Division	Lincoln
Dominion Laboratory	Wellington; Lower Hutt
Dominion Physical Laboratory	Lower Hutt
Entomology Division	Nelson
Fats Research Laboratory	Wellington
Fruit Research Division	Auckland
Geophysics Division	Wellington
Grasslands Division	Palmerston North
Hop Research Station	Riwaka; Nelson
Information Bureau	Wellington
Institute of Nuclear Sciences	Lower Hutt

Unit	*Location of Chief Centre*
New Zealand Geological Survey	Lower Hutt
New Zealand Oceanographic Institute	Wellington
Plant Chemistry Division	Palmerston North
Plant Diseases Division	Auckland
Scientific Liaison Service	Wellington; London; Washington
Soil Bureau	Wellington
Tobacco Research Station	Motueka, Nelson
Wheat Research Institute	Christchurch

Industrial Research Associations

The DSIR has sponsored the establishment of co-operative research associations in both primary and secondary industries. In primary industries there are the Wheat, Dairy, and Meat Industry Research Institutes, and in secondary industries there are four research associations—Leather and Shoe, Pottery and Ceramics, Wool Industries, Fertiliser Manufacturers—and a Research Institute of Launderers, Drycleaners and Dyers.

In 1944, a manufacturers' research committee was set up to co-ordinate the work of the existing research associations and to encourage more research in industry.

A very limited amount of research is done in the laboratories attached to some of the larger industrial organisations such as oil companies and paint manufacturers.

Engineering Research

Investigation into engineering problems is undertaken by the Central Laboratory of the Ministry of Works. This laboratory, which is divided into four sections—Soils, Concrete, Hydraulics, and Structural Engineering—confines its investigations to problems facing the Ministry of Works in its building programme. Some research into soil conservation and flood control is done by the Soil Conservation and Rivers Control Council, established in 1941, and this organisation has also successfully promoted the wide use of the aeroplane in agriculture in New Zealand.

Nuclear Research

Research into nuclear science is carried out mainly by the DSIR under the guidance of the New Zealand Atomic Energy Committee, set up in 1958. As indicated above, the Institute of Nuclear Sciences established in 1959 took over the functions of the Division of Nuclear Sciences of DSIR. Its purpose is to undertake research on isotopes and radiation generally, and to install and operate a 3 million electron volt (MeV) van de Graaff accelerator, and later, a 1 megawatt swimming pool reactor. It will introduce the tools and techniques of nuclear science into primary and secondary industry. It will also provide facilities for co-operative research between university and DSIR scientists on expensive pieces of equipment at present not available to individual groups of scientists.

Defence Research

The Royal New Zealand Navy has a Naval Research Laboratory in Auckland, which undertakes scientific research and development in some sections of oceanography for the Navy.

No classified work is undertaken in DSIR, although this department does short-term investigations for the Services upon request.

The secretary of DSIR and the three Chiefs of Staff form the Defence Science Policy Committee and advise the Government on matters of defence science. They also are the official body through which New Zealand maintains liaison with such Commonwealth bodies as the Commonwealth Advisory Committee on Defence Science (CACDS). The Policy Committee also has control of the Defence Scientific Corps, which is made up of graduates on short-service commissions in the three Services who after post-graduate training do defence research in New Zealand and elsewhere in the Commonwealth. The established strength of the Corps is 30.

Mining Research

Research has been going on in the School of Mines and Metallurgy in the Faculty of Technology, University of Otago, continuously since the war.

Mineral engineering research is limited to batch-scale investigations such as the separation by flotation of talc-magnesite deposits, various investigations on road-metal beneficiation, gravity concentration of scheelite, the suitability of clays for bloating, and the upgrading of raw material for the cement industry.

Research in coal mining is continuously going on, financed from the Coal Mines Welfare and Research Fund. It includes experimental work in field and laboratory on such problems as spontaneous heating, water infusion, atmospheric dust, ventilation measurements, and methane drainage.

The Surveying Department has begun a long-range precise investigation into the rate at which the Alpine Fault is moving. A great many of the mineral prospects in New Zealand have been assessed economically, and also others in the Pacific Islands and Australia, a very thorough study of mineral valuation methods has been made, and the school has been closely associated with the development of hydraulic methods of coal mining.

Triennial Mineral Conferences are held (1950, 1953, 1956, 1959) and are very widely attended both from New Zealand and overseas. The *Proceedings* of these conferences fill what was formerly a wide gap in the documentation of the New Zealand mineral industry, and are becoming widely known overseas.

Branches of the DSIR engaged on various aspects of research related to mining include the Geological Survey and the Dominion Laboratory.

Agricultural Research

A good deal of agricultural research is conducted under the various divisions of the Department of Agriculture.

The Animal Research Division works in co-operation with the Animal Industry, Dairy, and Farm Advisory Divisions and also collaborates with other institutions engaged in animal research, notably DSIR, Massey and Canterbury Agricultural Colleges, and industry research organisations. The division has well-equipped laboratories at its research stations at Wallaceville and Ruakura. Wallaceville is concerned mainly with animal disease and diagnostic work, and Ruakura mainly with animal nutrition and breeding. At both stations, diagnostic centres to service the veterinary profession are established and there is a substation of Wallaceville at Taieri, near Dunedin.

The Farm Advisory Division is concerned with research and advisory work in soil management, crop and pasture production, and farm management. A field staff of farm advisory officers acts as a link between the research stations and farmers. The division has sections devoted to seed certification and agronomy, field experimental work, soil conservation, and rural sociology. It controls the following stations: Seed-testing Station, Palmerston North; Rukuhia Soil Research Station, Hamilton; Experimental Area, Marton; Phormium Plantations, Moutoa; Flock House Farm of Instruction, Bulls; Winchmore Irriga-

tion Research Station, Ashburton; and Invermay Research Station, Taieri, with which is associated the Wallaceville sub-station veterinary diagnostic centre. Soil erosion problems are investigated at a number of conservation reserves throughout the country.

The Horticultural Division is associated with field investigations including disease control and management aspects of horticultural production, and carries out inspection and advisory services to commercial fruit and vegetable producers, nurserymen, home gardeners, and bee-keepers. The Te Kauwata Horticultural Station, in the Waikato district, is devoted to wine-growing and wine-making, and the Levin Station in the Wellington district to research, mainly relating to berry fruit production.

The Animal Industry Division, in association with its advisory and regulatory functions in regard to the livestock industry, carries out field investigations and research into animal health and management problems, noxious animal control on farm lands, and wool production.

The Dairy Division, in association with its advisory and regulatory functions in regard to the dairy industry, carries out field and factory investigations into dairy produce quality and processing and chemical analytical studies of produce and water supplies.

Research into some problems of the dairy industry is also carried out by the New Zealand Dairy Board, which is an organisation financed by a levy on butter manufactured and also subsidised by a Government grant. It undertakes research aimed at improving the genetic quality of dairy stock in New Zealand. It also investigates methods of improving the technique of artificial insemination.

Another organisation dealing with agricultural research is the Cawthron Institute, Nelson. Until recently it undertook research over a wide range which included entomology, mycology, plant/soil relationships, and plant nutrition. It has now been reorganised and in future will concentrate on plant nutrition problems, mainly from a biochemical angle.

Forestry Research

The Forest Research Institute (Rotorua) of the New Zealand Forestry Service, which was first established in 1947 as a Forest Experimental Station, now investigates all aspects of silviculture, forest pathology and management as they apply to New Zealand. It also deals with the utilisation of forest products, and, in particular, the question of timber preservation, and administers the National Forest Survey.

Fisheries Research

The Fisheries Research Laboratory (Wellington) of the Marine Department carries out research into problems of marine and freshwater fisheries in New Zealand. In the marine field, research is concerned primarily with the life history, growth, and migration of the principal commercial species of fish—schnapper and tarakihi. Work is also carried out on the most important invertebrates—crayfish and oysters. Freshwater research is directed mainly at the introduced fish species, particularly brown and rainbow trout.

Research in Museums

Research is carried out at the museums at the four main centres. The Dominion Museum is under Government control, but those in the other three centres are administered by special Museum Boards. Research is concerned mainly with (1) systematics, and population and distribution surveys of species of fauna found in New Zealand and in the surrounding South Pacific area,

and (2) studies of the ethnology and archæology of the same area. Some systematic work is also done on botanical species.

Medical Research

Under the Medical Research Council Act, 1950, a Medical Research Council was established as a corporate body with the following functions:

(*a*) To foster medical research and to prepare and publish such reports on these matters as may in its opinion be necessary or of value to teachers or other persons.

(*b*) To furnish information, advice and assistance to persons and organisations concerned with medical research.

This council took over and developed the work of the Departmental Committee, bearing the same name, which had been in existence since 1938. At the end of 1959 research in the following was in progress: chest diseases; clinical medicine; dentistry; endocrinology; hydatids; Island Territories research; microbiology; neuropathology and neurophysiology; nutrition; obstetrics; psychiatry; surgery; toxicology; pathology.

The council maintains liaison with the research work being carried out by the Travis Trust Laboratory for tuberculosis research and the New Zealand Branch of the British Empire Cancer Campaign Society.

The council administers the Medical Research Endowment Fund, from which annual expenditure of £100,000 is incurred in supporting research projects at the University of Otago, the University of Auckland, and the institutions of the Auckland Hospital Board.

The council employs a staff of 90 full-time workers, and some 40 associated workers contribute to the activities of the 14 research committees established by the council.

The council is empowered to receive bequests and donations to the Fund for furthering the objects of the council as set out in the Medical Research Council Act, 1950.

The National Health Institute, Wellington, established in 1954, is the Health Department's unit for research into public health problems. The institute, in addition to its diagnostic services in bacteriology and virology, provides for hospitals a reference laboratory for the identification of organisms of medical interest. The Health Department is also responsible for the Dominion X-ray and Radium Laboratory, Christchurch, which among other work calibrates and inspects regularly all X-ray installations in the country and is responsible for monitoring air, water, and soil for radio-active contamination. The staff of the laboratory also visit all places where radio-active substances are used, regularly checks the amount of radiation received by all radiation workers, and advises on radiation protection.

Scientific Publications

The main scientific journals for the publication of research papers are the *Transactions of the Royal Society of New Zealand* and the three journals issued by the DSIR, viz., the *New Zealand Journal of Agricultural Research*, the *New Zealand Journal of Science*, and the *New Zealand Journal of Geology and Geophysics*. These three journals replace the *New Zealand Journal of Science and Technology*, which ceased publication in 1957.

In addition, the DSIR issues a departmental bulletin series, a geological bulletin series, a palæontological bulletin series, a soil bureau series, and an information series.

SOUTH AFRICA

Before the Union was formed in 1910, systematic research in South Africa

was confined to museums and universities, but since then the Government has gradually emerged as the chief sponsor of scientific research.

At first only two Government departments, those of Agriculture and Mines, were much concerned, the latter chiefly on the geological side. The Research Grant Board, established under the Department of Mines and Industries in 1918, and transferred in 1933 to the newly created Department of Commerce and Industries, served all branches of the Government and all organisations in South Africa. In 1938, the Board became the National Research Council and Board, under the Department of Education. It continued to devote most of its attention to the natural sciences but set aside a small part of its funds for social research, supplementary to that subsidised through the South African Council for Educational and Social Research.

After the second world war, the functions of these bodies were taken over by two new organisations, the Council for Scientific and Industrial Research (CSIR) and the National Council for Social Research.

At present research in agriculture and mining is still organised separately from that carried on by the two main research bodies.

There are also several research institutes with direct Government support. The Fuel Research Institute is financed by a levy on coal production and a *pro rata* subsidy from the Department of Commerce and Industries, and the Wattle Research Institute by the wattle growers and the Department of Forestry. The South African Institute for Medical Research, established in 1912, receives equal grants from the Transvaal Chamber of Mines, the Union Government and the CSIR. Others, such as the research laboratories of the Transvaal Chamber of Mines, the Diamond Research Laboratory and the Sugar Experiment Station, are financed entirely by the industries they serve.

Agriculture, Forestry and Fisheries

The Department of Agriculture conducts research through nine divisions in Pretoria, Agricultural Research Institutes at the University of Pretoria and the University of Natal, the Stellenbosch-Elsenburg Colleges of Agriculture, the Western Province Fruit Research Station at the University of Stellenbosch and a Locust Administration in Pretoria. The Department of Forestry has two research institutions in Pretoria, and the Department of Commerce and Industries runs a research organisation in the Division of Fisheries. Meteorological research is conducted under the Weather Bureau of the Department of Transport.

Mining

The Department of Mines is responsible for a Geological Survey Division, a Government Metallurgical Laboratory at the University of the Witwatersrand in Johannesburg, a Government Mechanical Laboratory, a Silicosis Medical Bureau and a Miners' Phthisis Prevention Committee.

Council for Scientific and Industrial Research

The Council for Scientific and Industrial Research (CSIR), a corporate body established by the South African Parliament in October 1945, is responsible for all Government-sponsored research in relation to industry, except fuel research and metallurgical research. CSIR's position approximates in many respects to that of a Government organisation, but its employees are not civil servants.

The first laboratories to become fully operative were the National Building Research Institute and the Telecommunications Research Laboratory, the nuclei of which had been set up during 1945 under the Department of Commerce and Industries and the Department of Defence respectively. These were followed

during 1946 by the National Physical Laboratory and the National Bureau for Personnel Research.

In common with similar organisations in other Commonwealth countries—for example, the Department of Scientific and Industrial Research in the United Kingdom—the CSIR promotes co-operative industrial research by helping to finance industrial research associations. These associations (as in the United Kingdom) draw their funds partly from the industries concerned and partly from CSIR.

The Leather Industries Research Institute at Grahamstown was the first such association to be formed, and it has been followed by the Fishing Industry Research Institute, the Paint Industries Research Institute, and, during 1952, by the Wool Textile Research Institute. The institutes are independent bodies operated by boards of control, on which CSIR has only minor representation.

Today the CSIR organisation incorporates:

Nine national laboratories
- National Physical Research Laboratory
- National Chemical Research Laboratory
- National Nutrition Research Institute
- National Building Research Institute
- National Mechanical Engineering Research Institute
- National Institute for Road Research
- National Institute for Personnel Research
- National Institute for Telecommunications Research
- National Institute for Water Research.

Five industrial research institutes
- Fishing Industry Research Institute
- South African Wool Textile Research Institute
- Leather Industries Research Institute
- Sugar Milling Research Institute
- Paint Industries Research Institute.

Twenty-two research units
- Amœbiasis Research Unit
- Anæsthetic Deaths Research Project
- Arthropod-Borne Virus Diseases Research Unit
- Bilharzia Natural History Unit
- Cardio-pulmonary Research Unit
- Cardio-vascular Pulmonary Research Group
- Clinical Nutrition Research Unit
- Degenerative Diseases Research Group
- Dental Research Unit
- Endocrine Research Group
- Heart Research Unit
- Human Biochemistry Research Unit
- Nutrition and Dental Health Research Unit
- Nutrition Research Unit
- Oceanographic Research Group
- Pneumoconiosis Research Unit
- Prison Research Group on Diet and Metabolism
- Research Group for the Study of Ageing
- Research Group to study the Biological Effects of Ionising Radiation
- Research Group to study Sunlight Reactions of the Skin
- Tuberculosis Research Unit
- Virus Research Unit.

The council has also built up an extensive library of scientific literature which

is now considered to be the central scientific library and scientific information bureau for South Africa. The library includes works on both pure science and technology and these are available on loan to scientists and technologists all over the Union. It also offers a microfilm service which obtains for inquirers single photographic copies of articles in periodicals not available in the Union.

To help maintain the free flow of scientific information between working scientists, the council has established scientific liaison offices in London and Washington, and in Cologne in the German Federal Republic. These also act as sources of information on scientific matters in South Africa.

Furthermore the CSIR is the organisation which, on behalf of South Africa, adheres to the International Council of Scientific Unions (ICSU) and its affiliated unions.

The council also grants extended assistance to postgraduate students and senior research workers in the universities. The purposes of these postgraduate research bursaries are: (1) to ensure that senior research scientists of proven ability are given the opportunity to continue their researches effectively; and (2) to provide an adequate supply of trained research workers imbued with enthusiasm for research as a career.

A general review of its activities is given in the annual reports of the CSIR, to which the reader is referred for fuller information.

National Council for Social Research

The National Council for Social Research, in Pretoria, was created by the Minister of Education in April 1946, to promote, organise, co-ordinate and assist educational, sociological and humanistic research on a national basis, but not to dominate or monopolise the field. It encourages research projects and the training of highly qualified research workers by means of grants, scholarships and fellowships to selected individuals for attachment to university departments, Government departments and other institutions. It also provides library and information services.

Secretarial duties for the council are carried out by the National Bureau of Educational and Social Research, Pretoria, which also itself undertakes research in education and psychology, physical education and native education, serves as a central clearing house for information on education and research in South Africa and acts as a liaison with foreign educational and cultural organisations.

Nuclear Energy

An Atomic Energy Board was set up in 1949 to exercise general control over atomic energy work in South Africa and, in particular, to promote prospecting for uranium and the mining and refining of ores. The board inaugurated in 1950 a £50 million scheme for installing the necessary plant to produce uranium concentrates as a by-product from gold mines. The scheme has been supported by an agreement with the Combined Development Agency [see R.F.P. 4192 *Nuclear Energy in Britain*] which is providing finance and to which the board is selling uranium over a ten-year period. In the summer of 1955, a representative mission from South Africa visited the establishments of the United Kingdom Atomic Energy Authority, with which it discussed broad lines of development of the peaceful uses of atomic energy in South Africa.

INDIA

Encouraged by notable achievements in scientific research during the period of the first five-year plan, the Government of India has provided considerable funds for the furtherance of scientific research, development programmes of existing scientific and technical institutions and for the setting up of a number

of new institutions. Almost all the existing institutions are fully or partly financed, directly or indirectly, by the Central Government.

One of the first organisations in India to conduct research is the Geological Survey which was founded in 1851, before the establishment of the oldest universities, viz., the Universities of Calcutta, Bombay and Madras. Its main purpose was the preparation of a geological map of India and the appraisal of the country's mineral deposits.

Agricultural research began with the establishment at Poona in 1889 of a Central Veterinary Research Institute. This was moved to Mukteswar in the United Provinces (now Uttar Pradesh) in 1893. A Central Agricultural Research Institute formed at Pusa, Bihar, in 1903, was later moved to New Delhi and renamed the Indian Agricultural Research Institute.

Medical research dates from the introduction of western medical services in the nineteenth century. In 1845, Surgeon Major Dempster, in the course of investigations into malaria in the Punjab, introduced what is known as the 'spleen rate' as a measure of malarial endemicity. This has since become the main yardstick for measuring the incidence of malaria in many parts of the world. In 1906, a Central Research Institute was established at Kasauli, followed by similar institutes in Bombay and Madras. In 1912, the Indian Research Fund Association (now known as the Indian Council of Medical Research) was founded to foster and co-ordinate medical research. In 1921, the School of Tropical Medicine was established at Calcutta and, in 1925, the Nutritional Research Laboratory at Coonoor. The work in India of Sir Ronald Ross (the discoverer of the transmission of malaria through mosquitoes) was crowned by the opening, in 1926, of a Malaria Research Bureau at Kasauli, which later became the Malaria Institute of India with headquarters at Delhi. Later, in the 1940s, the All-India Institute of Hygiene and Public Health was established at Calcutta for the training of public health workers and research into problems of preventive medicine.

The promotion and co-ordination of scientific and industrial research in general became the responsibility of the Council of Scientific and Industrial Research, an autonomous non-official organisation set up in 1940 by the Government of India.

The present organisation of scientific research in India is perhaps more varied and complex than in other Commonwealth countries. But almost all the research institutes are, to a greater or lesser degree, under the sponsorship and control of three Central Government Ministries, viz., the Ministries of Food and Agriculture, Health, and Education and Scientific Research. These Ministries provide five-year block grants to the Indian Council of Agricultural Research, the Indian Council of Medical Research and the Council of Scientific and Industrial Research, respectively. The latter bodies are autonomous and use the grants to sponsor research in different institutes and at the universities.

Agriculture

The Indian Council of Agricultural Research (ICAR) was brought into being as a Registered Society in 1929 to develop and co-ordinate agricultural research and to disseminate research information. Under its ægis an Indian Council of Agricultural Education has been set up to co-ordinate agricultural and animal husbandry education.

The ICAR does not maintain any research laboratories of its own but finances research schemes in central and State research institutions, universities and private laboratories. There are six central research institutes: the Indian Agricultural Research Institute, the Indian Veterinary Research Institute, the Central Dairy Research Institute, the Central Rice Research Institute, the Central Potato Research Institute and the Indian Institute of Sugarcane Research.

In addition, there are a number of autonomous commodity committees for supervising research in cotton, jute, sugar, coconut, tobacco, oilseeds, areca nut and lac. Many of these committees have research laboratories.

The ICAR, originally financed entirely by the Central Government, now obtains its revenue from a 'cess' (or duty) levied on the export of certain agricultural commodities (e.g., pulses, spices) not otherwise subject to export duty. Some of the commodity committees are similarly supported by a 'cess' on commodities with which they are concerned (e.g., on lac).

Some assistance to research is provided by the activities of the Central Ministry of Food and Agriculture, Directorates of Plant Protection and Plant Quarantine, Economics and Statistics, and Marketing and Inspection, although they do not generally undertake original investigations.

The Forest Research Institute and College is one of the leading centres of forestry education and research in the world. It is under the control of the Ministry of Food and Agriculture. The work undertaken in the institute is meant primarily to deal with the forestry problems and forestry products research peculiar to India and the neighbouring countries. The institute also serves as a training centre for students and workers from India and neighbouring countries. In 1951, the institute was recognised by the Food and Agriculture Organisation (FAO) of the United Nations as a centre for technical training in forestry for the south-east Asian Region.

A network of organisations co-ordinated by the Central and State Information Committee makes research information available.

Medicine

The most important agency dealing with medical research in India is the Indian Council of Medical Research, an autonomous body, which was founded in 1911 under the name of Indian Research Fund Association. The chief objects of this council are:

(1) To initiate, aid, develop and co-ordinate medical research in India, to promote special inquiries and to assist institutions in the study of diseases, their prevention, causation and cure;

(2) to publish papers or periodicals in furtherance of the objects of the council and to propagate knowledge regarding the causation, mode of spread and preventive measures appropriate to diseases, especially those of a communicable nature;

(3) to finance research inquiries.

The council has been dependent for its activities on grants from the Government of India. Co-ordination between the council and the central and State laboratories and Public Health Department is maintained through (1) the Director-General of Health Services, who is the chairman of the Scientific Advisory Board of the council and is responsible in regard to matters connected with the health of the nation to the Union Ministry of Health and who is also in touch with the heads of State public health departments; and (2) the meetings of the Scientific Advisory Board and its advisory committees, which are held annually under the auspices of the council and to which are invited research workers from all over India and heads of medical and public health departments of the states.

Besides giving grants for *ad hoc* researches to institutions and workers, the council has set up special research units in many institutions which are on a quasi-permanent basis and which serve as centres for training in specialised subjects. During the last few years, the programme of research sponsored by the council has included most aspects of medical science. In the second five-year plan (1956–61), a sum of over Rs. 40 million has been allocated for medical

research programmes. Separate funds have also been provided for medical research by some State Governments. The programme of medical research during the second plan includes: (*a*) strengthening facilities available for research in existing institutions in the country; (*b*) creation of new institutions for research in specific subjects; (*c*) training of research workers by the grant of fellowships and by other means; (*d*) creation of a research cadre; and (*e*) initiation of research schemes for the solution of the many urgent problems in medicine and public health.

The council maintains the Nutrition Research Laboratories at Hyderabad (Deccan). This is a leading institution in India, entirely devoted to basic and fundamental research in nutrition and allied sciences. The laboratories were founded in 1925 in order to provide a centre for research on nutritional problems, to act as an information bureau, to make the results freely available to all concerned, and in collaboration with public health officers to translate the results of research into practical nutritional work.

An important event in the study of virus diseases in India was the establishment by the council, in 1953, of a Virus Research Centre at Poona which is maintained with the co-operation and help of the Rockefeller Foundation. The centre is primarily interested in the study of arthropod-borne viruses, which include many of the human encephalitis viruses.

The names of some of the important research institutions, where research in medicine and allied sciences is being undertaken, are given below:

Institution	*Location*	*Work done*
The Vallabhai Patel Chest Institute	Delhi	Research into tuberculosis and other diseases of the chest
The All-India Institute of Hygiene and Public Health	Calcutta	Instruction in preventive and social medicine and research into industrial diseases and wastes pollution problems of rivers, etc.
The Bengal Immunity Research Institute	Calcutta	Research into lung diseases
The School of Tropical Medicine	Calcutta	Medical research and clinical demonstrations
The Central Drugs Research Institute	Lucknow	Drug research
The Indian Cancer Research Centre	Bombay	Research on cancer
The King Institute of Preventive Medicine	Guindy, Madras	Functions as a blood bank and does research on vaccines
The Central Research Institute	Kasauli	Microbiological, serological and biochemical research
The Pasteur Institute of Southern India	Coonoor	Bacteriology and pathology
The Nutrition Research Laboratories	Hyderabad, Deccan	Nutrition and allied sciences
Malaria Institute of India	Delhi	Basic and applied research in malaria and other mosquito-borne diseases. Testing of antimalarial drugs

Institution	*Location*	*Work done*
Haffkine Institute	Bombay	Plague and KFD vaccines manufacture
The All-India Institute of Mental Health	Bangalore	Psychosomatic disease teaching and research
The Central Leprosy Teaching and Research Institute	Chingleput, Madras	Leprosy work
The Central Institute of Research in Indigenous Systems of Medicine	Jamnagar	Research in indigenous systems of medicine
The All-India Institute of Medical Sciences	New Delhi	Modern medicine

The other systems of medicine practised in India are the Ayurvedic system representing traditional Hindu medicine; the Unani system introduced by the Muslims; and Homœopathy, a comparatively recent introduction. Increasing facilities are being provided for undertaking research in these three systems of medicine in the second five-year plan.

Council of Scientific and Industrial Research

The Council of Scientific and Industrial Research (CSIR) was established in 1942 and assigned the function of promoting, guiding and co-ordinating scientific and industrial research, financing scientific research projects and giving assistance to special institutes and departments of existing institutes for specific studies of problems affecting particular industries and trades. Research work has been carried on in its own laboratories and extra-murally in universities and elsewhere under the grants-in-aid scheme. The CSIR controls seventeen national laboratories: National Physical Laboratory, New Delhi; National Chemical Laboratory, Poona; National Metallurgical Laboratory, Jamshedpur; Central Fuel Research Institute, Dhanbad; Central Glass and Ceramics Research Institute, Calcutta; Central Food Technological Research Institute, Mysore; Central Drugs Research Institute, Lucknow; Central Road Research Institute, Delhi; Central Electro-chemical Research Institute, Karaikudi; Central Leather Research Institute, Madras; Central Building Research Institute, Roorkee; National Botanic Gardens, Lucknow; Central Salt Research Institute, Bhavnagar; Central Electronics Engineering Research Institute, Pilani; Regional Research Laboratory, Hyderabad; Indian Institute of Biochemistry and Experimental Medicine, Calcutta; and Mining Research Station, Dhanbad.

In keeping with the industrial expansion in the second five-year plan, the Planning Commission have approved a provision of Rs. 200 million for the development activities of the CSIR during the second plan period. Provision for an expenditure of Rs. 103·8 million has been made for the current activities of the council.

A Central Mechanical Engineering Research Institute and a Science and Industry Museum at Calcutta are being planned. Similar to the Regional Research Laboratory at Hyderabad, it is proposed to set up more laboratories to deal with regional problems in the comparatively backward areas in the country, viz., one in Assam, another in Saurashtra and the third in Orissa or in Madhya Pradesh.

A national biological research laboratory with emphasis on fundamental biological problems, and central public health and sanitary engineering institutes dealing with the engineering aspects of water purification, sewage treatment and sanitation, have been projected.

The Indian National Scientific Documentation Centre was established by the Government of India in 1952, with the technical assistance of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), for providing documentation facilities to scientific and technical research workers. The centre has been growing steadily and has already established itself as an important part of the organisation of scientific research in the country.

Ministry of Education and Scientific Research (Department of Scientific Research and Technical Education)

Apart from the seventeen laboratories under the Council of Scientific and Industrial Research, the Ministry of Education and Scientific Research (Department of Scientific Research and Technical Education) finances and controls research in the following organisations: (1) The Geodetic Survey of India, Dehra Dun; (2) The Zoological Survey of India, Calcutta; (3) The Botanical Survey of India, Calcutta; (4) The Indian School of Mines, Dhanbad; and (5) The Central Board of Geophysics. This Ministry also gives grants-in-aid for the development of the following scientific institutions and societies: (1) The Indian Association for the Cultivation of Science, Calcutta; (2) The Birbal Sahni Institute of Palæobotany, Lucknow; (3) The Physical Research Laboratory, Navrangpura, Ahmedabad; (4) The Indian Academy of Sciences, Bangalore; (5) The Bose Institute, Calcutta; (6) The National Institute of Sciences, New Delhi; and (7) The Indian Science Congress Association, Calcutta.

State Government Institutes

Well-known institutions run by State Governments include the Jiwaji Industrial Research Laboratory, Gwalior, and the Harcourt Butler Technological Institute, Kanpur.

Industrial Research Associations

Of the four industrial research associations established in India, two—the Silk and Art Silk Manufacturers' Research Association and the Bombay Textile Research Association—are still in the formative stage. The Ahmedabad Textile Industry's Research Association, Ahmedabad, is carrying on research in the application of physics, physical chemistry, chemistry, statistics and industrial psychology to the textile industry. The analytical section provides laboratory testing facilities for textile mills without laboratories of their own. The South India Textile Research Association, Coimbatore, has recently been established and the laboratories are being set up and the necessary equipment is being obtained. Meanwhile, the association has done some work on productivity survey and routine quality control work confined to blow room and carding.

Industrial Research Institutions

There are also several industrial research institutions (i.e. as opposed to associations), including the well-known Indian Institute of Science, Bangalore, which conducts postgraduate research in physics, organic chemistry, biochemistry, aeronautical engineering, internal combustion engineering, metallurgy, electricity, electronics and chemical engineering; the Shri Ram Institute for Industrial Research, Delhi, which concentrates on short-term industrial research problems having direct application; the Tisco Research and Control Laboratory, Jamshedpur, maintained by the Tata Iron and Steel Company Ltd., and doing metallurgical research; and the Sir Profulla Chandra Research Laboratory, Calcutta, which carries on applied research in organic, synthetic and biochemical colloids and chemotherapy.

Universities

India today has 42 universities, all of which, with the exception of the SNDI Women's University, Bombay, and Indira Kala Sangeet Vishwa Vidhyalaya, Khuragarh (Madhya Pradesh), possess faculties of science. Research undertaken in their often very well-equipped laboratories is the general responsibility of the Ministry of Education.

Irrigation and Power Research

Organised research in irrigation and hydraulic engineering in India was begun in 1953 by the Central Board of Irrigation and Power, which is the central co-ordinating body for research connected with water resources utilisation. Under a scheme of fundamental and basic research formulated by the board the following problems are under investigation at 13 different institutions: (1) air-entrainment; (2) turbulence; (3) cavitation; (4) design of channels; (5) engineering properties of soils; (6) sedimentation studies in streams and reservoirs; (7) sub-soil flow; (8) standardisation of the use of Surkhi and other Puzzolanic materials in mortar and concrete; (9) principles of mortar and concrete mix design; (10) development of economic alternatives to stone for river protection works; and (11) instrumentation.

The research institutions participating in the programme are: (1) The Central Water and Power Research Station, Poona; (2) the Punjab Irrigation and Power Research Institute, Amritsar; (3) the Indian Institute of Science, Bangalore; (4) the Uttar Pradesh Irrigation Research Institute, Roorkee; (5) the River Research Institute, West Bengal, Calcutta; (6) the Andhra Pradesh Engineering Research Laboratories, Hyderabad; (7) the Silt and Construction Materials Directorate, Central Water and Power Commission, New Delhi; (8) the Soil Mechanics and Research Division, Chepauk, Madras; (9) the Bihar Institute of Hydraulic and Allied Research, Patna; (10) the Mysore Engineering Research Station, Krishnarajasagar; (11) the Irrigation Development Division, Poona; and (12) the Assam Research Station.

In addition, research on specialised subjects is being undertaken at universities, research institutions, State irrigation and power research stations, and laboratories of various hydro-electric projects and dams.

Other Research Institutions

The Research Department, All-India Radio, Delhi, deals with broadcast engineering practice in India and carries out ionospheric investigations in co-operation with the National Physical Laboratory of the United Kingdom and interested universities in India. There is an Institute of Psychological Research and Service which carries on research in applied psychology. Research on forestry and forest products is conducted by the Forest Research Institute, Dehra Dun. The Railway Testing Centre, Lucknow, undertakes research on problems pertaining to railways. Dairy research is undertaken at the Bangalore and Karnal Institutes. There is a Telecommunication Research Institute at New Delhi.

Nuclear Energy

The Atomic Energy Commission was set up in 1948, with the object of developing nuclear energy for peaceful purposes in India. The commission was constituted as an advisory and policy-making body. It was later decided to set up a separate Department of the Government of India, called the Department of Atomic Energy, charged solely with the development of nuclear energy. The Department of Atomic Energy was created with effect from 3rd August, 1954, and Dr. H. J. Bhabha (Fellow of the Royal Society of London) was

appointed secretary to the Government of India in the new department, which was allocated to the charge of the Prime Minister, Shri Jawaharlal Nehru.

In March 1958, a new Atomic Energy Commission, with the administrative and financial powers of the Government of India, was constituted. The Commission is responsible for (1) formulating the policy of the Department of Atomic Energy for the consideration and approval of the Prime Minister; (2) preparing the budget of the Department of Atomic Energy for each financial year and getting it approved by Government; and (3) the implementation of Government's policy in all matters concerning atomic energy. Dr. H. J. Bhabha is the chairman of the three-membered commission.

The Atomic Energy Establishment, Trombay, is the national centre of research and development in nuclear energy. It has four divisions: physics; chemistry; engineering; and biology, medicine and health. It maintains closest co-operation with the Tata Institute of Fundamental Research, which is the national centre of the Government of India for advanced study and fundamental research in nuclear science and mathematics. In addition, the establishment has set up plants for producing such substances as uranium, beryllium oxide, graphite, and plutonium. It is at this site that Apsara, India's first nuclear reactor, is located, for which Britain supplied enriched fuel elements. The reactor completed four years of operation on 4th August, 1960. It provides facilities for research in neutron physics, irradiation of specimens required for geological and chemical investigation and training. India's second atomic reactor, which has been set up with the help of Canada, is a high-power high-flux reactor of the Canadian NRX type. This reactor started operating in July 1960. A third reactor is being built which will assist such studies as the effect of different lattices, shapes and sizes of fuel elements, and mixed lattices containing uranium or plutonium or thorium. This reactor, which will be known as Zerlina, is likely to be in operation by the end of 1960.

An Atomic Minerals Division is attached to the department, the functions of which are: (1) conducting geological surveys for development of atomic minerals, including terrestrial, aerial and marine surveys, prospecting and planning for development; (2) geophysical surveys, including radiometric surveys, radiometric logging of boreholes, radiometric assays and mine face surveys; (3) geochemical survey; (4) mineral technology; (5) drilling; (6) mining; (7) stockpiling; (8) conservation of atomic minerals; and (9) technical assistance and training.

In addition to carrying out research in its own laboratories, the commission gives financial assistance for specific projects to encourage research in various branches of nuclear science in universities and research institutions and has instituted fellowships for study and research in cosmic rays and nuclear physics.

With the object of producing all the materials required for a full atomic power programme, the department conducts industrial operations through the following concerns and plants: (1) Indian Rare Earths (Private) Ltd., Alwaye; this company extracts rare earth (cerium) compounds and crude thorium hydroxide from monazite sand available on the west coast of India. The crude thorium cake is sent to Bombay for further processing at the thorium plant of the department, where attempts are being made to explore the possibilities of preparing nuclear grade thorium compounds and also of extracting uranium from the uranium fluoride which is obtained as a by-product; (2) Travancore Minerals (Private) Ltd., whose function is to survey the mineral resources and produce ilmenite and minor products such as rutile, zircon and monazite; (3) a plant to produce heavy water as a by-product of fertiliser manufacture at Nangal; (4) a pilot plant at Ghatsila to extract uranium from copper tailings.

On the basis of the results of a detailed study of the economics of nuclear

power in India, it has been decided to construct a nuclear power station of about 250 megawatts.

The department maintains close co-operation with international bodies concerned with the peaceful uses of nuclear energy.

Defence

An Indian Defence Science Organisation was set up in August 1948 to help in the integration of scientific and military thought and to assist the Armed Forces in maintaining and improving their efficiency, by carrying out research into various aspects of defence science. It includes a psychological research wing, which carries out research in assessments of human personality. An Institute of Armament Studies was started at Kirkee in May 1952 to carry out studies and research into the performance of weapons and equipment and for training technical staff officers for the Services.

A Defence Science Service was created in 1953 in order to provide a close integration of the scientific work in the various defence establishments, a more effective disposal and concentration of the available scientific effort and also flexibility to meet new demands of the Defence Services adequately and expeditiously.

A Defence Research and Development Organisation has been set up by amalgamating the Defence Science Organisation and the Technical Development Establishments with a view to raising the level of defence research and bring about a co-ordination with development. The organisation is in the charge of a scientific adviser who is assisted by a chief controller and a chief scientist. The organisation assists and advises the Government in the formulation of defence research and development policy, and maintains liaison with other Commonwealth countries in scientific matters concerned with defence.

PAKISTAN

The Government of Pakistan has paid close attention to the need for planning scientific research organisations, and provision has been made for research in agriculture, medicine, industry and engineering. Apart from the institutes mentioned below, the six universities of Pakistan provide scientific research facilities.

In April 1959, a Scientific Commission was appointed, under the chairmanship of the Minister of Industries, to report on problems and organisation of scientific research in Pakistan. It consisted of 12 members, among whom 2 were from the United Kingdom, 1 from Canada and 1 from Australia. In January 1960, it was announced that the commission had decided that a Pakistan Science Foundation, to be administered by scientists, should be created to co-ordinate and integrate scientific research in the universities, Government laboratories and other institutions. The foundation should have a statutory charter of its own and its constituent units should be: Food and Agricultural Research Council, Industrial Research Council, Industrial Medical Research Council, Atomic Energy and Physical Research Council, and Irrigation and Works Research Council. The function of these units would be to establish research institutes and research laboratories throughout East and West Pakistan.

Agriculture

Immediately after partition, a Food and Agriculture Committee was set up, which was replaced by the Food and Agriculture Council, inaugurated by the Pakistan Prime Minister on 2nd July, 1953. Its functions are to promote and co-ordinate scientific and technological research relating to agriculture, animal husbandry and fisheries, and to enable full advantage to be taken of the results of this research. The members of the council are officials of the Central and

Provincial Governments and representatives of producer interests. There is as yet no central research organisation for agriculture, so that the actual work of research is done in the provinces and at universities, the council helping with finance. There is an Animal Husbandry Research Institute. Governmental attention has also been given to tackling the locust menace. A Locust Control Committee set up in 1950 (for a period of two years in the first instance), which has initiated research into locust control with particular emphasis on control of flying swarms, made the discovery—described by Lord Boyd Orr as of 'far-reaching importance', and as one which would 'earn the gratitude of all those who have to control agricultural pests in many countries of the world'—that water, instead of the expensive oil used hitherto, could be used as a carrier in aerial spraying operations. This had previously been considered impossible.

Medicine

A six-year health plan for Pakistan was approved by the second All-Pakistan Health Conference held at Dacca in 1951. This provided, among other things, for a new Medical College in West Pakistan, a Medical Research Institute, a Drug Testing Laboratory, a factory for the manufacture of penicillin, an Institute of Hygiene and Preventive Medicine, a Radium Institute, a Nutrition Research Institute and improvements to medical colleges.

The Medical College in West Pakistan, known as Nishtar Medical College, has since been established at Multan. Other institutions were set up after the establishment of Pakistan.

The Jinnah Central Hospital, Karachi, was taken over from the Royal Air Force authorities in 1948, and is attached to the Dow Medical College for teaching facilities, and also has a nursing school and a tuberculosis sanatorium. Steps are being taken to set up a Medical Radioisotope Centre at the Jinnah Central Hospital.

The Malaria Institute of Pakistan, which came into existence on 15th August, 1947, conducts research on mosquitoes, malaria parasites, insecticides and anti-malaria drugs. It has gained recognition by the World Health Organisation as an international training centre for the training of medical officers and inspectors in malariology. It is at present situated at Dacca, East Bengal.

The Bureau of Laboratories, Pakistan, was established to manufacture sera and vaccines. It is now in a position to meet the country's demands and even to export sera to some foreign countries. These laboratories also do medical and serological research work for the Government and have a section devoted to antibiotics.

The Central Drugs Laboratory was established in 1953 for the analysis and standardisation of drugs, including patent and proprietary medicines.

The Pakistan Medical Research Association has been constituted by the Government of Pakistan to initiate, aid and develop medical researches in Pakistan. The principal aims and objects of the association are: (1) to initiate, aid, develop and co-ordinate medical research to the country, to promote special inquiries and to assist institutions in the study of diseases, their causation, prevention and remedy; (2) to publish papers, periodicals, etc., in furtherance of the objects of the association and to propagate knowledge on the causation, mode of spreading and prevention of diseases, especially those of communicable nature; (3) to maintain liaison with other similar bodies with the same aims and objects, accept and administer endowment funds and donations, and to grant scholarships to selected individuals for higher studies abroad; and (4) to issue appeals for funds to finance special inquiries.

The Tuberculosis Control and Training Institute was formally opened in Dacca on 14th May, 1953. It is well equipped and is being run by the East Bengal Government in co-operation with the United Nations Children's Fund

(UNICEF), which provided trained technical staff at the start and trained local people to take over from them.

The Skin and Social Hygiene Centre, opened on 4th May, 1953, was established under the joint auspices of the Government of Pakistan, the World Health Organisation and UNICEF, and is the first of its kind in the country. Its functions are, besides diagnosis and treatment for venereal and skin diseases, to provide laboratory facilities for serological examinations. The centre was constructed by the Pakistan Government at a cost of Rs. 167,000. A similar centre is expected to be opened in Chittagong.

Council of Scientific and Industrial Research

The Council of Scientific and Industrial Research was formally inaugurated in April 1953.

The aims and objects of the council are: (1) the initiation, promotion and guidance of scientific and industrial research bearing on problems connected with the establishment and development of industries or with other matter referred to the council by the Central Government; (2) to establish or develop national institutions for research, to utilise the economic resources of the country in the best possible manner; (3) to make grants-in-aid for specific research schemes at universities and other research institutions in Pakistan; (4) to undertake and foster developmental research for the utilisation of discoveries and inventions resulting from researches of the council; (5) the establishment and award of research fellowships; (6) the collection and dissemination of information of scientific and industrial matters and the publication of scientific reports and periodicals relating to the activities of the council; (7) to encourage the establishment of industrial research associations by various industries; and (8) to maintain contacts with industrial research organisations in other countries.

The council mainly functions through a central and three regional laboratories which it is establishing, and by means of grants to universities and other research projects having a bearing on industrial development. The four laboratories, construction of permanent buildings for which is in progress, are developing the following research divisions:

Central Laboratory at Karachi:

1. Physical Research and Testing;
2. Chemical Research;
3. Biochemical Research;
4. Drugs and Pharmaceuticals Research;
5. Building Materials Research;
6. Fuel Research; and
7. Plastics Research (including paints and varnishes).

Regional Laboratory at Dacca:

1. Leather Research (principally providing facilities for investigations in tanning material resources of the region);
2. Fuel Research (principally for work on peat lignite coal deposits of the area);
3. Food and Fruit Technology;
4. Plant and Animal Products Research (covering work on minor forest products, and biological, agricultural and industrial wastes); and
5. Glass and Ceramics Research.

Regional Laboratory at Lahore:

1. Metallurgical Research (including ore dressing and testing of minerals);
2. Industrial Fermentation Research;

3. Oils and Fats Research;
4. Glass and Ceramics Research; and
5. Food Technology Research.

Regional Laboratory at Peshawar:

1. Indigenous Drugs Research;
2. Fruit Technology Research;
3. Wood Research; and
4. Mineralogical Research.

The policy and supervision of the work of the council are determined by the Governing Body, consisting of 23 members elected or nominated according to a prescribed procedure. The universities are represented through six members. Every effort is being made for the closest co-operation between the various scientific departments of the universities and the laboratories of the council, which, for the purpose, will be located in close proximity to the universities. Further, specific research schemes having a bearing on industrial development are being financed at the universities by the council, on the recommendation of relevant research committees, in furtherance of its aims and objects.

The council was formed as an autonomous body under the Societies Act of 1860, but liaison with the Government is maintained through a Department of Scientific and Industrial Research, attached to the Ministry of Industries, Government of Pakistan, Karachi. The director of the department is the *ex officio* director and principal executive officer of the council. The department takes care of the official side of the research organisation of the country, and provides a basis for the co-ordination of the work of the council with the scientific and development activities under other ministries and departments of the Government, for example, the Ministry of Agriculture and the Ministry of Health; also with the activities of the Survey and Development Departments of the Ministry of Industries.

A nucleus of the central laboratory has been set up at Karachi in existing accommodation which has been improvised to meet its requirements. The Director of Scientific and Industrial Research is also in charge of the direction of the nucleus of the central laboratories. The foundation stone for permanent buildings was laid in April 1959.

Temporary scientific and other staff are appointed under the council for handling various research schemes at the universities and other research institutions. Further, the objects of the council include the establishment and award of research fellowships in subjects within the sphere of its work.

Liaison with industry is a matter of vital concern to the council, and it is rendering advice to firms on problems relating to the development of the various industries, either on direct reference from them or by ascertaining their problems through the industrial liaison service of the council.

A *Journal of Scientific and Industrial Research* is published quarterly, and is to be issued monthly in due course. For the purpose of screening and vetting the articles sent for publication in the journal, an editorial board consisting of senior scientists has been formed.

The council has established an information service to provide effective liaison with industry through collection and dissemination of scientific and technical information, available from local and international sources as well as by giving technical advice on problems which may be referred to it by industry.

A National Scientific and Technical Documentation Centre under the Council of Scientific and Industrial Research has been established in co-operation with the United Nations Educational, Scientific and Cultural Organisation (UNESCO). This centre will cater for the needs of research workers by helping

to provide them with technical and scientific literature on the problems on which they are required to work. This will involve compilation of bibliographies, documentation, microfilming and translation from other languages.

Institute of Cotton Research and Technology

Cotton is important to the economy of Pakistan, and it is essential not merely to maintain the quality of the crop but also to improve it and raise the volume of production. A Cotton Research Institute was therefore established in 1956, for making fibre and spinning tests on standard varieties and improved strains of cotton, for carrying out fundamental research on the physical and chemical properties of cotton fibre and their relationship with its quality, for the issue of authoritative test reports to trade and industry, and for investigations on cotton seed and its derivatives.

The institute is centrally located in the Federal capital and is housed in a well-planned building. It is equipped with standard apparatus and machinery.

The institute is divided into the following six major divisions:

1. Processing laboratories;
2. Textile Testing;
3. Textile Physics;
4. Microscopy;
5. Seed Study;
6. Chemistry and Biochemistry.

The institute also has a grading, classifying, and marketing department, and a museum. It provides free testing services to Middle Eastern countries.

Pakistan Railways Research Centre

In 1955, Pakistan Railways set up an independent nucleus research centre at Lahore. This centre is composed of small sections for the Civil and Mechanical Engineering Departments where research and development of other advanced countries are studied with a view to their adoption after any necessary adaptation and modification. Original work is also undertaken, mainly with a view to utilising the railways' existing resources and capacity for the manufacture of their own requirements and their further development.

The Pakistan Tea Board

The Pakistan Tea Board, an autonomous body under the control of the Central Government, is equipping a tea research station near Srimangal in south Sylhet. Capital expenditure and recurring expenditure are exclusively met by the board. The board employs a chief scientific officer, scientific officers and field assistants. The research station caters exclusively for the tea industry and deals with specific aspects of research concerning that industry only.

Engineering

The construction of a Soil Mechanics and Hydraulics Laboratory at Karachi was announced in April 1953. The laboratory will provide research services for all parts of Pakistan and will be under the Central Government. The Central Engineering Authority will be responsible for the operation of this project.

The soil mechanics section of the laboratory will provide facilities for soil sampling and analysis, testing of cement concrete and of aggregates, petrographic examination of rocks and grouting and permeability tests.

The hydraulics section will provide facilities for model tests for river works, canals and canal works, conduits, pipes and spillways, analysis of the mechanics of sediment transportation, testing and rating of current meters, and chemical analysis of water and sediment samples.

Nuclear Energy

An Atomic Energy Council was set up in 1956 under the Ministry of Industries, consisting of a governing body and an Atomic Energy Commission. The council's function is to regulate the procurement, supply, manufacture and disposal of all radioactive substances, and to carry out surveys for radioactive materials.

Pakistan has availed itself of opportunities for training scientists and medical personnel in nuclear reactor technology and the use of radioisotopes under the Colombo Plan, the US International Co-operation Administration (ICA), the Central Treaty Organisation (CENTO) and the International Atomic Energy Agency (IAEA).

A nuclear energy laboratory has been established in Karachi with five main divisions: (1) health and physics radiation; (2) physics and mathematics; (3) engineering and metallurgy; (4) electronics; (5) general services. Besides workshops and drawing offices, the laboratory has two light water pools for housing gamma-ray sources, such as cobalt-60, for radiation work. Equipment has been received from the United Kingdom and Canada under the Colombo Plan, and from the United States under ICA.

Medical and agricultural radioisotopes centres are being established, and equipment for them has been received from the agencies already mentioned.

A research reactor is planned.

CEYLON

Among the oldest institutions conducting research in Ceylon are the Royal Botanic Gardens, Peradeniya, which were founded in 1821. There are other botanical gardens at Hakgala and Heneratgoda.

The gardens at Peradeniya, which were founded on the model of the Royal Botanic Gardens at Kew in the United Kingdom and were originally governed and staffed largely by United Kingdom scientists, were of the greatest importance in the introduction of new crops, such as rubber and cinchona, to Asia, and in finding a new staple crop for Ceylon in the 1880s, after the decay of the coffee plantations. As a result of the work at Peradeniya, cinchona was first introduced to take the place of coffee, but with over-production and disastrous falls in price by 1892, this too was almost abandoned in the 1900s, and tea was introduced. The Royal Botanic Gardens have become a department of scientific tropical agriculture and a bureau of information and advice on botany, agriculture, horticulture, entomology, plant pathology and chemistry.

Other well-established centres of research are the Colombo Observatory, founded in 1907, a Tea Research Institute, founded in 1926, a Coconut Research Institute, founded in 1928, a Rubber Research Institute, founded in 1930, and the Ceylon Institute of Scientific and Industrial Research (CISIR), established in 1955.

The University of Ceylon, at Colombo, formed in 1942 by the Union of the University College, Colombo, with the Colombo Medical College, has faculties of medicine and science (mathematics, physics, chemistry and zoology).

Agriculture

The Department of Agriculture is responsible for all agricultural research, including that done in the Royal Botanic Gardens and the Tea, Coconut and Rubber Research Institutes. During 1952, the Department of Agriculture became incorporated in a new Ministry of Food and Agriculture, but retained control of its 14 research divisions: botany, agriculture (southern and eastern divisions), dry farming, sugarcane research, chemistry, entomology, plant pathology, horticulture, tobacco, agricultural engineering, systematic botany,

soil conservation and botanic gardens. There are also 81 farms, agricultural stations, nurseries and animal breeding centres under the department. Research is principally associated with the six experimental stations at Maha Illuppallama (farming in the dry zone), Batalagoda (rice breeding), Ketugastota (vegetable breeding), Hambantota (cotton research), Polonnaruwa (sugarcane research) and Tissamaharama (paddy seed research).

The Tea Research Institute does fundamental research and advisory work in connection with the pathology, physiology, chemistry and general technology of tea.

The Coconut Research Institute conducts research in soil chemistry, tapering disease, botany and other problems connected with coconuts.

The Rubber Research Institute's main subjects of research are agronomy, botany, chemistry and pathology.

Medicine

Medical research is controlled by the Department of Health Services and carried out principally in the Medical Research Institute, the Pasteur Institute, and the various sections of the department, especially those of pharmacology and nutrition. There is also a Department of Indigenous Medicine for the promotion of the Ayurvedic, Siddha and Unani systems of medicine, but little in the nature of research as generally understood is carried out by it.

Ceylon Institute of Scientific and Industrial Research

The Ceylon Institute of Scientific and Industrial Research was established in 1955 by Act of the Ceylon Parliament, as the result of recommendations of a survey mission of the International Bank for Reconstruction and Development. The Act provided for an initial Government donation of Rs. 0·5 million and certain other aids towards its support over the first five years; during the same period it has received roughly the equivalent amount of help in the form of administrative direction and guidance provided by the International Bank and United Nations Technical Assistance Administration, plus technical assistance and equipment donations from the United Kingdom, Canada, the United States and the Asia Foundation.

The CISIR is not a Government agency. It is an autonomous, non-profit-making corporate institution operated on business lines, with its own governing board, administration and full-time staff of practical research engineers, industrial management advisors, scientists and assistants. It deals directly with its clients on a confidential basis, charging for its work, and renders its broad technical services individually to private firms, producers' associations, financial institutions, Government departments and even other research organisations.

Its objects are: (1) to undertake research to improve technical processes used in industry and to discover new processes for expanding existing, or developing new, industries; (2) to advise on scientific and technological matters affecting the use of Ceylon's natural resources and industrial development; (3) to foster the training of research workers and the establishment of research associations of persons engaged in industry; (4) to undertake or collaborate in the preparation, publication and dissemination of technical information; and (5) to co-operate with Government departments, universities and technical colleges in promoting research and the training of research workers, technical experts, craftsmen and artisans.

The main operating support of the CISIR today comes from the more than 200 industrial firms and organisations which it serves. Its clientèle also includes some 30 Government departments. In addition, the CISIR performs the functions of a Ceylon Bureau of Standards, and maintains for free public use the country's finest technical library, which is also the Ceylon depository for

publications of the United Kingdom DSIR. The institute's large main establishment is in Colombo, with an eastern branch laboratory in the Gal Oya Valley.

Other Research

Chemical analysis is performed by the Government Analyst, while 17 meteorological stations are controlled and operated by the Department of Meteorology, formerly under the Ministry of Agriculture and Lands, but transferred in 1952 to the Ministry of Posts and Information (now Posts and Broadcasting), which is also responsible for Colombo Observatory.

FEDERATION OF MALAYA

Scientific research in Malaya is expanding but is still mainly confined to agriculture, fisheries, forestry and public health. Research in connection with civil engineering projects and irrigation engineering is undertaken by the design and research unit of the Public Works Department and the research laboratories of Drainage and Irrigation Department respectively.

The Federal Department of Agriculture undertakes a broad programme of agricultural research as the basis for its extension and advisory work in all branches of Malayan agriculture. This programme includes comprehensive reconnaissance, and detailed soil surveys of areas of land development programmes.

Rubber Research

Research and technical advisory services for the rubber industry in Malaya are provided by three organisations: the Rubber Research Institute of Malaya (RRI), established in 1925; the Natural (British) Rubber Producers' Research Association (NRPRA, formerly the British Rubber Producers' Research Association); and the Natural Rubber Development Board. The two latter organisations were established in the United Kingdom during the period of 1936–38. All three bodies are financed from a cess on rubber produced and exported from Malaya —the present rate of cess is three-quarters of a cent (Malayan) per pound, producing an income of about $M 11 million per year.

Financial and administrative control is now exercised by the Malayan Rubber Fund (Research and Development) Board, established under the provisions of the Malayan Rubber Fund (Research Development) Ordinance, January 1959. The membership consists of representatives of all sections of the rubber producing industry in Malaya, scientific members and representatives of the Government of the Federation. The chairman of the board is also controller of rubber research and the affairs of the board come within the portfolio of the Ministry of Commerce and Industry. Proposals have already been formulated for the reorganisation of the structure and control of the three main research bodies financed from the fund and these are currently under consideration by the appropriate authorities. It is expected that this reorganisation will lead to an even more vigorous pursuit of research and development to meet successfully the competition from synthetic rubber.

The three principal bodies financed by the board have the following duties and functions. The Rubber Research Institute of Malaya undertakes research on all aspects of the agricultural production of natural rubber, the processing of latex and preparation of rubber for export to consuming countries. It also undertakes an extensive programme of basic research on latex that can only be carried out satisfactorily on latex fresh from the tree. This work is within the purview of the Chemical Division of the RRI. In the biological field, basic research on the genetics of the rubber tree, nutrition of the tree, and control of

diseases and pests is undertaken by the Botanical, Soils and Pathological Divisions.

The Natural (British) Rubber Producers' Research Association undertakes research on natural rubber mainly from the standpoint of the relationship between its chemical and physical properties and its applications in industry. Generally, the work of the NRPRA is undertaken in close contact with the consumers of natural rubber, while at the same time, by liaison with the RRI in Malaya, close contact with the producer is maintained.

The Natural Rubber Development Board is principally concerned with the promotion and extension of the usage of natural rubber and in the stimulation of new applications. In close liaison with the NRPRA, technical services to consumers are provided. These services are being developed vigorously in the United Kingdom to meet the rival service in the same field provided by the manufacturers of synthetic rubber. Similar services are provided in the United States, Australia, New Zealand, South Africa, India and Malaya.

In addition to the research and information activities, the Rubber Research Institute in Malaya provides through its advisory services direct advice to producers, both on estates and smallholdings, on all aspects of natural rubber production. By co-operation with the Department of Agriculture, the RRI provides direct advisory services to smallholder rubber producers and, through the replanting boards, direct assistance in the supply of approved high yielding planting material. Approximately half of the annual income of the RRI is spent on research and technical development work and one-half upon direct advisory services to producers.

Forestry

Research in forestry is carried out by the Federal Forest Research Institute. Work is being done in botany, chemistry, ecology, entomology, mensuration, silviculture, utilisation and wood technology. The institute contains a new Timber Research Laboratory divided into three sections dealing with composite wood, timber, mechanics, and wood preservation and seasoning.

Other Research

Medical research is conducted by the Institute for Medical Research at Kuala Lumpur, founded in 1900, with the title of the Pathological Institute, as part of the United Kingdom policy of scientific research on tropical diseases. The institute pursues a varied programme of research in pathology, bacteriology, nutrition and biochemistry as applied to disease in Malaya. It has played a leading role in diagnosis, treatment and prevention of malaria and has done work on cancer, filariasis, some rickettsial and virus diseases, as well as attempting the isolation of new antibiotics.

Some geological research, over and above the normal work of the Geological Survey, is carried out by the Geological Survey Federal Headquarters at Ipoh. It includes the development of special prospecting techniques, and work on mineralogical and petrological problems, particularly in connection with tin ore, iron ore and associated minerals.

Research in fisheries is carried out by the Federal Fisheries Department. Work is being done on the important chub mackerel (*rastrelliger*) fisheries, and the cockle (*anadara granosa*) fisheries, preservation of fresh and salted fish and on the breeding of suitable fish for stocking ponds, disused mining pools, rivers and swamps. The Singapore Government contributes ten per cent of the costs of this work. The Fish Culture Research Institute at Malacca, which was built from UK Colonial Development and Welfare funds and is staffed from the United Kingdom, conducts basic research on productivity in fish-ponds. The Federation Government contributes an annual grant to this institute.

Veterinary research is undertaken in modern laboratories at Ipoh, and work is progressing steadily on projects directly connected with stock improvement in Malaya.

The Department of Chemistry, Federation of Malaya, is normally occupied in analytical work submitted by other Government departments. It does, however, undertake research in connection with its own analytical methods, particularly those arising from toxic insecticides and mixtures of synthetic and natural rubber. In conjunction with other Government departments it is also engaged in a pilot-scale phyto-chemical survey.

Research of industrial relevance is almost entirely limited to that done by the Forest Research Institute at Kepong and the Mines Research Laboratories at Ipoh. The former is engaged in research into improvements in the use of timber and the use of local raw materials for the manufacture of paper and board, and the latter is engaged in research in hydraulic mining techniques and ore-dressing.

This lack of industrial research was the subject of comment by the mission organised by the International Bank for Reconstruction and Development which states in its report (*The Economic Development of Malaya*, pub. Johns Hopkins, 1955) that the scope for fairly quick rewards from industrial research was probably greater in Malaya than in most of the less-developed countries, since Malaya possessed a considerable entrepreneurial class with the interest, initiative and capital to put research findings to practical use. It recommended the setting up of an institute of industrial research to investigate the technological and economic opportunities for industrial expansion. Such an organisation should serve both the Federation and Singapore, but should not be established as part of the machinery of either government. Following this suggestion, discussions were held between the two governments with the object of setting up an Industrial Research Institute. It appears unlikely, at the present moment, however, that the Government of Singapore wishes, for a variety of reasons, to engage in this project. A report on the setting up of an Industrial Research Institute has already been prepared by an expert in these matters, but the Government of the Federation of Malaya requires still further investigations to be made and to this end has asked for further expert assistance from the United Nations Technical Assistance Board.

In addition to the research work described in the previous paragraphs a certain amount of research into the production and processing of rubber latex and cacao is undertaken by research laboratories financed and staffed by private enterprise.

GHANA

In a statement to the Ghana Parliament in September 1957, the then Prime Minister, Dr. Nkrumah, referred to the future of research. He said:

> 'As to research, we are continuing our investigations into the possibility of increasing and strengthening all research activities which could be beneficial to our economy and to public health. With the attainment of independence, problems of controlling the research stations previously run on a West African basis arose and the Government is consulting with the other West African Governments as to the best means of administering these stations in the future to the mutual benefit of all concerned.
>
> 'We are fortunate that the new Principal of the University College . . . is himself a distinguished scientist and I am sure that he will be able to make an important contribution to our research activities in addition to his vitally important duties at the University College. . . .'

The West African Institute for Social and Economic Research has recently been wound up, and in Ghana has been replaced by the Economic Research Unit, directed by the Professor of Economics at the University College.

Much research work, on a variety of subjects, is centred at the University College of Ghana, and much is undertaken by Government departments, sometimes in collaboration with the University College.

New developments include the establishment of a Biological Research Unit at the University College, which in the first place will take over the functions of the Department of Tsetse Control, now discontinued. The Government provides an annual subvention of approximately £20,000.

Under the Medical Department there is a Medical Research Institute at Accra and a Tuberculosis Research Unit at Kumasi. The Department of Animal Health carries out veterinary research at its farms at Nungwa and Pong-Tamale. The Department of Agriculture runs two Government Agricultural Research Stations and a number of experimental farms, as well as a chain of smaller stations, where investigations into local agricultural problems can be undertaken. The Forestry Department has a research programme covering all branches of scientific forestry. Geological mapping and investigations are undertaken by the Geological Survey Department.

There are two West African Regional Organisations with headquarters in the territory of Ghana. The West African Cocoa Research Institute was established in 1944 to take over the work of the former Cocoa Research Station at Tafo. The institute is responsible for research into diseases and pests which affect cocoa, the evolution of better methods of growing cocoa and preparing beans for market. There are sub-stations in Ghana and Nigeria. The West African Timber-Borer Research Unit was established in 1953. It is located at Kumasi in Ghana. The unit concentrates on the problems of ambrosia beetles (pin hole borers) in logs and lumber and on control of damage by other insects to timber trees and sawmill stock. One of the two centres of the West African Building Research Institute, set up in 1952 to undertake research into problems associated with the design and erection of modern and traditional buildings, is at Accra, Ghana.

The headquarters of the West African Inter-Territorial Secretariat, which serves the West African Territorial Council, are at Accra. Its duties include fostering international collaboration with non-British territories in West Africa, organising inter-territorial collaboration on technical subjects, supervising the administration of joint research services and co-ordinating the military and civil aspects of West African defence. The costs of the organisation are borne by the four West African Governments. Also administered by the Secretariat is the West African Standing Advisory Committee for Agricultural Research which has been established to co-ordinate the research policies of the West African Governments and to provide advice and liaison on matters pertaining to agricultural research.

FEDERATION OF RHODESIA AND NYASALAND[1]

The University College of Rhodesia and Nyasaland opened in 1957 with faculties of arts and of science (agriculture, botany, chemistry, mathematics, physics and zoology). From the start it placed emphasis on the provision of research facilities for members of its staff, for guest research workers and for postgraduate students. The staff of the science departments number 34, including six research fellows. The Department of Agriculture, which has an experimental

[1]In accordance with the terms of the Order-in-Council of 1953, setting up the Federation of Rhodesia and Nyasaland (comprising Southern and Northern Rhodesia and Nyasaland), scientific and industrial research is a 'concurrent' subject—i.e. is within the competence of both federal and territorial legislatures, with federal law prevailing in case of inconsistency. For research undertaken in, and on behalf of, Northern Rhodesia and Nyasaland see also RF.P. 4035 of November 1958, *Research and the United Kingdom Dependencies.*

farm of 1,200 acres, has initiated research on crop rotations, dairy husbandry, adaptability of sheep to tropical environment and soil surveys. Research in the botany department centres round three broad subjects, the origin of the African flora, water-relations of plants and soil microbiology. In the chemistry department research has been developed in the alkaloids of Strychnos species, the analysis of trace metals, and reaction mechanisms, and a radio-carbon dating laboratory is being established. The physics department has initiated research particularly in the fields of geophysics and ionospheric measurements. The zoology department has an active programme of research in such fields as insect physiology, parasitology and the comparative anatomy of lymphatic systems in primates.

The college has appointed a Kariba Research Committee to take advantage of the scientific research opportunities presented by the creation of Lake Kariba, particularly in the biological sphere. The college library is establishing a scientific and technical information service to serve the Federation.

Up to the present time, scientific research on an organised basis has been conducted for the most part by the four Governments in the Federation. The mining groups in Northern Rhodesia, however, have considerable research and development laboratories which conduct basic research into problems of mining and metallurgy.

The Research Act, 1959, which provides for the establishment of a Research Foundation and research councils as statutory bodies marks an important step forward in the co-ordination and promotion of scientific and industrial research, including agricultural, veterinary and tsetse research. The functions of the foundation will be to co-ordinate research generally in the Federation, to supervise the programmes of research councils, to initiate research on its own account, and to co-operate with research organisation overseas. The Act empowers the Minister of Economic Affairs to perform certain duties until the foundation has been established. In point of time, the foundation has been preceded by the establishment of an Agricultural Research Council. The foundation and research councils are expected to undertake basic research complementary to that already conducted by the Governments, statutory boards and private organisations.

The Federal Government is responsible for research in agriculture, veterinary science, tsetse and trypanosomiasis control, public health, meteorology, trigonometrical and topographical surveys; and maintains a Scientific Liaison Office in London. The territorial Governments also maintain veterinary research establishments and, in addition, geological survey departments, mining engineering and metallurgical laboratories, irrigation and hydrological research establishments, and road research and materials testing laboratories.

Agriculture

The Federal Government conducts research through the Department of Research and the specialist services of the Ministry of Agriculture. The department is composed of specialist branches and research stations together with an agricultural college. The research stations cover different ecological zones, soil types or farming systems and are eight in number. Their activities are intimately related with the specialist branches of pasture research, animal husbandry, dairying, agricultural chemistry, botany and plant pathology and entomology. All aspects of crop and animal husbandry are studied. A separate department deals with veterinary and trypanosomiasis research in Southern Rhodesia. Tobacco research is conducted by the Tobacco Research Board under the joint sponsorship of government and industry.

Medicine

The Ministry of Health has a research laboratory dealing principally with

problems in malaria and bilharziasis. Research is directed towards immediate health problems, entomology, the biology and ecology of bilharziasis vector snails, the relationship between animal and human schistosomiasis and the study of the natural history of this disease in the African rural population. The Ministry is also investigating nutrition problems with an advisory nutrition council and a small research organisation.

Southern Rhodesia

Certain subjects, which fall within the competence of the Territorial Government of Southern Rhodesia, give rise to scientific research sponsored by the Government departments concerned.

The Division of Roads and Road Traffic undertakes research into the problems of road construction and road traffic which are peculiar to Southern Rhodesia. This research covers the design of traffic signs and the compaction and stabilisation of sands with locally produced bituminous materials. Studies on other stabilising materials such as cement, lime and bituminous emulsions are also being carried out. In addition the tri-axial method of assessing materials for road bases is being developed and modified to meet Southern Rhodesian conditions.

The Department of Geological Survey carries out the systematic geological mapping of the Colony (about 30 per cent of the area of which has by now been mapped in detail), and also studies the mineral deposits. Chemical and mineralogical laboratories are maintained at the survey's headquarters in Salisbury. The results of the work are published from time to time in bulletins and short reports (pamphlets).

The Department of Mines concerns itself with the study of scientific problems relating to the development and working of mineral deposits, roof control, use of explosives, mineral utilisation and the control and abatement of dangerous dusts. It also administers the law relating to mines and minerals. The metallurgical laboratory of the department is largely occupied in applying known techniques to mineral dressing and ore treatment problems of gold ores and numerous other metal and mineral ores. The useful results of this work are put into practice by close co-operation with the mine operators. Some research is done in the direction of flotation of oxidised minerals, solution and precipitation of metals, and the removal of deleterious minerals from the variety of concentrates dealt with. This research side of the work arises from the testing of refractory ores which do not prove amenable to the usual methods of treatment.

The hydrological branch of the Division of Irrigation is responsible for the collection and collation of all hydrological data in Southern Rhodesia and the hydrology of the Zambezi River in collaboration with the Department of Water Affairs, Northern Rhodesia. Research in hydrology is co-ordinated through the Hydrological Co-ordinating Committee which consists of representatives of all territorial and federal departments concerned, the Forestry Commission, and the University of Rhodesia and Nyasaland. Research is in progress on experimental catchments to determine the effect of afforestation on streamflow, run-off and erosion under varying pasture management, evaporation and evapotranspiration and methds of improving infiltration. Further research is being carried out into transport and deposition of sediment.

The Department of Native Engineering is conducting experiments with domestic solar heaters and solar cookers. Assessments of the average power rating of the solar heater and of the simplest production methods for cookers are being made, especially with regard to the cheapest method of producing the necessary reflector. The use of ultrasonic equipment is being examined and a machine has been imported which will shortly be calibrated against concrete

blocks of various Rhodesian aggregates and mixes. This is a non-destructive tester for checking the quality of concrete *in situ*, and other materials used in construction and industry. A laboratory has recently been established and a limited amount of research is being done on power production. Research is also being carried out on economic forms of transport for the development of the country and particularly for suburban traffic. A third scale working model has been produced and is now under test by the Electrical and Mechanical Department of the South African Council for Scientific and Industrial Research.

The Department of Native Agriculture is conducting research into the breeding of indigenous cattle.

Northern Rhodesia

Some research in Northern Rhodesia is organised by departments under the control of the Territorial Government.

Agricultural research and investigation in Northern Rhodesia is carried out at the Central Agricultural Research Station, near Lusaka, and at a number of regional agricultural research stations in the province. The research programme includes experiments with natural and established pastures; land use and soil surveys; plant breeding, particularly with summer wheat and native food crops; soil fertility studies, including trials with the fertilisers, farmyard manure and green manures; and irrigation trials on the Kafue Flats and Barotse flood plain.

Investigations in animal husbandry—now falling under agriculture, although increasingly close touch is kept with veterinary services at their Mazabuka Research Station—are concerned mainly with the nutrition and breeding of indigenous Zebu type cattle, while the introduction of improved strains of poultry is also receiving attention.

The Department of Game and Fisheries administers the Northern Rhodesia Division of the Joint Fisheries Research Organisation. Research is conducted into the biology of fish and general aquatic fauna of the waters of the territory. Fish farming, fishing methods and processing of fish products are also being investigated.

Faunal investigations into special problems are conducted by specialists from time to time.

Geological research goes hand in hand with regional mapping by the Geological Survey Department on the one hand and the mining exploration of the large mining groups on the other. It comprises mainly mineralogical, petrological and geochemical research, but includes also a certain amount of field research in basic problems.

At the present time the Geological Survey is concerning itself mainly with the problems of correlation, the investigation of the age of granites in the territory and the examination of graphite deposits. In conjunction with universities, geochemical research and investigation of the structure and mineral associations of pegmatites is being undertaken.

The two large mining groups continue to carry out research into problems affecting the industry, particularly problems in the metallurgical field.

Research into the medical aspects of pneumoconiosis and related diseases of the chest is carried out by the Pneumoconiosis Medical and Research Bureau. The three main categories of such research are epidemiological, pathological and animal experimental studies.

The work of the newly established research laboratory of the Mines Department is mainly concerned with the study of the fine injurious dust produced in different mining operations, together with a comprehensive dust survey on the Copperbelt mines, which started in 1959. The X-ray diffraction method (Geiger counter and photographic technique), the use of various dust sampling instru-

ments, optical and electron microscopy, form an essential part of the research programme. Apart from this, an appreciable amount of time is spent on the supervision of various projects for dust suppression carried out in collaboration with the mines. The electron microscopic study of biological specimens and lung tissues, and their analysis by the X-ray diffraction method, is the joint work of the Pneumoconiosis Medical and Research Bureau and the research laboratory of the Mines Department.

The main functions of the materials laboratory of the Roads Branch are the design of road foundations and surface treatment, including the execution of all necessary soil tests and subsequent control during construction, but some limited experimental work with low-cost surfacing is also being undertaken.

Research in the social sciences in Rhodesia and Nyasaland has been carried out by the Rhodes-Livingstone Institute (RLI), headquarters of which have, since 1938, been in Lusaka. The results are to be found in the various series of RLI publications (the journal, the papers, the conference reports, the communications and books), which enjoy a high scientific reputation in academic and other centres throughout the world. Rural studies at present in progress include field investigations in social anthropology, in economics, and in human geography. Topics in urban research include absenteeism and labour turnover in Northern Rhodesia and Southern Rhodesia, the social and economic composition of African urban areas in Northern Rhodesia and Nyasaland, and the absorption of European immigrants in Southern Rhodesia from a social psychological point of view. If research being carried out by affiliates of the RLI is included as well as projects being undertaken by its own staff, then the Indian element in Northern Rhodesia is also represented in the scope of the institute's studies. One institute affiliate is surveying something of the social and economic structure of the Asian community in Northern Rhodesia; another affiliate is analysing the early effects of missions in various fields in Northern Rhodesia; another, who is trained in agricultural economics, is studying various present and historical aspects of African trade marketing. At the institute's headquarters in Lusaka various research projects in comparative sociology are facilitated by considerable library resources. Institute conferences, which are held at frequent intervals, provide excellent opportunities for the exchange of ideas between research workers and Government and other officials, especially in applied social and economic research, which at present accounts for a large part of the institute's activity.

Forest research is concerned with silviculture, particularly the introduction of exotic tree species and the regeneration of the indigenous woodlands of the territory. This research is carried out at Research Headquarters Laboratories at Kitwe and at field research stations at Samfya, Ndola and Choma. In addition there are small trial plots in most of the provinces of the territory under supervision of the silviculturist. A utilisation division has been in existence since early 1958 and is carrying out research into the improvement and utilisation of local timber with special reference to the requirements of the mining industry.

Nyasaland

Most of the scientific research carried out at present in Nyasaland is undertaken within the organisation of Government. The Agricultural Department has a main research and experimental station at Chitedze, near Lilongwe in the Central Province; a station at Makanga in the Lower River that deals with cotton breeding, irrigation practices and general crops; and a station at Bvumbwe, in the Southern Highlands, that deals with tung, coffee, fruit and mixed farming. In addition there are smaller agricultural research stations at Tuchila, in the Southern Province, at Chitala and Mwera Hill, in the Central

Province, and Mbawa, in the Northern Province. The Tea Association has recently taken over responsibility for all research in tea. During the past seven years, the Department of Veterinary Services, with its research laboratory at Blantyre, has undertaken applied research on a limited scale into such problems as contagious abortion, Q-fever, clostridial infections and the techniques of rapid rabies diagnosis. Academic research as such is not undertaken; field research, except into trypanosomiasis, is still hindered by lack of available staff. The laboratory offers a versatile diagnostic service. The Department of Forestry has a Silvicultural Research Station in Chongoni Forest near Dedza in the Central Province, and experimental plantations throughout the country. It also has certain facilities for timber research and investigation at its sawmill at Blantyre. A Joint Fisheries Research Organisation has been working under the auspices of the Governments of both Northern Rhodesia and Nyasaland with a station at Nkata Bay, in the northern part of Lake Nyasa.

Where engaged on primary geological mapping, the work of the Geological Survey Department is in the nature of research and, in addition, specific research is in progress on carbonatites and related structures, which occur mainly in southern Nyasaland, both from the economic and purely scientific aspects. A small amount of research work has been carried out in Nyasaland by members of the Institute of African Geology of Leeds University in the United Kingdom.

STANDARDS ORGANISATIONS

The British standards movement, which originated in the United Kingdom in 1901, has helped to create national standards bodies in many other countries, and has now taken its due place in a world-wide movement aimed at raising productive efficiency.

The main function of this movement is to set up and maintain standards of quality, fitness for purpose, and performance for a multifarious and constantly growing range of items used throughout industry. But the work goes further, and has been summed up as covering the three 'S's—simplification, standardisation and specialisation—which together make for a higher national standard of productivity.

Although the British Standards Institution (BSI) did not receive its Royal Charter until 1929 or its present name until 1931, the main character of the institution and its line of work were decided in 1901. It is a voluntary body formed and maintained by industry, approved and supported by the United Kingdom Government, which aims at the preparation and publication of technical standards to assist industrial progress.

One of the objectives laid down in the articles of the British Engineering Standards Association (out of which BSI grew), was the establishment of committees which were the precursors of later national bodies in overseas countries, including Commonwealth countries. By 1926, no fewer than 18 countries had established national standards bodies. At a subsequent international conference, an organisation entitled the International Federation of National Standards Bodies, but usually spoken of as the International Standards Association (ISA), was set up, of which BSI was a member until 1939, when ISA ceased to function.

In 1944, a United Nations Standards Co-ordinating Committee (UNSCC) was formed, with offices in London and New York. This was established on a permanent footing in 1946 as the International Organisation for Standardisation (IOS), with headquarters in Geneva.

There are now independent standards organisations in most member countries of the Commonwealth.

Canada

In 1919, as a result of a joint effort of the Canadian Advisory Committee of the Institution of Civil Engineers and the Canadian Honorary Advisory Council for Scientific and Industrial Research, a standards body was formed and incorporated under Dominion charter as the Canadian Engineering Standards Association (CESA). For some years this was the only standards body on the American continent comparable with the United Kingdom prototype. The term 'Canadian Standard' was legalised at the end of the first world war by an Act of the Canadian Federal Parliament and in 1944, under the Act, the CESA became the Canadian Standards Association. It now covers not only engineering products, but textiles, metals, chemicals, agriculture, pulp and paper, and other commodities. Its approvals service also ensures that all electrical apparatus and appliances comply with Canadian standards of safety and performance.

Australia

Australia has a voluntary standards organisation similar in constitution to the BSI. The first step was the foundation, in 1922, of the Australian Commonwealth Engineering Standards Association. Five years later another body, called the Australian Commonwealth Association of Simplified Practice, was formed. In 1939, these two organisations were amalgamated under the title of Standards Association of Australia. With the change of name, the functions of the Association were extended to other industries besides engineering.

New Zealand

A local committee of the British Engineering Standards Association was formed in New Zealand in 1920. An active part was taken in its formation by the UK Trade Commissioner for New Zealand, the chairman of the New Zealand Advisory Committee of the Institution of Civil Engineers, and the engineers of the Public Works Department at Wellington. This committee was superseded in 1932 by the New Zealand Standards Institution, which operated under the Society of Civil Engineers. Four years later this body was wound up, and a new organisation, the New Zealand Standards Institute, was formed. Today it is a statutory body, with divisions embracing engineering, textiles, chemicals and domestic commodities.

South Africa

A local committee was formed in South Africa in 1908 at the suggestion of the then President of the Transvaal Institute of Mechanical Engineering. In 1917, it agreed to act as the South African branch of the UK Engineering Standards Committee of the British Engineering Standards Association, and it proposed that the Union Government should adopt British standards, with such modifications as it might recommend, as the official standards for South Africa. In 1934, the South African Standards Institution was founded as a voluntary organisation, very much on the lines of the BSI. In 1945 two new statutory bodies were set up under an Act of the Union Parliament—the Standards Council, a co-ordinating body, to which the Standards Institution had the right to nominate two members; and the South African Bureau of Standards, working directly under the Standards Council. In August 1956, the South African Bureau of Standards (SABS) was amalgamated with the Council for Scientific and Industrial Research (CSIR). The Standards Council was abolished and the administering body for the merged organisation is the Council for Scientific and Industrial Research, enlarged to consist of 14 members, representing science, industry and standards.

India

The Institution of Engineers (India) set up in 1919 a local committee to act as agents for British Standards. During the inter-war years the committee advised the British Engineering Standards Association and the BSI, and was responsible for promulgating British standards throughout India, including what is now Pakistan. In 1946, the Indian Standards Institution was founded on lines similar to those of the BSI.

Pakistan

In December 1947, the first Pakistan industries conference was held, when it was recommended that a standards organisation should be formed. Steps have since been taken by the Government of Pakistan to set up, under the Department of Supply and Development, a Pakistan Standards Institution, and the first meeting of the General Council was held in January 1951.

For the scientific assessment of raw materials and finished products of the country by standard technological and analytical methods, the Government of Pakistan established the Central Testing and Standards Laboratories at Karachi early in 1951. Tests and analyses on all materials are carried out in accordance with the standard specifications adopted by various countries. The laboratories are equipped with standard testing instruments and machines and a well-furnished library containing relevant reference books, periodicals and journals. A similar laboratory has recently been established at Dacca in East Pakistan.

Some equipment for both the laboratories was supplied by the United Kingdom Government under the Colombo Plan.

Federation of Rhodesia and Nyasaland

The Standards Association of Rhodesia and Nyasaland, established in 1957, evolved from a local committee of the British Standards Institution set up in 1950 to foster the use of standards in Central Africa. The association is affiliated to the BSI and follows British practice to the extent that local conditions permit. The governing body is a General Council comprising representatives of the Federal and Territorial Governments, local authorities, professional institutions, industry and commerce. The establishment of standard specifications and codes of practice is assigned to Industry Councils, each with their own technical committees. The association is financed in part by subscriptions from members and in part by the four Governments in the Federation.

THE FRAMEWORK OF COLLABORATION

Means of scientific collaboration within the Commonwealth range from permanent institutions, such as the learned societies, the Commonwealth Agricultural Bureaux and the Commonwealth Scientific Liaison Offices, through regular Commonwealth Scientific Conferences, Standards Conferences and schemes for the interchange of scientists to *ad hoc* meetings on specific subjects, e.g., nuclear energy or cables standards.

The Commonwealth Agricultural Bureaux

The Commonwealth Agricultural Bureaux serve as clearing houses of information and intelligence centres for scientists and research workers in agriculture and forestry, not only throughout the Commonwealth but, increasingly, throughout the world.

History and Development: The Commonwealth Agricultural Bureaux Organisation is the result of growth and adaptation. Beginning in the field of entomology, it has expanded its services to all branches of agricultural science and forestry, and is today one of the best of many examples of organisations helping scientists in Commonwealth countries to contribute to the solution of problems, both within the Commonwealth and in the world as a whole.

An Entomological Research Committee (Tropical Africa), formed in 1909 with headquarters at the Natural History Museum, South Kensington, London, was expanded in 1913 into the Imperial Bureau of Entomology, the chief functions of which were (*a*) to assist in the 'identification of all injurious insects sent in by officers attached to departments of Agriculture and Public Health in countries of the Empire'; (*b*) to issue 'a monthly periodical, giving summaries of current literature, both British and foreign, dealing with noxious insects, whether agricultural pests or disease carriers'. This bureau, the prototype of the institutes and bureaux of today, was managed by a committee representing its Commonwealth scope and responsibilities. Administrative supervision remained with the Secretary of State for the Colonies until 1933, when the Commonwealth Bureaux Executive Council took over its administration.

An Imperial Bureau of Mycology, similar in functions, control and methods of finance to that of Entomology, was started at Kew in 1920, following the approval of the Imperial War Conference of 1918.

The valuable services which these bureaux had been rendering to pathologists soon led to a recommendation by the Imperial Agricultural Research Conference of 1927 for the establishment of eight bureaux in eight selected branches of agricultural science. In 1928, the Governments of the Commonwealth countries appointed an organising committee to define the functions of the new bureaux and to advise on their location, finance and administration. On 1st April, 1929, the Executive Council of the Imperial Agricultural Bureaux came into being and the eight bureaux were opened during the financial year 1929–30. In 1933, the Bureau of Entomology and the Mycological Bureau passed to the control of the Executive Council and were given the name of institutes to distinguish them from the eight bureaux. The Farnham House Laboratory, an offshoot of the Bureau of Entomology, known first as the Bureau, and now as the Institute, of Biological Control, also came under the control of the Executive Council; in 1940 it was moved to Canada. The British Commonwealth Scientific Conference, in 1936, recommended the addition of two bureaux—of dairy science and forestry, both of which were started in 1938. In that year the organisation also began field expeditions to South American countries to collect indigenous varieties of potato, and set up a Commonwealth Potato Collection at Cambridge, now transferred to the United Kingdom Agricultural Research Council.

The organisation became known as the Commonwealth Agricultural Bureaux on 1st January, 1948, this revised title being deemed to represent more accurately the free association of participating Governments.

Organisation and Administration: The administration of the bureaux is in the hands of the Executive Council, which comprises one representative from each of the contributing countries, the UK dependencies being considered as one unit for this purpose. The Executive Council, through its individual members, is responsible directly and equally to all Governments. The agreements on finance, and the proportions in which finance is provided, are agreements between Governments co-operating for a common and defined purpose.

The Executive Council is assisted on the scientific side by a Scientific Advisory Committee. Close touch is maintained between Commonwealth countries and individual bureaux by a system of 'official correspondents', each country nominating a scientist who specialises in a bureau's subject to act in this capacity. To provide a similar link in the administration, there is a liaison officer in each country, having functions on the administrative side parallel to those of the official correspondents for individual bureaux on the scientific side.

Each bureau is located at a research institute working in the same scientific field.

The individual organisations at present controlled by the Executive Council, and the institute with which it is associated, are given below. All except the Bureau of Biological Control are situated in the United Kingdom.

Institutes: Commonwealth Institute of Entomology, British Museum (Natural History), Cromwell Road, London, S.W.7.

Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey, England.

Commonwealth Institute of Biological Control, Science Buildings, Carling Avenue, Ottawa, Canada.

Bureaux: Commonwealth Bureau of Animal Breeding and Genetics, Institute of Animal Genetics, University of Edinburgh, King's Buildings, West Mains Road, Edinburgh, Scotland.

Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey, England.

Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeen, Scotland.

Commonwealth Bureau of Dairy Science and Technology, National Institute for Research in Dairying, Shinfield, Reading, England.

Commonwealth Bureau of Forestry, Imperial Forestry Institute, South Park Road, Oxford, England.

Commonwealth Bureau of Helminthology, The White House, 103 St. Peter's Street, St. Albans, Hertfordshire, England.

Commonwealth Bureau of Horticulture and Plantation Crops, East Malling Research Station, East Malling, Kent, England.

Commonwealth Bureau of Pastures and Field Crops, Hurley, nr. Maidenhead, Berks, England.

Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge, England.

Commonwealth Bureau of Soils, Rothamsted Experimental Station, Harpenden, Hertfordshire, England.

The funds for the Commonwealth Agricultural Bureaux are provided by contributions from the Governments of member countries. There are four different funds—for the Institute of Entomology; for the Mycological Institute; for the Institute of Biological Control; and for the Headquarters, Sales and Bureaux.

The Executive Council has control of these funds and can borrow temporarily from one to the other, provided the amount is repaid; it cannot transfer permanently from one fund to another.

Methods: The institutes and bureaux collect their information by the constant scrutiny of scientific literature in all languages; the information is then classified and the essence of it published in the indexed abstract journal which each one issues. This regular service is supplemented by occasional publications giving reviews of published work on particular problems or experiments, and by answering inquiries from scientists.

The Institute of Entomology maintains no collection of its own, as its work is very closely integrated with the British Museum. The Mycological Institute keeps its own working herbarium, which at present contains over 50,000 specimens of fungi. It also maintains the United Kingdom national collection of type cultures for all fungi except medical fungi, timber rotting fungi and yeasts.

Another method by which the Commonwealth Agricultural Bureaux have helped in the dissemination of knowledge in particular fields is by convening conferences for the study of special problems. Examples of such conferences include a specialist conference on tropical and sub-tropical soils, in June 1948, at Rothamsted Experimental Station, and three specialist conferences on mycology, entomology and animal breeding, in London during July 1948. Specialist conferences are now confined to entomology and mycology.

Review Conferences: Review Conferences, reviewing the work and usefulness of the organisation, normally take place every five years. They have been held in 1936, 1946, 1950 and 1955. A fifth conference was held in August 1960.

Among other things, the Fourth Review Conference recommended that the Executive Council be given power to develop further co-operation between the institutes and bureaux and foreign governments and international bodies; that greater personal contact between the official correspondents of the institutes and bureaux in the constituent countries be encouraged; that the names of three bureaux be changed—Bureau of Agricultural Parasitology (Helminthology) to Bureau of Helminthology, Bureau of Soil Science to Bureau of Soils, and Bureau of Dairy Science to Bureau of Dairy Science and Technology; that the question of the establishment of a Bureau of Agricultural Economics be further considered in consultation with the International Conference of Agricultural Economists; that a grant be made to the United Kingdom National Institute of Agricultural Engineering (at Silsoe, Bedfordshire) for strengthening the abstracting and information service in that subject; and that the question of establishing a Bureau of Agricultural Engineering be included in the agenda at the next Review Conference.

Scientific Conferences

So far, Commonwealth Scientific Conferences have been held in London in 1936 and 1946, and in Canberra and Melbourne, Australia, in 1952.

These conferences originated from a suggestion made in the 1933 report of the Imperial Committee of Economic Consultation and Co-operation. It was intended that the 1936 conference should be a general one, but this proved impracticable and the discussions were mainly limited to agricultural subjects and in particular to a review of the activities associated with the Executive Council of the Imperial Agricultural Bureaux.

Early in 1945 the Royal Society of London, with the approval of the UK Government, arranged to convene an Empire Scientific Conference during 1946. Since the conclusions reached at such a conference would require a background of official policy and support, it was proposed by the UK Government to the

other Commonwealth Governments that an official scientific conference should be convened in close association with the Royal Society Conference, as well as an investigation into the working of the Executive Council of the Imperial Agricultural Bureaux. Accordingly three conferences were held in the United Kingdom during the summer of 1946.

These conferences were attended by over 100 overseas delegates representing all Commonwealth countries and many of the United Kingdom Dependencies. 'An atmosphere of the greatest cordiality pervaded the proceedings', says the report of the official conference, '. . . and the desire for the fullest co-operation in every possible way was extremely marked. Practically no differences of principle were revealed and complete agreement on most subjects was arrived at with little difficulty. This was no doubt due in large measure to the careful preparation for the conference and to the prominent part played during the preparatory period by the Scientific Liaison Officers in London and . . . Washington. . . .'

The 1952 conference, much smaller than its predecessors, was attended by 34 senior scientists from the Commonwealth countries and an observer from the United States.

At a meeting of the British Commonwealth Scientific Committee in Canada in 1958, it was decided to abolish full-scale Commonwealth Scientific Conferences and to substitute regular meetings of the British Commonwealth Scientific Committee consisting of the heads of the national research organisations of the Commonwealth countries. Such a meeting was held in 1960 in the United Kingdom.

Standards Conferences

The two Imperial Conferences of 1926 and 1930 stimulated the extension and co-ordination of standards work throughout the Commonwealth.

The most important progress was recorded at the conference in 1930, when two committees were formed, dealing respectively with industrial standards and fundamental standards.

These meetings finally recommended that the standards bodies of the Commonwealth countries should maintain regular and systematic consultations with a view to establishing, so far as practicable, uniform standards. They were also recommended to include in the scope of their work codes and rules, as well as standard specifications for materials and apparatus. Emphasis was laid on the importance of each standards body adopting a trade mark or brand, which could be applied under licence to goods which complied with appropriate standards (i.e. certification marking).

Largely as a result of war-time experiences, it was recognised in 1944 that the standards bodies of the Commonwealth countries had reached a stage of development which justified bringing them together in independent conference as soon as possible. It was agreed that a Commonwealth Standards Conference should take place in London in October 1946, and its organisation was undertaken by the British Standards Institution. Representatives of the national standards organisations of the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Eire and Palestine attended. The UK Colonial Office was also represented (the Crown Agents for the Colonies are represented on a number of committees of BSI).

The two main items discussed were the development of certification marking and the influence of the Commonwealth standards bodies in the wider field of international standardisation. Full agreement was reached on the importance of close co-operation between the standards organisations within the Commonwealth, while leaving each organisation to take its own part in the long-term work of co-ordinating national standards with world-wide trends.

A further Commonwealth Standards Conference, held in June 1951, was attended by representatives of the national organisations of the United Kingdom, Canada, Australia, New Zealand, South Africa, India and Pakistan. The conference discussed standard marks in Commonwealth countries and expressed complete agreement on the objective of reciprocal recognition and protection of each other's registered standard marks. While stressing the importance of aligning all Commonwealth standards to the maximum extent, it was recognised that differences of practice rendered this difficult in certain cases, particularly where marks had to be applied in connection with special safety regulations in overseas markets. Note was taken of the procedure being operated between the BSI and the Canadian Standards Association under which BSI were acting as agents in London of the CSA to ensure that electrical equipment received the necessary CSA approval before being shipped from the United Kingdom to Canada. The view of the conference was that this procedure held out promising possibilities for extension to other classes of trade and between other Commonwealth countries.

A further meeting, in lieu of a full conference in Canada which had proved impracticable, was held in New York in June 1952.

The third full-scale Commonwealth Standards Conference was held in January and February 1957 at New Delhi. Subjects discussed included, in the general policy sessions, the effects on Indian standards practice and Commonwealth trade of the Indian Government's decision to adopt the metric system, and, in the technical sessions, standards for electrical equipment, machine tools, electric cables, steel, and the co-ordination of safety requirements for domestic electrical appliances.

The fourth Commonwealth Standards Conference was held in Ottawa in August and September 1959. Further progress was made in problems of inch-metric dimensions in standards, and other topics discussed included schemes of supervision of certification marking, modular co-ordination, consumer protection, alignment of Commonwealth standards for hot-rolled steel sections, and standards for air receivers and cranes.

ABC Conferences: A series of conferences on engineering standards (of particular importance in standardising weapons between NATO countries), involving the United Kingdom, Canada and the United States, have been held since 1945. These are known as the ABC Conferences (America–Britain–Canada). The first was held in Ottawa in 1945. In November 1948, agreements between the three governments on a range of standardised screw-threads and hexagonal bolts was signed in Washington. Further ABC conferences have been held, such as those on screw-threads, pipe-threads, limits and fits, in New York on 2nd June, 1952. Another example of such agreements was that made in Toronto in October 1957, on the use of a single unified procedure for presenting information on engineering drawings.

Scientific Liaison Offices

A feature of the pattern of scientific collaboration during the second world war was the establishment of scientific missions in London by the United States and the Commonwealth countries, and in Washington by the United Kingdom and other Commonwealth countries; the latter subsequently joined together as the British Commonwealth Scientific Office in Washington.

The success achieved as a result of collaboration between scientists from all parts of the Commonwealth stimulated the desire for the continuance of this method of approach in dealing with problems of common interest. In 1943 the Report of the British Commonwealth Science Committee set up by the Royal Society of London, stressed the desirability, on the return to peace-time

conditions, of establishing machinery for permanent scientific liaison between Commonwealth countries, for extending existing information services and improving facilities for personal contact between scientists and for the interchange of scientific staff.

Immediately after the war the Scientific Conference held in London in 1946 recommended that the Washington Office be continued in peace time, and in addition that a British Commonwealth Scientific Office (BCSO) be set up in London. These recommendations were approved by all the Commonwealth Governments. Since 1948 the Scientific Offices in London of the Commonwealth countries have been located in the same building (Africa House, Kingsway, London, W.C.2), and are closely associated with the Overseas Liaison Division of the United Kingdom Department for Scientific and Industrial Research.

The function of these offices is to act as points of contact between the scientific organisations of the member countries for the communication of scientific ideas and information. For instance, following resolutions passed at the British Commonwealth Scientific Conference of 1946, the offices have started a Commonwealth index of translations into English of published scientific papers, reports and journal articles. Each country has an agency, which collects details of translations made by organisations in that country which are co-operating with the scheme. The information is then passed to BCSO (London), where index cards are prepared to send out to the agencies within the Commonwealth.

Interchange of Scientists

Other examples of Commonwealth collaboration in scientific research was provided by those schemes, some of them privately financed, which assist the interchange of science graduates and lecturers between Commonwealth universities and the promotion of research projects.

The British Council, for example, which has so far established representations in five Commonwealth countries, does much to assist this process in six ways:

1. It makes travel grants for interchanges between universities in the United Kingdom and in the rest of the Commonwealth. These grants are extended to:
   (*a*) University teachers on recognised study leave.
   (*b*) Distinguished scholars invited by universities for short visits.
   (*c*) Postgraduate university research workers holding research grants.
2. It awards postgraduate research scholarships tenable in the United Kingdom for ten months or, in special cases, for a longer period. These scholars have all their expenses, including travel, covered by their scholarships.
3. It encourages, by grant and otherwise, attendance at selected scientific congresses in the United Kingdom and in other Commonwealth countries.
4. It assists the United Kingdom programmes of visiting Commonwealth scientists and others.
5. It provides short courses in the United Kingdom on engineering and scientific subjects in which the United Kingdom has made notable recent progress.
6. It places and supervises, on behalf of the United Nations and the Commonwealth Relations Office, all holders of United Nations and Colombo Plan awards for study in the United Kingdom.

The Nuffield Foundation, established in April 1943 by Lord Nuffield to promote the advancement of education, health and social well-being, sponsors and finances scientific, medical and sociological research projects in the United

Kingdom and also in other Commonwealth countries and provides grants for fellowships and scholarships for Commonwealth students. Its schemes include fellowships for doctors, scientists and others from other Commonwealth countries to come to the United Kingdom for specialised higher training and experience. Selection committees, set up in Australia, New Zealand and South Africa, allocate travelling scholarships.

In the second five years of its existence the foundation extended the scope of its help to cover direct support for research outside the United Kingdom. The committees in Australia, New Zealand and South Africa (currency restrictions prevented similar action for Canada) were asked to recommend research projects deserving support.

A Commonwealth Bursaries Scheme was initiated on 27th July, 1953, jointly by the Royal Society of London and the Nuffield Foundation. The Nuffield support is complementary to its already established programme of fellowships and grants mentioned above.

The object is to provide facilities for increasing the efficiency of investigators of proven worth by enabling them to pursue research, learn techniques, or follow other forms of study where the physical or personal environment overseas in the Commonwealth is peculiarly favourable. The scheme was at first operated for an experimental period of five years, during which the Nuffield Foundation provided £5,000 a year for bursaries to United Kingdom scientists wishing to go to overseas Commonwealth countries and to scientists of one part of the overseas Commonwealth wishing to go to another. The Royal Society contributed £2,500 for movement in any direction within the Commonwealth, including to the United Kingdom. It is hoped, however, that funds may be obtained from other sources, particularly from overseas, to make possible the full development of the scheme, especially by increasing the proportion of bursaries for scientists of overseas Commonwealth countries who wish for facilities in the United Kingdom. Dr. D. C. Martin, Assistant Secretary to the Royal Society, is secretary to the joint committee which administers the scheme.

The Rutherford Memorial Scheme was launched by the Royal Society of London in 1950 as a suitable memorial to Lord Rutherford of Nelson, perhaps the greatest Commonwealth scientist of the twentieth century. An appeal for funds was launched simultaneously in the United Kingdom and in other parts of the Commonwealth, which met with an encouraging response. So significant was Rutherford in the context of Commonwealth science that the words used by the then President of the Royal Society, Sir Robert Robinson, in launching the appeal, deserve quotation in full:

'Those who knew Rutherford will never forget him. So long as men study atoms, they will remember his achievements as they do those of Newton, Dalton, J. J. Thomson and others who laid the foundations on which scientists build. The record of achievement of such brilliant lives forms the most enduring memorial; yet it has always been fitting to pay public homage to the memory of a great man, especially in a manner which helps others to continue his work.

'Rutherford was born at Nelson, New Zealand, on 30th August, 1871. He was a student first at Christchurch, New Zealand, and then at Cambridge, England. He was Professor successively at Montreal, Manchester and Cambridge. He died on 19th October, 1937, and was buried in Westminster Abbey.

'Rutherford was the father of nuclear physics. The inspired interpretation of his observations, and his genius for experiment, led to practically all we know about the structure of atoms. He developed the theory of the atom in Montreal; the final convincing proof he provided at Manchester, where he showed conclusively that an atom contains a central nucleus which is the seat of intense electric forces. Through his investigations of the structure of the nucleus itself, he founded in the Cavendish Laboratory, Cambridge, the modern

science of nuclear physics. He always worked on problems at the limits of human knowledge, inventing and developing the methods used for observation in these new fields. His uncanny judgment and his sheer energy made him the greatest physical scientist of his age. The practical results of his work—atomic energy and its by-products—followed a lifetime of devotion to the pursuit of knowledge.

'It is probable that Rutherford will be remembered equally for his great powers of inspiring others. By his personality and forceful leadership his colleagues and students were stimulated to reach heights of achievement which they could not have reached alone. From his laboratories came many of the world's leaders of physical science today: all countries have felt the impact of his inspiration through the influence of scientific men trained by him. Moreover, he did not confine his interest to purely academic science. For many years, as chairman of the Advisory Council of the Department of Scientific and Industrial Research, he gave wise guidance to the Government in the encouragement and extension of the use of the scientific method in industry.'

A special committee set up by the Council of the Royal Society decided that the memorial should take two forms:

(1) Rutherford Scholarships tenable for three years to be awarded to postgraduate students within the Commonwealth, for research in the natural sciences with a preference for experimental physics. A scholar is normally required to carry out his research in an institution in some part of the Commonwealth other than that in which he graduated.

(2) A Rutherford Memorial Lecture, to be delivered at intervals at selected university centres in the Commonwealth overseas, at least one in three to be given in New Zealand.

Rutherford's correspondence has been collected together and copies of this will be placed in those universities with which he was associated, namely, Canterbury College in New Zealand, McGill University in Canada, Manchester and Cambridge Universities in England.

Athlone Fellowships, which commemorate the Earl of Athlone's term of office as Governor-General of Canada from 1940 to 1946, were inaugurated by the United Kingdom Government in 1950. They are awarded annually by the UK Government to enable Canadian engineering graduates to take postgraduate training in the United Kingdom.

The fellowships fall into two groups:

1. Twenty-eight are available for graduates on completion of a bachelor's or higher degree.
2. Ten are available for engineers who have already spent some time in industry.

They provide for a period of two years in the United Kingdom and are awarded on the understanding that their holders afterwards return to Canada to follow their careers. Candidates receive advice on their proposed course of training from the Athlone Fellowship Committee in the United Kingdom, representative of industry, the universities, and the United Kingdom Government, and arrangements for their reception and placing are supervised by this body. The committee also concerns itself with the welfare and progress of the Fellows throughout their stay in the United Kingdom. The Fellowship Grants cover (1) cost of travel from home to the United Kingdom and back, and within the United Kingdom as may be approved; (2) cost of approved university or college tuition fees; (3) maintenance allowance payable quarterly in advance, not subject to United Kingdom income tax or national insurance contributions.

Post-Doctorate Fellowships, inaugurated by the Canadian National Research

Council in 1948, are also granted to research students from other Commonwealth countries as well as to those from foreign countries.

In addition to these schemes are others run by large industrial groups in the United Kingdom which include Commonwealth students among those offered facilities in their research departments.

Nuclear Energy

Commonwealth collaboration in atomic energy is close and widespread. Though Britain and Canada are at present most advanced, other member countries have built or are building research reactors and are investigating possibilities of developing the peaceful uses of nuclear energy. Australia and South Africa, besides Canada, are producers of uranium, India contains large deposits of thorium, and is proposing to build a nuclear power station.

The Combined Development Agency (representing the Governments of Canada, the United Kingdom, the United States) has current contracts for the supply of uranium with Australia and South Africa, while the United Kingdom has direct contracts for this purpose with Canada, Australia and the Federation of Rhodesia and Nyasaland and has made offers to buy concentrates containing uranium from small producers in the Federation and in the United Kingdom Dependencies.

The United Kingdom and Canada have agreements with India. Britain supplied fuel elements for Apsara, the first Asian reactor (outside the Soviet Union) at Bombay, and Canada assisted with the setting up in India of a high-power research reactor at Trombay, similar to the NRX reactor in Canada. UK firms have also supplied a research reactor to the Australian Atomic Energy Commission at Lucas Heights, near Sydney. Equipment for nuclear work in Pakistan has been supplied by the United Kingdom and Canada under the Colombo Plan.

Australia, New Zealand and Canada have co-operated in nuclear weapon trials at Woomera and elsewhere.

But perhaps the greatest Commonwealth link at present in this field lies in the interchange of students and staff between the various universities and nuclear energy establishments in Commonwealth countries, which has gone on since the earliest discoveries. Britain, in particular, with its Isotope, Reactor and Operations Schools, is doing much to share its technical knowledge with other Commonwealth countries.

A conference of Commonwealth nuclear scientists was held in Britain in 1958.

[For fuller information see R.3928 *Nuclear Development and Co-operation in the Commonwealth,* and RF.P.4192 *Nuclear Energy in Britain.*]

Space Research

Though no Commonwealth country has as yet a space research programme comparable to those of the United States and the Soviet Union, there are a number of instances of Commonwealth co-operation on limited projects. Over 20 of the United Kingdom *Skylark* upper atmosphere rockets, as well as the second stage vehicle, *Black Knight,* have been successfully fired from the Woomera testing grounds in Australia. A United Kingdom team of scientists interested in space exploration visited Australia in June 1960 with a view to collaboration in joint projects, and in September 1960, the UK Minister of Aviation visited Australia and Canada for discussion of possible joint projects. The United Kingdom, Canada and Australia are to provide instrumentation for satellites to be launched in the United States.

An interesting joint United Kingdom–Australia astronomy project is the stellar intensity interferometer at Narrabi, New South Wales. The project will

be carried out jointly by the Universities of Manchester (England) and Sydney (Australia). The United Kingdom Department of Scientific and Industrial Research has granted £A 100,000 towards the cost.

The Australian CSIRO retained the London consulting engineers, Freeman Fox and Partners, to prepare designs and specifications for a £A 750,000, 210-ft.-diameter steerable radio telescope to be built at Parkes, New South Wales. The electrical drive and control gear are being supplied by the United Kingdom firm, Associated Electrical Industries Ltd.

The United Kingdom Overseas Research Council

An important step towards further Commonwealth collaboration was taken in July 1959 when the United Kingdom formed an Overseas Research Council, under the general control of a Committee of the Privy Council. Its principal functions are to formulate policy in respect of scientific research for overseas, and to co-ordinate advice and assistance on research matters provided by the United Kingdom research councils. Matters concerning scientific development in the United Kingdom dependencies, in Commonwealth countries and in countries outside the Commonwealth can be referred to it. The council thus provides a central point to which Commonwealth Government and research institutions can refer for advice and information, and advise generally on United Kingdom co-operation in scientific research overseas.

Commonwealth Institute of Social Research

It was announced in February 1960 that a Commonwealth Institute of Social Research is to be established in Ottawa as a centre for fundamental research in the social sciences and humanities and will serve the Commonwealth as a whole. The executive of the institute is entirely Canadian and is composed largely of professors. Officers include: the Hon. Mark R. Drouin, honorary president; Dr. John E. Robbins, president; and Mr. Bernard Ostry, executive secretary-treasurer. A small research and administrative staff will be appointed and a library and statistical laboratory are to be set up. Plans include the raising of a $C 10 million endowment fund, to produce the required $C 500,000 a year. It is hoped that the institute will bring to Canada leading Commonwealth scholars, and that it will enrich and strengthen cultural development throughout the Commonwealth.

The economic and social development of the dependent territories for whose administration the United Kingdom is still ultimately responsible involves research into a wide range of problems. Research has therefore become an integral part of the United Kingdom's long-established colonial policy of promoting self-government in the dependencies on stable economic and social foundations.

The passing of the Colonial Development and Welfare Act, 1940, was the starting point of a new phase in colonial research. The Act provided, among other things, for the expenditure in any one year on 'research and inquiry' of such sums not exceeding £500,000 as Parliament might approve as part of an expanded programme of development as a whole. The association of the grant with the general purposes of the Act made it possible for the Colonial Research Committee, which was created in 1942, to advise on the expenditure of the fund with a view to co-ordinating the whole range of colonial studies, and to decide (*a*) that the money should be spent on financing investigations in any field of scientific, economic or social activity where knowledge was essential in the interests of the dependent territories, and (*b*) that it was to be available both for schemes initiated by colonial governments and for those originating in the United Kingdom.

As a result of these decisions, the administrative machinery in the United Kingdom for colonial research was overhauled—a number of expert advisory committees were created, and a Research Department was established within the Colonial Office itself. No immediate large-scale expansion of research projects was possible, owing to the incidence of war, but a good deal of exploratory work was done, and plans were made both for extending the number and scope of the research institutes in the dependent territories and for establishing conditions which would attract qualified scientists to the colonial field.

After the war, the position was further improved by the Colonial Development and Welfare Acts of 1945 and 1950, which increased the annual maximum disbursement ceiling under the Acts, first to £1 million and subsequently to £2·5 million. The Act of 1945 also provided for a total sum of £120 million for all types of schemes made under it in the ten years ending 31st March, 1956; and this sum was increased to £140 million by the 1950 Act. The life of the Acts was extended to 1960 by the 1955 Act, which also provided for a further sum of £80 million to be spent on colonial development and research. The 1959 CD & W Act extended the life of the previous Acts up to 31st March, 1964, made a further sum of £95 million available, and cancelled the annual limit on expenditure.

By March 1960, the sum committed to research schemes from this total amounted to some £18·7 million, out of which nearly £16 million had been actually issued. About half as much again has been provided by the governments of the United Kingdom dependencies, in cash or in kind, towards the cost of these schemes.

Organisation of Colonial Research

The United Kingdom Secretary of State for the Colonies is responsible to Parliament for ensuring that any schemes made under the Colonial Development and Welfare Acts are for purposes calculated to promote the development of the dependent territories and the welfare of their peoples, and that any money provided for these purposes is wisely and economically spent. He is assisted in the discharge of these duties by ten specialist advising bodies, the Research Department of the United Kingdom Colonial Office, and qualified scientists working in the field.

Specialist Research Advisory Committees: In 1960, the advisory committees were:

Committee for Colonial Agricultural, Animal Health, and Forestry Research;
Colonial Economic Research Committee;
Colonial Fisheries Advisory Committee;
Colonial Medical Research Committee[1];
Colonial Pesticides Research Committee;
Colonial Products Council;
Colonial Road Research Committee;
Colonial Social Science Research Council;
Tsetse Fly and Trypanosomiasis Committee; and
Anti-Locust Research Centre.

Some of these committees have specialist sub-committees for dealing with particular aspects of the work of the main committee, e.g., sub-committees for malaria, leprosy, helminthiasis and mollusc-borne diseases and a working party on sickle cell anæmia set up by the Medical Research Committee,[1] and sub-committees for soil protection, cocoa research, stored products research and crop protection of the Committee for Colonial Agricultural, Animal Health and Forestry Research.

The majority of the members of all the committees and sub-committees are eminent British scientists.

The functions of the specialist committees are to advise the Secretary of State on the best use of funds in the field of research in which they are particularly concerned, to consider and give expert advice on proposals for research plans and projects initiated by colonial governments, and to suggest appropriate schemes of research themselves. The committees also study and advise on research projects initiated by unofficial organisations, for it is recognised that the scientific needs of the dependencies are too wide and complex to be the preserve of governments only, and that action in this field cannot be too widespread and diverse.

Members of the committees maintain contact with institutions, teams and individuals at work in the dependencies, both by paying frequent visits to the places where research projects are being carried out and by welcoming overseas research workers at their meetings in London, so that first-hand progress reports may be made. All proposals initiated by the committees are referred to the Governors of the territories where the schemes are to be put into effect, before any action is taken. This is done to find out whether a colonial government approves of a scheme suggested and is willing to co-operate in its execution.

Proposals for research in subjects not dealt with separately by the specialist committees are dealt with in various ways, for example, advice on housing and building is obtained through a liaison officer who, with a small staff, is attached to the building research station of the United Kingdom Department of Scientific and Industrial Research. Similarly, a research fellow has recently been appointed to advise on tropical paint problems. Other subjects such as industry and engineering, meteorology and water pollution, are referred to other specialist departments in the United Kingdom for advice, in order to ensure that no important point of inquiry is overlooked by reason of the fact that it does not fall within the scope of one or other of the specialist committees, as well as to maintain a proper balance of effort and funds.

Research Department of the Colonial Office: Responsibility for action on research schemes recommended for financial assistance by the specialist committees rests with the Research Department of the Colonial Office, which was

[1] In 1960 it was announced that a Tropical Medicine Research Board was to be set up to take over the work of the Colonial Medical Research Committee.

established in 1945 within the Economics Division under the supervision of an Assistant Under-Secretary of State. The duties of the department (which accepts and acts upon advice given by the specialist committees and their sub-committees) include translating the proposals of colonial governments and of the specialist committees into effective schemes, agreeing such schemes with the Treasury of the United Kingdom (whose concurrence is needed in all such matters), and making the necessary arrangements for putting into effect those schemes which involve studies in the United Kingdom or comparatively short visits to the dependent territories. Administrative responsibility for schemes that involve lengthy investigations or applied research overseas is usually vested in the colonial government concerned, which receives a grant to cover the whole or part of the cost, depending on a wide variety of circumstances.

Scientific Direction: While the administration of research schemes rests with the United Kingdom Colonial Office and the various colonial governments (which also supervise and control such matters as the erection and equipment of laboratories and the provision of living accommodation for overseas research workers), scientific direction is left, to the greatest possible extent, in the hands of qualified scientists, who discharge their responsibilities in a variety of ways, e.g., as directors of local or regional research institutes or commodity stations in the dependent territories, as controllers of the technical departments of colonial governments, as heads of United Kingdom research organisations or of university departments both in the United Kingdom and in the dependent territories, and as leaders of small teams of experts carrying out short-term investigations overseas.

Types of Research Project

Research projects are organised in a number of different ways, depending on the nature of the investigations and the extent to which their results are likely to be of immediate or long-term use. No hard-and-fast line can be drawn between the various types of scheme, but, in general, they may be classified as follows:

1. Schemes organised on a regional basis, for example, the East African Institute for Medical Research, the West African Tuberculosis Research Unit, the East African Agriculture and Forestry Research Organisation, the East African Veterinary Research Organisation, and the West African Institute for Trypanosomiasis Research. The number of regional research institutes has steadily increased, since schemes organised regionally can be carried through more economically than those arranged on a purely local basis. Regional institutes also afford greater opportunities of collaboration between research workers in the same field, which is of value in organising schemes which affect more than one territory.

   Research at the regional institutes is planned and controlled by the director, who can obtain the advice and assistance of the appropriate specialist committee, with the members of which he usually discusses his work. In those territories where regional organisation is far advanced, the director works under the ægis of regional councils, which are responsible for reviewing progress and making recommendations to their own governments and to the Colonial Office of the United Kingdom concerning the priority of projects and the appropriate allocation of research funds. Regional councils at present include: the East African Agricultural and Fisheries Research Council, the East and West African councils for medical research, and the Standing Advisory Committee for Medical Research in the Caribbean.
2. Schemes organised and directed by the heads of individual research

stations and laboratories and research units in the dependent territories, for example, the Mount Makulu Central Agricultural Research Station in Northern Rhodesia, which was completed in 1957, and now extends to 2,800 acres, including a full range of scientific laboratories, together with a well-developed mixed farm; and the Tropical Metabolism Research Unit, Jamaica, where recent investigations have been concerned primarily with protein malnutrition in infants.

3. Research undertaken in the dependent territories by such bodies as the Empire Cotton Growing Corporation.
4. Officially sponsored research organised in collaboration with particular industries, for instance, the British West Indies sugar research scheme, which is financed jointly from United Kingdom Colonial Development and Welfare funds and by the West Indies Sugar Association, and is controlled by the director of the Sugar Technological Laboratory in Trinidad.
5. Research sponsored by academic or non-official research institutes in the dependent territories, for example, the East African, Nigerian and West Indian Institutes of Social Research, which are associated with the local university colleges; the Rhodes-Livingstone Institute, which was founded in 1938 by private interests with government financial assistance to conduct social research in Central Africa; the Royal University of Malta, which is investigating the agricultural economy of the island in conjunction with the University of Durham in England; and the regional research centre for the Caribbean, based at the Imperial College of Tropical Agriculture, Trinidad, where soils, banana and cocoa investigations are being conducted under the direction of the principal of the college, who is also the director of research.
6. Schemes organised as part of the research activities of the technical departments of colonial governments, for example, mineral surveys in Kenya; citrus rootstock trials in Jamaica.
7. Investigation carried out in the dependencies under the direction of official United Kingdom research bodies such as the Medical Research Council, the Department of Scientific and Industrial Research, and the Agricultural Research Council, for example, work at the medical research laboratories at Fajara in the Gambia.
8. Schemes organised under the ægis of the specialist advisory committees. Research organised in this way is, as a rule, of general interest, and not specifically related to any one territory or group of territories. For example, the Colonial Pesticides Research Unit, Tanganyika, arose from a small team formed in Uganda in 1945 to undertake investigations on the use of new synthetic insecticides against tsetse flies and mosquitoes. It has been expanded, under the ægis of the Colonial Pesticides Research Committee, to provide experienced research workers for investigations in other dependent territories. In addition, a small unit comprising two entomologists, one chemist, one physicist and an engineer, together with ancillary staff, has been established at the Chemical Defence Experimental Establishment of the Ministry of Supply at Porton, near Salisbury, to undertake research on the many problems of insect control which are essentially fundamental in character, and can best be studied in laboratories in the United Kingdom, where there are many more facilities than are available in the field.
9. Special investigations carried out in the United Kingdom either (*a*) by arrangement with such research institutes as the Imperial College of Science and Technology; the Royal College of Science and Technology

(Glasgow); the Lister Institute of Preventive Medicine; and the National Institute for Medical Research; or (*b*) in the specialist establishments of the Department of Scientific and Industrial Research (for example, the Tropical Products Institute, the Building Research Station, the Road Research Laboratory, the Pest Infestation Laboratory, and the Water Pollution Laboratory), of the Ministry of Agriculture, Fisheries and Food, and the Agricultural Research Council (for example, the Royal Botanic Gardens, Kew, and the Rothamsted Experimental Station). At the Road Research Laboratory, a colonial section has been established to deal solely with colonial problems; and colonial liaison officers and supporting staff have been appointed at the Building Research Station and the Pest Infestation Laboratory to collate and disseminate relevant information, and to visit the dependent territories to study local conditions at first hand.

10. Research carried out independently in institutes of higher learning in the United Kingdom and other Commonwealth countries as part of their normal activities, e.g., the bibliographical work of the Institute of Colonial Studies at Oxford; research in colonial history and administration by fellows of Nuffield College, Oxford; work on race relations carried out under the auspices of the Department of Anthropology of the University of Edinburgh; work on colonial products carried out by various departments of the universities of Cambridge, Birmingham, Nottingham, Glasgow and Edinburgh; and the research projects of the Department of Anthropology of the Australian National University.

11. Research schemes involving investigations in the dependent territories, usually of a short-term nature, undertaken by experts from the United Kingdom, e.g., studies on the economics of road development in Uganda completed during 1957, and a survey of farm production in British Honduras.

Colonial Research Workers

In order to encourage qualified scientists to give special attention to the problems of the dependent territories, and to enable them to pursue researches abroad for uninterrupted periods, a scheme for providing 25 colonial research Fellowships was devised by the Secretary of State for the Colonies in 1944. Between 1944 and 1956, 12 awards were made under the scheme, and provision now exists for the appointment of a further eight Fellows, two of whom have already been selected. The Fellowships are normally reserved for university graduates in the natural or social sciences, under 35 years of age, from any part of the Commonwealth; and they are intended primarily for original field work, although, in exceptional circumstances, arrangements may be made for a brief period of work in the United Kingdom. A series of research studentships in various fields—medical, social science, fisheries, soil science, insecticides, stored products, entomological, agricultural, and veterinary—are also awarded, with the object of enabling young workers to receive preliminary training before going to do field or laboratory work in the dependent territories. Eight studentships were awarded during 1957–58.

The position of research workers was further improved during 1950 by the establishment of a Colonial Research Service, which was reorganised as the Research Branch of the Overseas Civil Service in 1954. The object of this move was to create a branch for overseas research workers with salaries, terms of service and standards comparable to those available to scientists working in the United Kingdom, and thereby to facilitate the interchange of workers between the United Kingdom and the dependent territories and to make it possible for the research worker to earn a continuous pension, whether he

part of his service overseas. Officers appointed to the e required to serve in any dependent territory to which they from time to time, in the United Kingdom or elsewhere, as ied by the Secretary of State for the Colonies. They must sh subjects or British protected persons, but candidates of other ay be accepted by the Secretary of State at his discretion.

entists: Four pools of scientists have been established in the United a pool of entomologists attached to the Commonwealth Institute of y; a pool of plant pathologists, attached to the Commonwealth Institute; a pool of soil surveyors, attached partly to the Soil ngland and Wales and partly to the Soil Survey of Scotland; and stored products research workers attached to the Pest Infestation Laboratory o. . Department of Scientific and Industrial Research. Members of these pools are assigned for limited periods to the dependent territories, to work on specific problems of economic importance.

International Co-operation

Research in and for the dependencies is assisted by the Commonwealth Agricultural Institutes and Bureaux (see p. 58) and by regional organisations.

The principal regional research organisation in Africa is the Scientific Council for Africa south of the Sahara, which acts as the scientific adviser to the Commission for Technical Co-operation in Africa south of the Sahara —a body composed of representatives of the eleven member Governments of Belgium, France, Portugal, the Federation of Rhodesia and Nyasaland, the Union of South Africa, the United Kingdom, Liberia, Ghana, the Republic of Guinea, Cameroon and the Republic of the Congo (formerly Belgian). The council, which was established in 1950 and consists of eminent scientific specialists, is advisory and consultative, and its main functions are: to encourage and establish contacts between workers in the same or related fields, or in the same region; to study what research problems of common interest may usefully be suggested to governments, research agencies or universities; to promote inter-governmental collaboration; to compile and distribute reports and information of general value (not already being compiled and distributed by other agencies) concerning scientific workers, scientific equipment and libraries; to foster the creation in Africa of centres of specialised documentation in respect of each of the major scientific subjects; to sponsor the convening of conferences and meetings between groups of specialists; and to submit recommendations to governments with a view to securing joint administrative action through the Commission for Technical Co-operation.

The commission has also been instrumental in setting up (*a*) a series of inter-African bureaux covering tsetse and trypanosomiasis, soils, epizootic diseases and labour questions in order to put the exchange of information and the close technical links between the various administrations on a permanent basis, (*b*) inter-African advisory committees or correspondents for statistics, housing, nutrition, geology, health, maps and surveys, social sciences and epizootic diseases, (*c*) an inter-African research fund to finance joint projects, and (*d*) a foundation for mutual assistance in Africa south of the Sahara.

Other multi-national regional research organisations are: the Caribbean Research Council—an auxiliary body of the Caribbean Commission—which is representative of all the countries with responsibilities for non-self-governing territories in the Caribbean, and aims at promoting scientific, technical and economic development, facilitating the use of resources and concerted treatment of mutual problems and avoiding duplication of research work in that area; and the research council of the South Pacific Commission (the members of which are Australia, France, the Netherlands, New Zealand, the United

Kingdom and the United States), which operates a work pr[he National a considerable number of projects in the fields of health, s[shments of and economic development. [mple, the [he Road

International Agencies: The chief international agencies respe[Water promotion of co-operation in the economic and social fields w[Food, helping to achieve economic stability and raise standards of livin[otanic self-governing territories (including the United Kingdom dependenci[oad Economic and Social Council of the United Nations, the Food and A[Organisation (FAO), the World Health Organisation (WHO), th[Nations Educational, Scientific and Cultural Organisation (UNES[International Labour Organisation (ILO), and the United Nations Techn[Assistance Administration.

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