C.S.I.R.O.

1960-61

COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANIZATION

THIRTEENTH ANNUAL REPORT

Thirteenth Annual Report of the Commonwealth Scientific & Industrial Research Organization

FOR THE YEAR ENDING JUNE 30, 1961

COMMONWEALTH OF AUSTRALIA

Printed by C.S.I.R.O., Melbourne

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This report for the year 1960–61 follows the same form as that of the Annual Report for 1959–60. In that publication radical changes from the form of earlier reports were made so that it could be prepared in time for presentation to Parliament early in the Budget Session.

Detailed information about the C.S.I.R.O. research program will now be available in the separate annual reports of the Divisions and Sections. It is proposed to issue at approximately five-yearly intervals a comprehensive Research Review similar to that published for 1959–60.

During the year C.S.I.R.O. has received valuable help from a number of sources including Commonwealth and State Government departments and instrumentalities, the universities, and various private establishments and individuals. This is gratefully acknowledged. The Executive also wishes to thank members of the various C.S.I.R.O. committees who have made their knowledge and experience so freely available.

I

General Review

In addition to investigations of a fundamental and applied character, of which some of the more important are mentioned in Chapter 2, consideration has been given to some broader problems of national importance. For example, the Executive has been giving some thought during the past 12 months to the difficulties facing Australia in its drive for exports, since it believes that with adequate support the scientific work of C.S.I.R.O. can play a part in overcoming some of these. In the primary industries, markets are now very competitive and there is a necessity for increased efficiency in production of all exportable products in the agricultural, animal, and mining industries. In the export of manufactured goods there is an even greater need for the encouragement of invention, research, and development.

The fostering of secondary industry is not only important for the export trade. As the population of Australia rises only a diminishing proportion of the work force can be absorbed in rural pursuits. Balanced national development demands a rapid growth of Australian manufacturing industries which are competitive by world standards, and this cannot be achieved without an adequate investment in appropriate scientific and industrial research.

The practical results of importance to both primary and secondary industry in Australia are, of course, the main *raison d'être* of C.S.I.R.O. However, there are other returns from the Organization's research which cannot be measured in economic values only. At a time when international affairs are increasingly influenced by the impact of science, national prestige is increasingly related to scientific status. As a result of the work of C.S.I.R.O. and other scientific establishments, Australia now ranks as one of the leading scientific countries of the world.

In developing the existing C.S.I.R.O. research programs and modifying them so as to contribute to new objectives such as those mentioned above, the Executive is at present facing a number of general difficulties which are referred to in other sections of this chapter. One of these arises from the deliberate policy which has been followed in the past of concentrating on the appointment of the most highly qualified professional staff, at the expense of achieving a proper balance between professional and non-professional staff. This has been necessary to ensure the initial development along sound lines of important research programs, but the time has now been reached when the situation must be redressed. Other problems to which attention is drawn are those concerned with the provision of adequate modern equipment and buildings. It is most important that the working conditions in C.S.I.R.O. should not be allowed to decline in comparison with those of other employers of scientists.

Despite the fact that the Commonwealth Government has each year provided a significant increase in the amount of money available to C.S.I.R.O. from Consolidated Revenue, it has not been possible because of inflation to increase the Organization's activities in the same proportion. Thus, although between 1950 and 1960 the total C.S.I.R.O. budget increased from £2·7 million to £9·6 million, it has been possible in this time to increase the research staff only from 750 to 880.

The Executive believes that this increase has not been nearly great enough in terms of the needs of a developing country like Australia. The proportion of its national income which a country can afford to invest in research is a matter for debate, but evidence is available that the amount spent in Australia—both by governments and private sources—is, in proportion, considerably below that spent by a number of other western countries.

Executive

Emeritus Professor L. G. H. Huxley, M.A., D.Phil., Ph.D., F.A.A., resigned as a Member of the Executive on his appointment as Vice-Chancellor of the Australian National University, Canberra.

Dr. I. W. Wark, Ph.D., D.Sc., F.A.A., formerly Director, Chemical Research Laboratories, was appointed a full-time Member of the Executive for a period of 5 years to fill the vacancy created by the resignation of Emeritus Professor Huxley.

The complete list of the Members of the Executive is now:

Dr. F. W. G. White, C.B.E., M.Sc., Ph.D., F.A.A. (*Chairman*)
Dr. S. H. Bastow, D.S.O., B.Sc., Ph.D.
Dr. R. N. Robertson, Ph.D., D.Sc., F.A.A., F.R.S.
Mr. C. S. Christian, B.Agr.Sc., M.S.
Dr. I. W. Wark, Ph.D., D.Sc., F.A.A.
Sir Arthur Coles, Kt.
Dr. J. Melville, M.Sc., Ph.D.
The Rt. Hon. the Lord Casey, P.C., C.H., D.S.O., M.C., M.A.
Mr. E. P. S. Roberts.

Advisory Council

The following members retired from the Advisory Council during the year:

Mr. A. McCulloch, M.E.
Mr. M. A. E. Mawby, C.B.E., F.S.T.C., D.Sc.
Mr. H. B. Somerset, C.B.E., M.Sc.
Dr. J. Vernon, B.Sc., Ph.D.

The following new members were appointed to the Council:

Mr. V. G. Burley, B.E.
Professor Sir John Eccles, Kt., M.A., M.B., B.S., D.Phil., Sc.D., F.A.A., F.R.S.
Mr. J. W. Foots, B.M.E.
Mr. W. W. Killough, O.B.E.

The Council met twice during the year—at Melbourne in November 1960, and at Canberra in May 1961.

Obituary

Sir David Rivett, K.C.M.G., M.A., D.Sc., F.A.A., F.R.S., formerly Chairman of the Council for Scientific and Industrial Research, died on April 1, 1961, after a long illness.

Sir David relinquished the Chair of Professor of Chemistry at the University of Melbourne to accept appointment as the Chief Executive Officer and Deputy Chairman of the C.S.I.R. immediately after its formation. He became Chairman in 1946 and retired in 1949. Sir David's vision and leadership were responsible, perhaps to a greater extent than any other individual's, for the basic pattern of C.S.I.R. and its successor C.S.I.R.O. His encouragement of fundamental scientific research for the assistance of primary and secondary industries has been a national contribution of vital importance to the welfare of Australia.

To commemorate Sir David's name in C.S.I.R.O., the Executive has decided to call the new building which is to be erected at Clayton in Victoria for the Division of Chemical Physics the David Rivett Laboratory.

Dr. A. B. Edwards, Ph.D., D.Sc., D.I.C., Officer-in-Charge of the Mineragraphic Investigations section, died while on a visit to Europe to inspect mines and centres of mineragraphic research. Dr. Edwards joined C.S.I.R. in 1935 and became Officer-in-Charge of the Mineragraphic Investigations section in 1953. Dr. Edwards's researches have been an important contribution to the mining and metallurgical industries in Australia.

State Committees

The following members were appointed to the various State Committees during the year:

New South Wales

Mr. S. B. Dickenson, M.Sc.
Dr. J. W. Evans, M.A., Sc.D., D.Sc.

Victoria

Mr. W. W. Killough, O.B.E.

Queensland

Mr. J. W. Foots, B.M.E.

Western Australia

Dr. T. C. Dunne, B.Sc.(Agric.), Ph.D.

Tasmania

Mr. V. G. Burley, B.E.
Mr. E. J. Cameron, B.A.
Professor G. H. Newstead, M.E.E.

Complete lists of the members of the State Committees are given in Chapter 4.

During the year, the Executive, in consultation with members of the Advisory Council and others, has given much thought to the role of the State Committees. This has changed considerably since the time when C.S.I.R. was established and they were first set up. There is now much more C.S.I.R.O. activity in most States, and the role of science in agricultural and industrial development is much more widely appreciated. Nevertheless, the Executive believes that these Committees still have an important part to play in C.S.I.R.O. affairs. In those States where there is less C.S.I.R.O. activity they give advice on specific problems needing attention by the Organization and in the other States they fulfil an invaluable role as "friends of C.S.I.R.O.".

Organizational Changes

Chemical Research Laboratories

Following the appointment of Dr. Wark as a Member of the Executive, the overall management of the Chemical Research Laboratories has been made the responsibility of a Committee comprising the Chiefs and Officers-in-Charge of the various Divisions and Sections. Dr. A. L. G. Rees, Ph.D., D.Sc., F.A.A., is Chairman of the new Committee.

Sugar Research Laboratory.—A Sugar Research Laboratory was established as part of the Chemical Research Laboratories. Dr. H. H. Hatt, Ph.D., D.Sc., formerly Officer-in-Charge of the Organic Chemistry Section, was placed in charge of the new unit. The Sugar Research Laboratory has been established in collaboration with the sugar industry, and will aim to find new uses for sugar which is at present in surplus production in Australia.

Division of Organic Chemistry.—The Organic Chemistry Section of the Chemical Research Laboratories has now been designated a Division, and Dr. J. R. Price, D.Sc., D.Phil., F.A.A., was appointed Chief of the Division.

Division of Food Preservation

The name of the Division of Food Preservation and Transport was changed to the Division of Food Preservation.

Mineragraphic Investigations

Following the recommendations of an Advisory Council Committee of Review, it was decided that there should be closer association between units of C.S.I.R.O. engaged on research related to the development and utilization of Australia's mineral deposits. As a step in this direction Mr. A. J. Gaskin, Officer-in-Charge of the Cement and Refractories Section, has also been made Officer-in-Charge of Mineragraphic Investigations. The unit will continue to be located without change of name at the University of Melbourne.

Honours and Awards

Present and former officers of C.S.I.R.O. who received honors or awards during the year under review were:

Dr. F. W. G. White, Chairman: Member of the Council, Australian National University.

Dr. R. N. Robertson, Member of the Executive: Fellow, Royal Society of London; Doctor of Science, University of Sydney.

Mr. C. S. Christian, Member of the Executive: President, Fellowship, and 1961 Medal for Agricultural Science, Australian Institute of Agricultural Science.

Dr. W. Boas, Chief, Division of Tribophysics: Silver Medal, Australian Institute of Medals.

Dr. H. E. Dadswell, Chief, Division of Forest Products: Member, Forest Biology Committee, Technical Association of the Pulp and Paper Industry, U.S.A.

Dr. G. F. Humphrey, Chief, Division of Fisheries and Oceanography: President, Special Committee on Oceanic Research, International Council of Scientific Unions.

Dr. J. R. Price, Chief, Division of Organic Chemistry: President, Victorian Branch, Royal Australian Chemical Institute.

Dr. J. L. Pawsey, Assistant Chief, Division of Radiophysics: Hughes Medal, Royal Society of London; Doctor of Science, Australian National University.

Mr. G. B. Gresford, Secretary: Fellow, Royal Australian Chemical Institute.

Dr. A. J. Nicholson, Senior Research Fellow and former Chief, Division of Entomology: Commander of the Order of the British Empire.

Mr. A. V. Lyon, a former Officer-in-Charge, Commonwealth Research Station, Merbein: Member of the Order of the British Empire.

Mr. R. N. Morse, Officer-in-Charge, Engineering Section: Member, Institution of Engineers, Australia.

Dr. A. J. Anderson, Senior Principal Research Officer, Division of Plant Industry: Fellow, Australian Institute of Agricultural Science.

Dr. J. M. Cowley, Senior Principal Research Officer, Division of Chemical Physics: Fellow, Australian Academy of Science.

Dr. J. E. Falk, Senior Principal Research Officer, Division of Plant Industry: Fellow, Australian Academy of Science.

Mr. J. F. Kefford, Senior Principal Research Officer, Division of Food Preservation: Australian Award, Institute of Food Technology.

Dr. A. McL. Mathieson, Senior Principal Research Officer, Division of Chemical Physics: Member, Commission of Crystallographic Apparatus, International Union of Crystallography.

Mr. M. V. Tracey, Senior Principal Research Officer, Wheat Research Unit: Fellow, Royal Australian Chemical Institute.

Dr. G. Baker, Principal Research Officer, Mineragraphic Investigations: Research Medal, Royal Society of Victoria.

Miss N. T. Burbidge, Principal Research Officer, Division of Plant Industry: Doctor of Science, University of Western Australia.

Mr. J. Czulak, Principal Research Officer, Dairy Research Section: Gold Medal for Dairy Research, Australian Society of Dairy Research.

Dr. W. F. Forbes, Principal Research Officer, Division of Protein Chemistry: Fellow, Royal Australian Chemical Institute.

Dr. R. D. B. Fraser, Principal Research Officer, Division of Protein Chemistry: Doctor of Science, University of London.

Dr. R. C. Gifkins, Principal Research Officer, Physical Metallurgy Section: Doctor of Science, University of Melbourne.

Mr. H. J. Lee, Principal Research Officer, Division of Biochemistry and General Nutrition: Federal President, Australian Society of Animal Production.

Dr. R. J. Meakins, Principal Research Officer, Division of Electrotechnology: Fellow, Royal Australian Chemical Institute.

Dr. J. N. Phillips, Principal Research Officer, Division of Plant Industry: Royal Society and Nuffield Foundation Commonwealth Bursary; Fellow, Royal Australian Chemical Institute.

Dr. C. A. Anderson, Senior Research Officer, Division of Textile Industry: Silver Medal for Wool Research, Worshipful Company of Woolmen of the United Kingdom.

Dr. C. S. Barnes, Senior Research Officer, Division of Organic Chemistry: Fellow, Royal Australian Chemical Institute.

Dr. F. J. Bergersen, Senior Research Officer, Division of Plant Industry: Doctor of Science, University of New Zealand.

Dr. J. H. Bradbury, Senior Research Officer, Division of Textile Industry: Fellow, Royal Australian Chemical Institute.

Dr. S. M. Bromfield, Senior Research Officer, Division of Plant Industry: Nuffield Foundation Commonwealth Bursary.

Mr. H. A. Stephens, Officer-in-Charge, Foundry Sands Section: Diploma, Institute Of British Foundrymen.

Dr. M. P. W. Hegarty, Research Officer, Division of Tropical Pastures: Fellow, Royal Australian Chemical Institute.

Mr. L. G. Peres, Staff Relations Officer, Head Office: Science and Public Policy Fellowship, Harvard University, Graduate School of Public Administration.

Mrs. J. Cronshaw, Librarian, Head Office: Fellow, Library Association of Great Britain.

Dr. C. W. A. Wouters, Translation Section: 1961 Gertrude Kumm Citizenship Award.

Retirements, Resignations, and Transfers

Mr. S. A. Clarke, B.E., Chief, Division of Forest Products, retired in August 1960. Mr. Clarke had been associated with the Division since 1928 and had played a major part in developing the effective exploitation of Australian timber resources.

Mr. R. G. Thomas, B.Sc., retired as Chief of the Division of Mineral Chemistry after about 32 years' service with C.S.I.R. and C.S.I.R.O. Mr. Thomas, in establishing and developing his Division, played a leading role in the development of techniques for the exploitation of Australia's mineral resources.

Mr. F. N. Ratcliffe, O.B.E., B.A.(Hons.), resigned as Officer-in-Charge of the Wildlife Survey Section to become Assistant Chief, Division of Entomology.

Dr. A. W. Turner, O.B.E., D.Sc., D.V.Sc., F.A.A., Assistant Chief, Division of Animal Health, retired in August 1960. Dr. Turner played a conspicuous part in the development and application of veterinary science in Australia.

Mr. F. Penman, M.Sc., formerly Senior Officer-in-Charge, Irrigation Research Stations, was transferred to the Organization's Head Office to assist the Executive.

New Chiefs and Officers-in-Charge

Dr. H. E. Dadswell, D.Sc., formerly Assistant Chief, Division of Forest Products, was appointed Chief of the Division.

Dr. J. R. Price, D.Sc., D.Phil., F.A.A., formerly Senior Principal Research Officer in the Organic Chemistry Section, was appointed Chief of the Division of Organic Chemistry.

Dr. S. D. Hamann, M.Sc., Ph.D., formerly in charge of the High Pressure Laboratory, was appointed Chief, Division of Physical Chemistry.

Mr. G. A. Stewart, M.Agr.Sc., formerly in charge of Regional Land Surveys in the Division of Land Research and Regional Survey, was appointed Chief of the Division.

Mr. H. J. Frith, B.Sc.Agr., formerly Principal Research Officer, Wildlife Survey Section, was appointed Officer-in-Charge of the Section.

Dr. A. Walsh, M.Sc.Tech., D.Sc., F.A.A., Chief Research Officer of the Division of Chemical Physics, was appointed Assistant Chief of this Division.

Meeting of Executive with Chiefs and Officers-in-Charge

During October 1960 a two-day residential conference of the Executive, Chiefs, and Officers-in-Charge was held at the Mayer Chalet at Warburton, Vic. A meeting of this nature had not been held for several years, and this was the first time that it had taken the form of a residential conference. The Minister-in-Charge of C.S.I.R.O., Dr. the Hon. D. A. Cameron, O.B.E., B.A., M.B., B.S., M.P., attended the first sessions of the conference.

The conference provided a unique opportunity for Chiefs and Officers-in-Charge to come together to discuss mutual aspects of administration, and problems of common interest in seemingly different fields of activity.

The agenda included some items of an administrative and machinery nature, and general discussions were held on such diverse subjects as: a possible portfolio for science in the Federal Government, overseas study leave and overseas visits, status and work of Experimental Officers, preparation of financial estimates, C.S.I.R.O. liaison activities, patenting policy, technological research in Australian industry, selection of research projects, and the F.A.O. Freedom from Hunger Campaign.

Liaison Activities

It is proposed to hold a similar residential conference in about 2 years' time. To help discharge its responsibility to disseminate research results, C.S.I.R.O. maintains Agricultural and Industrial Research Liaison Sections.

The Agricultural Research Liaison Section carries out its functions chiefly by means of publications such as *Rural Research in C.S.I.R.O.*, by means of conferences such as the Rabbit Control Symposium held at Sydney in October 1960, and the Northern Territory Scientific Liaison Conference held at Darwin, in February 1961, and by maintaining appropriate liaison with commercial firms and primary industry organizations, and State Departments of Agriculture.

During 1960–61 the Section produced "C.S.I.R.O. and the Woolgrower", a booklet designed to help fulfil C.S.I.R.O.'s obligation to keep woolgrowers informed of the research being done on their behalf. The booklet was widely distributed to woolgrowers in Australia, and attracted favourable notice both here and overseas.

The Industrial Research Liaison Section has continued to issue a bi-monthly publication, *C.S.I.R.O. Industrial Research News*, giving information about developments from C.S.I.R.O. research programs likely to be of interest to Australian manufacturers. The Section has also prepared other publications aimed at bringing aspects of C.S.I.R.O. research to the attention of industry and the general public.

An important part of the work of the Industrial Research Liaison Section relates to patents and patent licences. Some hundreds of patents and patent applications arising from research in C.S.I.R.O. laboratories are current. The Section has continued to provide assistance to the Divisions and Sections with patenting and licensing programs, and with all aspects of the industrial application of patents.

Because of the wide range of the research program of C.S.I.R.O. it is not always possible to investigate problems of interest to specialized branches of industry. Industrial groups and individual firms have provided in many instances financial support to permit the research program to be expanded to cover fields in which they have special interest. Research projects sponsored by industry in this way have become an established feature of C.S.I.R.O. activities, and the Section has been concerned with making suitable arrangements for projects of this kind.

Collaboration with the Universities

The Organization is closely associated with the various universities in many of the research programs undertaken in the Divisions and Sections. In addition to the grants which are made to support specific university activities, C.S.I.R.O. officers have continued to assist in university teaching work by giving courses of lectures in specialized fields of study.

The following grants have been continued to the universities:

University of Melbourne:

Mathematical computing
Plant nutrition studies
Research on hardening of metals
Brown coal pollen research

University of Queensland:

Research Fellowship in Parasitology
Research Fellowship in Protozoology
Research Fellowship in Veterinary Anatomy

University of Adelaide:

Chair of Genetics
Readership in Animal Ecology

University of Western Australia:

Research on marsupials

University of Sydney:

Colloid science research
Research on dairy and beef production
Readership in Dairy Husbandry
Research on nitrogen metabolism

Australian National University:

Readership in Chemistry

University of Tasmania:

Research on biophysics

C.S.I.R.O. has continued its support to the Electrical Research Board, which made grants this year to the Universities of Sydney, Melbourne, Queensland, Adelaide, and New England, and has also provided post-graduate scholarships in the Universities of Sydney and New South Wales.

The Radio Research Board to which C.S.I.R.O. is a major contributor has made grants for research in radio science at the Universities of Sydney, Melbourne, Queensland, Adelaide, Tasmania, and New England, and to the Australian National University.

Many C.S.I.R.O. Divisions and Sections have close ties with specific universities, and the Executive desires to acknowledge with gratitude the assistance and cooperation of these universities.

Cooperative Industrial Research

C.S.I.R.O. cooperates with industry in activities that range from limited sponsored research programs to autonomous industrial research associations. The Organization welcomes proposals for cooperative research from firms or industrial associations.

The Organization has continued to support the Bread Research Institute of Australia, the Australian Wine Research Institute, and the Australian Coal Association (Research) Limited.

A number of new cooperative research projects have begun during the year with support from industrial firms and other agencies. These include the establishment of a Sugar Research Laboratory with support from Colonial Sugar Refining Co. Ltd.; research by the Division of Mineral Chemistry on fuel cells, supported by the Reserve Bank of Australia; an investigation in the Division of Coal Research on problems arising in the combustion of brown coal, and in the production of brown coal briquettes, supported by the State Electricity Commission of Victoria; research on the use of concrete masonry, in the Division of Building Research, supported by Jayworth Besser Ltd.; research on the canning of foodstuffs, in the Division of Food Preservation, supported by the Broken Hill Pty. Co. Ltd.; a study of the design of a tailings dam by the Soil Mechanics Section, also supported by the Broken Hill Pty. Co. Ltd.; research on factors influencing the movement of strontium 90 from soils to plants, in the Division of Plant Industry, sponsored by the International Atomic Energy Agency; research on organic semiconductors, in the Division of Physical Chemistry, and on heterogeneous catalysts, in the Division of Tribophysics, supported by a firm of chemical manufacturers; research into problems connected with the growth of *Pinus radiata*, supported jointly by A.P.M. Forests Pty. Ltd., the Department of Woods and Forests of South Australia, and the Department of Forestry of Western Australia; an investigation by the Soil Mechanics Section of the stabilization of a landslip area, sponsored by the City of Launceston.

A full list of contributions and donations for research received by the Organization is given in Chapter 5.

Australia's Giant Radio Telescope

The giant radio telescope being erected at Parkes for the Division of Radiophysics is now structurally complete. Finishing touches are being made to the complex equipment which controls its pointing and movement, and the instrument will then be put through a series of tests to ensure that it meets fully the stringent specifications for accuracy of the parabolic reflecting surface, and for the precision with which it can be moved and pointed. The telescope will be available full-time for research purposes towards the end of 1961.

The radio telescope was designed in consultation with Messrs. Freeman, Fox and Partners of the United Kingdom, and the prime contractor for its erection was the West German firm of Maschinenfabrik Augsburg-Nürnberg, AG. Under subcontract to this firm the servo drive and control gear and all the electrical wiring were provided by Associated Electrical Industries, and the master equatorial control

equipment by the West German firm of Askania. Although unavoidable delays prevented completion within the originally agreed period, the contractors are to be congratulated on having completed a novel and major feat of engineering construction within the remarkable time of 2 years from placing of the contract.

The erection of this magnificent scientific instrument has been made possible by gifts to C.S.I.R.O. from the Rockefeller Foundation and the Carnegie Corporation in the U.S.A., together with donations from industry and private individuals in Australia, and grants from the Commonwealth Government.

Controlled Environment Research Laboratory

In last year's Annual Report it was reported that the design of the Controlled Environment Research Laboratory (C.E.R.L.) (phytotron) was approaching completion. During the year a contract was let to the firm of K. D. Morris and Sons for the construction of the building and the actual site preparation, and building commenced in December 1960. The building is scheduled to be completed early in 1962.

Contracts have been let with the Commonwealth Aircraft Corporation as main contractors for most of the environment control cabinets. The two main types of naturally lit cabinets are now under commercial production and will also be completed early in 1962.

Other cabinet types have been under engineering development during the year, and testing of the artificially lit cabinets is now almost completed. The specification of the equipment to monitor the very large number of controlled conditions in the C.E.R.L. is almost completed. Design also commenced on the cabinets with a wide range of humidity control.

The more specialized cabinets will be built by the Engineering Section of C.S.I.R.O.

Overseas Visitors

A number of scientists from overseas establishments visited C.S.I.R.O. laboratories during the year, many of these collaborating with the Organization's officers in specific fields of study. Amongst these overseas visitors were:

Professor Sir Alexander Todd, F.R.S., Professor of Organic Chemistry, Cambridge University, who visited Australia to preside at the symposium on "The Chemistry of Natural Products", organized in Australia by the International Union of Pure and Applied Chemistry. Sir Alexander conferred with the Executive and visited a number of C.S.I.R.O. Divisions and Sections during his stay in Australia.

Professor Sarwono Prawirohardjo, President of the Council for Sciences of Indonesia, who was invited to spent 4 weeks in Australia visiting C.S.I.R.O. establishments in Melbourne, Adelaide, Sydney, Canberra, and Perth. Professor Sarwono also took the opportunity to visit Australian universities and other scientific institutions.

Sir Lawrence Bragg, F.R.S., Director, Royal Institution, London, visited a number of the Organization's laboratories during a visit to Australasia to deliver the Royal Society Rutherford Lecture in New Zealand.

Dr. A. Sundralingam, Director, Ceylon Institute of Scientific and Industrial Research, spent 3 weeks visiting a number of C.S.I.R.O. establishments.

Professor P. C. Mahalanobis, F.R.S., a Senior Advisor to the Indian Government, addressed a meeting of Chiefs and Officers-in-Charge during a visit to Australia sponsored by the Reserve Bank of Australia.

Dr. D. Heinrichs, Head of the Forage Crops Section, Research Branch, Canadian Department of Agriculture, is spending a year with the Genetics Section, Division of Plant Industry. His visit was arranged under the Canadian Government Transfer of Duties system whereby workers are enabled to continue their research programs at centres other than their own headquarters.

Dr. A. W. Galston, Professor of Plant Physiology, Yale University, spent 9 months at the Division of Plant Industry under a Fulbright Fellowship studying the hormone regulation of plant growth.

Dr. E. C. Crittendon, Jnr., Professor of Physics, U.S. Naval Postgraduate School, Monterey, California, spent 5 months' sabbatical leave with the Division of Physics, developing material for a text-book on quantum electronics.

Professor I. Chester Jones, Department of Zoology, University of Sheffield, spent a month at the Division of Biochemistry and General Nutrition studying sheep metabolism. Professor Chester Jones's visit was sponsored jointly by the Wellcome Foundation and C.S.I.R.O.

Professor D. S. Lieberman, University of Illinois, Urbana, U.S.A., visited the Division of Tribophysics whilst on a visit to Australia to attend the symposium on "Phase Transformations in Metals" held by the Australian Institute of Metals in November 1960. Professor Lieberman's visit to Australia was sponsored by the National Science Foundation.

Professor Takesi Nagata, Geophysical Institute, Tokyo University, Professor Ken-ichi-Maeda, Department of Electronics, Kyoto University, and Professor Yoshio Kato, Geophysical Institute, Tohoku University, Japan, visited Australia at the invitation of C.S.I.R.O. to confer with officers of the Upper Atmosphere Section and to attend the Conference on the Sun–Earth Environment arranged by the Institute of Physics in conjunction with the A.N.Z.A.A.S. meeting in Brisbane.

Dr. J. T. Slykhuis, Plant Pathology Section, Canadian Department of Agriculture, spent 2 months at the Division of Entomology studying virus diseases of plants.

Dr. L. Chalk, Imperial Forestry Institute, University of Oxford, spent some weeks in the Division of Forest Products collecting information for his forthcoming book, "The Anatomy of Dicotyledons". Dr. Chalk's visit to Australia was sponsored jointly by the Commonwealth Forestry and Timber Bureau and C.S.I.R.O.

Professor S. G. Wildman, Department of Botany, University of California, is spending 9 months under a Fulbright Award at the Division of Plant Industry, studying virus reproduction in plant cells.

Dr. A. S. Fox, Associate Professor of Biochemistry, Michigan State University, spent 6 months under a Fulbright Award with the Division of Animal Genetics undertaking biochemical and immunogenetic studies of protein specificity in *Drosophila* and the mouse.

Mr. Shigeru Matsuo, from Hyushu University, is visiting the Division of Tribophysics under an Australian International Award Fellowship studying temperature changes associated with metal recrystallization.

Dr. S. Kuwabara, Department of Physics, Hiroshima University, is working in the Division of Chemical Physics on the application of electron diffraction methods to crystal structure determination.

Dr. Paul Marmet, Physics Department, Université Laval, Quebec, spent a year in the Division of Chemical Physics studying mass spectroscopy. Dr. Marmet visited Australia under a Canadian National Research Council Post-Doctorate Overseas Fellowship.

Captain D. W. Stevens, Geophysics Directorate, United States Air Force, visited the Division of Meteorological Physics to discuss problems concerning the atmospheric boundary layer.

Mr. A. R. Stobbs, of the British Colonial Service, undertook a period of 6 months' post-graduate training with the Division of Soils studying irrigation and drainage problems.

Dr. F. Aragon de la Cruz, University of Madrid, is working in the Division of Chemical Physics on structural analytical methods using electron diffraction. Dr. Aragon de la Cruz is visiting Australia under a Selby Fellowship of the Australian Academy of Science.

Dr. J. Gjønnes, University of Oslo, is working at the Division of Chemical Physics on the theory of scattering of electrons by atoms. Dr. Gjønnes is visiting Australia under a Norwegian Science Council Fellowship.

Dr. P. C. Roheja, Director, Central Arid Zone Research Institute, Jodhpur, and Mr. G. Ghose, Geomorphologist of the Institute, spent some months with the Division of Land Research and Regional Survey gaining experience in arid zone research.

C.S.I.R.O. scientists played a leading part in the International Symposium on the Chemistry of Natural Products which was held in Australia in August 1960, under the auspices of the International Union of Pure and Applied Chemistry. Four of the overseas scientists visiting Australia for the Symposium elected to remain for a period as guest workers in the Division of Organic Chemistry. These were:

Dr. Marvin Carmack, Professor of Chemistry, University of Indiana, working under a Fulbright Fellowship studying structure problems, who remained for 9 months.

Professor N. A. Sørensen, Institute of Organic Chemistry, Technical University of Norway, Trondheim, and Mrs. Sørensen, who spent 8 months investigating the occurrence of acetylenic compounds in Australian plants.

Dr. R. Schoental, Toxicology Research Unit, United Kingdom Medical Research Council, Carshalton, Surrey, who remained for 4 months. Dr. Schoental's research interests relate to the liver damaging properties of pyrrolizidine alkaloids to which attention has been paid both by the Chemical Research Laboratories and the Division of Animal Health in connexion with stock poison plants.

The Organization has continued to provide facilities for training F.A.O., U.N.E.S.C.O., and Colombo Plan Fellows and Students.

Overseas Visits

Invitations were received by C.S.I.R.O. officers to participate in a number of overseas scientific conferences. These included the fifth Biennial Conference on Carbon, Pennsylvania, U.S.A.; the A.S.T.M. Meeting on Mass Spectrometry, Chicago, U.S.A.; the International Whaling Commission Scientific Workshop Meeting, Rome; the Symposium on Marine Biology, Chicago, U.S.A.; the Symposium on Temperature Measurement and Control, Ohio, U.S.A.; the Symposium on Statistical Genetics and Plant Breeding, Raleigh, U.S.A.; the Quantum Chemistry Conference, Oxford, U.K.; the International Astronomical Union on the Magellanic Clouds, Cordoba, Argentine; the Second International Congress of Bioclimatology, U.K.; the meeting of the International Association of Physical Oceanography, Helsinki, Finland; the Fifth International Congress of the International Union of Crystallography, Cambridge, U.K.; the International Conference on Freeze-Drying Techniques, France; the Manchester Summer School on Crystallography, U.K.; the World Forestry Congress, Seattle, U.S.A.; and the International Symposium on Combustion, Los Angeles, U.S.A.

The Rt. Hon. the Lord Casey, C.H., D.S.O., M.C., a Member of the Executive, accepted an invitation to attend the Centennial Conference on Science and Engineering Education at the Massachusetts Institute of Technology.

Mr. C. S. Christian, a Member of the Executive, attended the Seventh Session of the International Rice Commission in Saigon, South Vietnam, and was an Australian delegate to the F.A.O. Regional Conference for the Far East.

Mr. W. Ives, Executive Officer, led the Australian delegation to the Review Conference of the Commonwealth Agricultural Bureaux held in the United Kingdom. Other C.S.I.R.O. members of the Australian delegation were Sir Arthur Coles, Dr. J. Griffiths Davies, Mr. D. A. Gill, and Mr. F. Wilson.

Dr. E. G. Bowen, Chief, Division of Radiophysics, visited Europe, Israel, the United Kingdom, and North America, and attended the International Conference on the Role of Science in the Advancement of New States at Rehovoth at the invitation of the Weizmann Institute of Israel. He also attended the International Conference on Cloud Physics at Verona, Italy.

Mr. N. A. Esserman, Director, National Standards Laboratory, visited research establishments in the United Kingdom, Europe, and North America. He attended meetings at the International Bureau of Weights and Measures and the International Institution for Production Engineering Research at Hapsburg, Germany, and also a Symposium on Machine Tools at Cranfield, England.

Dr. O. H. Frankel, Chief, Division of Plant Industry, attended the F.A.O. Conference in Rome, and later visited the United Kingdom and the U.S.A.

Dr. G. F. Humphrey, Chief, Division of Fisheries and Oceanography, visited the U.S.A., the United Kingdom, and Europe, and attended the meeting in Paris of the Special Committee on Oceanic Research at the invitation of the Committee, the U.N.E.S.C.O. Intergovernmental Meeting on Oceanography in Copenhagen on behalf of the Department of External Affairs, and the U.N.E.S.C.O. Working Group for the Coral and Tasman Seas in New Zealand at the invitation of U.N.E.S.C.O.

Dr. J. R. Vickery, Chief, Division of Food Preservation, visited New Zealand to attend the official opening of the new laboratories of the Meat Industry Research Institute at Hamilton, N.Z.

Dr. T. S. Gregory, Chief, Division of Animal Health, paid an official visit to research establishments in New Zealand. His main purpose was to attend and address the Annual Conference of the New Zealand Veterinary Association.

Dr. R. G. Giovanelli, Chief, Division of Physics, attended the International Symposium on Solar Seeing in Rome, at the invitation of the Italian National Research Council.

Dr. H. R. Marston, Chief, Division of Biochemistry and General Nutrition, visited research establishments in the United Kingdom, Europe, and North America. He attended the Royal Society Tercentenary Celebrations in London.

Dr. D. F. Martyn, Officer-in-Charge, Upper Atmosphere Section, visited the United Kingdom and Europe. He was nominated by the Australian Academy of Science to attend the Meeting and Symposium of the Special Committee on Space Research—C.O.S.P.A.R.(I.C.S.U.) held at Florence, Italy.

Mr. F. G. Nicholls, Research Secretary, has spent 12 months in Bangkok, under the sponsorship of the United Nations Technical Assistance Administration, advising the Government of Thailand on the organization of scientific research.

Dr. H. H. Hatt, Officer-in-Charge, Sugar Research Laboratory, visited research establishments in the United Kingdom, Europe, North America, and Japan, studying developments in the field of sugar chemistry.

Mr. A. J. Gaskin, Officer-in-Charge, Cement and Ceramics Section, visited research establishments in the U.S.A. He attended the Fourth International Symposium on the Chemistry of Cement in Washington.

A number of officers undertook assignments overseas on behalf of agencies of the United Nations.

C.S.I.R.O. Post-Graduate Studentships

The Organization again awarded a number of post-graduate studentships to graduates for training in research, both in Australia and overseas. The Studentship Committee recommended an increase in the allowances paid to studentship holders in the U.S.A., and as a result, the C.S.I.R.O. awards now carry the following allowances:

Junior Studentships	£600–800 p.a.
Senior Studentships	£900–1100 p.a.
Overseas Studentships	£750 sterling p.a. in the U.K. and Europe $3600–4440 in the U.S.A.

Junior Post-Graduate Studentships

These are awarded for one year only, to persons holding a pass degree in Science, Agricultural Science, Veterinary Science, Engineering, or Arts with Mathematics as the main subject. During the year, from 124 applications received, 24 of these studentships were awarded (three were subsequently declined), successful candidates (and their universities) being:

B. D. O. Anderson (Sydney)
N. L. Arthur (Adelaide)
F. J. Ballard (W.A.)
G. W. Bennett (Adelaide)
P. J. Black (W.A.)
S. von der Borch (Miss) (Adelaide)
G. S. Chandler (Adelaide)
R. J. Drewer (Adelaide)
R. A. Fischer (Melbourne)
N. D. Fowkes (Qld.)
R. C. Freeman (W.A.)
L. J. Gleeson (Melbourne)
F. P. Johnson (New England)
B. J. H. McKellar (Sydney)
R. H. Mazzucchelli (W.A.)
C. E. Nockolds (W.A.)
A. K. Parkin (Melbourne)
J. A. Senior (Miss) (Sydney)
N. J. A. Sloane (Melbourne)
J. C. Swann (Adelaide)
J. Tendys (Qld.)
R. T. Waechter (Adelaide)
J. R. Williams (W.A.)
G. Wilson (Sydney)

Senior Post-Graduate Studentships

These are awarded for two years initially to persons holding at least an Honours degree in the fields listed. The period of the studentship may be extended for an additional year under special circumstances. During the year 33 awards were made from 135 applications received, seven of them being declined subsequently.

Successful candidates were:

Miss I. Auzins (Adelaide)
P. E. Best (W.A.)
D. J. Binet (W.A.)
J. H. Bowie (Melbourne)
N. G. Brink (Tas.)
G. A. Chilvers (Sydney)
J. V. Corbett (Adelaide)
J. D. Cotton (Melbourne)
L. R. Davidson (W.A.)
B. R. Davis (Adelaide)
M. J. Dilworth (W.A)
R. W. Eyland (Sydney)
C. M. Francis (W.A.)
R. L. Harris (Adelaide)
G. M. Holder (Sydney)
J. L. Huppatz (Adelaide)
F. E. Irons (Sydney)
J. F. Jackson (Adelaide)
A. S. Jones (Adelaide)
F. R. A. Jorgenson (Adelaide)
D. R. Liljegren (Adelaide)
G. A. McLean (Sydney)
C. S. Nilsson (Adelaide)
E. M. Palandri (W.A.)
L. A. Parcell (Qld.)
L. S. Peak (Sydney)
B. J. Pullman (Adelaide)
G. C. Ramsay (Adelaide)
J. Roberts (New England)
J. A. Sved (Adelaide)
P. Szekeres (Adelaide)
H. Weigold (Adelaide)
P. C. Whiteman (Qld.)

Overseas Studentships

These are awarded to research workers in science and allied fields who have obtained a Ph.D., or who are about to obtain that degree, to enable them to proceed overseas, usually for one year only, to work with leaders of research in their special field of interest. During the year, 36 applications were received, and 10 candidates were selected (two declined in favour of other awards):

B. A. W. Coller (Melbourne)
J. B. Coombe (Melbourne)
R. G. Florence (Sydney)
B. N. Richards (Qld.)
R. M. T. S. Sadleir (W.A.)
K. D. Shortman (Melbourne)
J. A. Stiles (Sydney)
R. H. Symons (Melbourne)
J. A. Talent (Melbourne)
K. J. Watson (W.A.)

Studentships Awarded by Outside Bodies

The Organization was again asked to select candidates for Australian Dairy Produce Board Post-Graduate Studentships at the request of the Board. In addition, the Australian Cattle and Beef Research Committee also asked for assistance in the selection of suitable candidates for its Post-Graduate Studentships.

Science and Industry Endowment Fund

The Trustees of the Science and Industry Endowment Fund (who are the Members of the Executive) made grants to assist the following research workers: Dr. T. O. Browning, to undertake a project on the ecology of animals in dry country; Mr. W.

H. Dawbin, to complete whale investigations in Europe and continue a program of research in the South Pacific; Mr. F. J. Rigby, to purchase equipment for palynological research; Dr. R. T. Patton, to continue preparation of a book describing plant communities of Victoria; Mr. K. Gillet, to purchase equipment for preparation of a publication on the Mollusca of the Great Barrier Reef, and revision of his book "The Great Barrier Reef and Adjacent Isles"; Mr. N. V. Dobrotworsky, to continue research on the systematics and ecology of Victorian mosquitoes; Mr. A. W. Parrot, to complete taxonomic studies of Australian parasitic wasps; Dr. Mary E. Gillam, to assist in costs of publication on studies of the ecology of the mutton bird nesting areas around the Australian coast; Mr. J. Pearson, to continue studies on the anatomy and embryology of the marsupial urogenital system.

Grants were made towards travelling expenses of the following research workers: Mr. A. Robinson, for ornithological investigations in Australia; Mr. I. M. Thomas and Dr. R. W. George, to attend a meeting in Canberra on Crayfishing in Australia; Dr. C. J. Magee to attend the C.A.B. Review Conference in London; Mr. G. Caughley for a research project on the red and grey kangaroo in New South Wales; Dr. D. F. McMichael, to continue studies on molluscs at the British Museum in London; Mr. A. Dunbavin Butcher to attend a meeting of the American Fisheries Society in the U.S.A.

Grants were also made to: the supplementing of Australian awards of 1851 Scholarships; the Science Teachers' Association of Victoria, for expenses in conducting the Science Talent Search; Science Teachers' Association of New South Wales for science competition prizes; the Australian Science Teachers' Association to complete a survey of conditions and facilities for science education at secondary school level throughout Australia; the National Museum of Victoria, to purchase a camera; students of the Universities of Tasmania and Adelaide, to enable them to attend the School of Marine Biology held at the Division of Fisheries and Oceanography, Cronulla, N.S.W.; Mr. W. H. Dawbin, for expenses in procuring cards relating to hump back whale statistics from the International Whaling Statistics Organization, Norway.

Pastoral Research Laboratory, Armidale

This Laboratory, which is a wing of the new Faculty of Rural Science building at the University of New England, Armidale, N.S.W., was officially opened in March 1961 by His Excellency the Governor of New South Wales, Lieutenant-General Sir Eric Woodward. The Pastoral Research Laboratory is a unit of the Division of Animal Physiology which, in association with "Chiswick" Field Station, is engaged in studying the scientific problems of the woolgrowing industry of the Northern Tablelands of New South Wales. The new building of the Faculty of Rural Science was a joint undertaking between the University of New England and C.S.I.R.O. The Organization's contribution to the cost was provided from Wool Research Funds.

Recruitment of Scientific Staff

The Executive welcomes and, indeed, encourages a reasonable movement of research staff from C.S.I.R.O. to the universities, State instrumentalities, and industry, since it believes this to be a healthy aspect of scientific employment. At present the Organization loses about 45 Research Officers and 60 Experimental Officers each year. To make good these normal losses, the Organization thus needs to recruit annually substantial numbers of scientific staff.

The Executive also encourages a degree of turnover amongst its scientists by making short-term (usually three-year) appointments since these also contribute to the exchange of ideas with other institutions. Program modifications and new lines of investigation also frequently call for staff changes.

Recruitment of scientific staff is becoming increasingly difficult. During the year 1959–60, 50 Research Officers and 84 Experimental Officers were recruited, but this resulted in a net gain of only 2 research and 23 experimental staff. Figures for the year under review are not yet available, but are unlikely to show substantial improvement.

Recruitment from overseas continued to supply approximately two-thirds of all new research scientists. Over 60% of new Research Officers had proceeded to Ph.D. level, while most others had at least equivalent research experience.

Of the advertisements issued during the year, 22 for research staff and 35 for experimental staff did not lead to appointments. The principal shortage continues to be for physicists. Engineers for experimental activities are also difficult to find.

The Executive is determined to maintain the highest standards in the selection of staff. Other countries and other institutions have improved their research facilities, and it is essential that the same should be done by C.S.I.R.O. if good scientists are to be attracted to the staff.

Supporting Staff

For some years the Executive has been concerned at the lack of balance which has arisen in the Organization between professional staff and supporting staff. To establish research programs, it has been necessary to recruit highly qualified professional staff first, and this policy has been carefully followed. With increasing salary costs, however, it has not been possible to provide adequate funds for the appointment of supporting staff. There is now an urgent need for all kinds of supporting staff, particularly workshop staff, laboratory assistants, and field assistants. To re-establish what is regarded as an ideal balance between staff categories throughout C.S.I.R.O. will require the addition of several hundred supporting staff over the next few years.

Buildings and Accommodation

One of the major difficulties facing C.S.I.R.O. since the end of the war has been the provision of adequate buildings. A large expansion of the Organization occurred during the war and in the period immediately afterwards when it was impossible to

erect suitable laboratories. As a result, many of the Divisions and Sections have been housed in wholly inadequate and unsuitable quarters.

The Executive has been encouraged by the action of the Government in increasing the sum available for capital works to £1 million per annum for the last 2 years. Although a large proportion of this has been needed for two major capital works—the giant radio telescope and the Controlled Environment Research Laboratory (phytotron)—it has made possible the erection of a major new laboratory, which is now almost completed, for the Division of Food Preservation. This will permit the rehousing of the Division, which, since its inception, has occupied temporary accommodation at the Homebush Abattoirs of the Meat Industry Board. This accommodation has been grossly inadequate. The increased sum has also provided for the commencement of two other laboratories together with the minor buildings, alterations, repairs, and maintenance which are inescapable every year. If the Government continues to make available a similar annual sum most of the present research staff should be adequately housed within a period of 9 or 10 years. This, however, does not take account of any completely new requirements which may arise in this period, or of the need for re-setting existing laboratories for other reasons.

Among the Divisions urgently requiring rehousing or increased space are the Division of Chemical Physics (a new laboratory costing £450,000 has recently been approved for this Division by the Parliamentary Standing Committee and it is hoped to commence building in 1962 on a site adjacent to the Monash University), and the Divisions of Animal Genetics, Land Research and Regional Survey, Coal Research, Forest Products, and Radiophysics, as well as the Wildlife Survey Section.

All the newer C.S.I.R.O. buildings have been, of necessity, designed on economical, functional lines, to obtain the maximum laboratory space at minimum cost.

During the year under review the following buildings have been completed:

New South Wales:

Armidale	C.S.I.R.O. wing of Rural Science Building, Division of Animal Physiology
Ryde	New laboratory and associated buildings, Division of Food Preservation; High Pressure Laboratory, Division of Physical Chemistry
Griffith	Hydrology Laboratory and extensions to main building, Irrigation Research Station
Prospect	Caretaker's cottage, feed store, and radioisotope laboratory, Division of Animal Physiology
Chippendale	Laboratory annexe, Division of Physics

Victoria:

South Melbourne	Alterations and extension, Division of Forest Products
Parkville	Insect-proof cattle accommodation, Division of Animal Health
Collingwood	Building alterations, Publishing Section

South Australia:

Adelaide	Glass-house, Division of Soils

Australian Capital Territory:

Canberra	Insect-proof glass-house, Division of Entomology
Ginninderra	Laboratory and office buildings, Manager's residence, implement shed, and small farm buildings, Division of Plant Industry

The following buildings are now in the course of construction:

New South Wales:

Albury	Laboratory for phasmatid investigations, Division of Entomology

Victoria:

East Melbourne	Building alterations, Head Office
Clayton	Caretaker's Cottage, Chemical Research Laboratories
Geelong	Main laboratory building, Division of Textile Industry
Parkville	Central block laboratory, Division of Protein Chemistry

Queensland:

St. Lucia	Conversion of garage accommodation to radioisotope laboratory, Division of Tropical Pastures

South Australia:

Adelaide	Laboratory No. 2, Division of Soils

Australian Capital Territory:

Canberra	Biochemistry Laboratory and new Genetics Laboratory wing, Division of Plant Industry; C.E.R.L. Building, Division of Plant Industry

Provision of Equipment

In recent years there has been a steep rise in the cost of scientific equipment. At the same time the modern tendency in science is to make greater use of instruments since it is becoming uneconomic not to do so. Thus computers are now required where desk calculating machines formerly sufficed.

Without up-to-date equipment the scientist cannot make his maximum contribution. He may make progress but results are less rapidly obtained, and a season may be lost in effecting an improvement in yield or in introducing a new process. Whereas 10 years ago C.S.I.R.O. laboratories were as well provided with modern equipment as most laboratories overseas, this is no longer the case. When the electron microscope first became available about 15 years ago C.S.I.R.O. was able to purchase for approximately £5000 one of the first instruments to leave the U.S.A. To-day, however, to provide appropriate equipment for the essential new technique

of nuclear magnetic resonance it would be necessary to allot £60,000. Similar instances could be quoted in many other fields.

It is a source of grave concern to the Executive that it is experiencing more and more difficulty in providing sufficient funds for purchasing new instruments and replacing obsolete equipment. It is a matter to which close attention must be paid in future.

Research Services

Films

The following films were completed and released by the Film Unit during the year:

"Dangerous Immigrant"
"Challenge of the North—the Katherine Area"
"Science and Sheep Breeding".

Work has continued on the following films: "Rainmaking", "Cattle Tick", "Pressure Coring of Wool Bales", "Cattle for Northern Australia", "Bird Banding", "Land", "Green Pea Harvest Prediction", and "Better Building Through Research".

As usual, two prints of each of the films produced during the year have been presented to the National Library, Canberra, and one print of each to both Australian Scientific Liaison Offices, in London and Washington. In addition, the Film Unit has sold at cost in Australia and overseas 151 prints of released films. Prints of "Meiosis" and "Mitosis", two earlier C.S.I.R.O. film productions, have been distributed throughout the U.S.A. by International Films Incorp., earning a total of 1500 dollars in royalties.

The film, "The Biological Control of Insects", released last year, was entered in two leading overseas international scientific film festivals and earned a first and second award.

An indexed catalogue of C.S.I.R.O. film productions prepared during 1959–60 was distributed early this year and has contributed to the increase in the demand for C.S.I.R.O. films.

Overseas Liaison

C.S.I.R.O. has Scientific Liaison Offices in London and Washington as constituent units of the British Commonwealth Scientific Office (London) and the British Commonwealth Scientific Office (North America). These offices maintain close contact with overseas scientific developments and serve as centres for visitors, research students, and visiting scientists. The Chief Scientific Liaison Officers in London and Washington have represented Australia at scientific conferences in the United Kingdom, Europe, and the U.S.A.

Libraries

There has been continued expansion, both of bookstock and library services throughout the system during the year, and a new library has been established at the Division of Food Preservation.

At Head Office the Library has undertaken to provide the Commonwealth Agricultural Bureaux with abstracts of papers published in Australian journals in the fields of pastures, field crops, and horticulture. In addition, the general responsibility for the mailing list for the Organization's publications has been delegated to the Chief Librarian.

Subject enquiries received by C.S.I.R.O. and not specifically directed to the work of any Division or Section have increased. These enquiries are now handled by a senior officer on the library staff who ensures that, where possible, such enquiries are answered by an appropriate specialist within the Organization, or directed to a suitable outside source of reference.

A Bibliography of Beef Production in Australia (1930–58) was compiled by the Librarian of the McMaster Animal Health Laboratory. This has been referred to as an outstanding example of the important part that trained librarians play in scientific research.

Publications

C.S.I.R.O. publishes its research results in a series of scientific journals, in bulletins, in technical papers of the Divisions and Sections, and in special publications such as the "Land Research" series and the "Soil Publication" series. Many research papers are also contributed by C.S.I.R.O. officers to other scientific journals both in Australia and overseas.

The Australian Academy of Science continued to cooperate with C.S.I.R.O. in maintaining a high standard in papers appearing in the scientific journals published by the Organization.

These journals are: the *Australian Journal of Agricultural Research*, the *Australian Journal of Applied Science*, the *Australian Journal of Biological Sciences*, the *Australian Journal of Botany*, the *Australian Journal of Chemistry*, the *Australian Journal of Marine and Freshwater Research*, the *Australian Journal of Physics*, and the *Australian Journal of Zoology*.

Editorial policy is decided by a Board of Standards comprising: Sir Macfarlane Burnet (Chairman), Dr. N. S. Noble (Editor), Professor J. S. Turner, Professor W. P. Rogers, Professor N. S. Bayliss, and Dr. J. L. Pawsey. Advisory committees are responsible for editorial matters affecting each individual journal, and members of the Board serve on appropriate journal committees.

The Royal Australian Chemical Institute collaborates in the publication of the *Australian Journal of Chemistry;* the Institute of Physics (Australian Branch) collaborates in the publication of the *Australian Journal of Physics;* and the Australian Veterinary Association and the Australian Institute of Agricultural Science collaborate in the publication of the *Australian Journal of Agricultural Research.*

The journals receive contributions from research workers, irrespective of country or the establishment to which they are attached. Many papers from workers in Australian universities and a limited number from overseas sources have been published.

Translation

The Translation Section has carried out translation, written, oral, and recorded, as required by Divisions and Sections of the Organization. Recorded translations were made on tape, or plastic disks, according to the playback facilities available at the Division or Section concerned.

The Translation Section has operated as Australian agent for the Index of Translations of the British Commonwealth of Nations Scientific Office, supplying copies of its own translation on request.

The languages handled within the Section have been German, Dutch, Swedish, Norwegian, Danish, French, Italian, Spanish, Portuguese, Russian, and Ukrainian.

Finance

Details of the expenditure of £10,618,066 incurred during 1960–61 are set out in Chapter 5. Of this sum £9,603,963 was expended on normal research activities, £846,903 on capital works, and £167,200 on grants to outside bodies. Funds for this expenditure were derived from the Commonwealth Treasury, contributions from other sources including the Wool Research Trust Fund, and revenue from miscellaneous sources.

The following table summarizes the sources of these funds, and activities on which they were expended.

SOURCE OF FUNDS	*Investigations*	*Capital Works*	*Grants to Outside Bodies*	TOTAL
	£	£	£	£
Treasury Appropriation	7,571,104	364,042	167,200	8,102,346
C.S.I.R.O. Revenue	89,949			89,949
Total Treasury Funds	7,661,053	364,042	167,200	8,192,295
Wool Research Trust Fund	1,437,336	333,031		1,770,367
Contributions (other than Wool)	505,574	149,830		655,404
	9,603,963	846,903	167,200	**10,618,066**

The Organization is particularly gratified by the way that many organizations continue their support, and by the marked interest shown by certain sections of industry which provided funds for cooperative research. Among the many contributions received, reference should be made to those of the Australian Meat Board, the Australian Egg Board, the Queensland Meat Industry Board, the New South Wales Department of Agriculture, the New South Wales Water Conservation and Irrigation Commission, the Metropolitan Meat Industry Board of New South Wales, the Ian McMaster Bequest, the Alexander Fraser Memorial Fund, the Burdekin Bequest, the dried fruits industry, the fertilizer industry, the Australasian Institute of Mining and Metallurgy, the State Electricity Commission of Victoria, the Cement and Concrete Association of Australia, the timber industry, the mining industry, the plaster industry, the Paint Manufacturers' Association, the paper industry, the

United Graziers' Association of Queensland, Broken Hill Associated Smelters Pty. Ltd., the River Murray Commission, the Snowy Mountains Hydro-Electric Authority, the Department of Health, Education, and Welfare (U.S.A), Smith, Kline, and French Laboratories, U.S.A., Western Australian Chamber of Mines (Inc.), the Population Council (Inc.), U.S.A., the International Atomic Energy Commission, the Rockefeller Foundation, the Australian Petroleum Exploration Association, the Egg Producers' Council, Consolidated Zinc Pty. Ltd., Union Carbide Australia Ltd., the Colonial Sugar Refinery, H. C. Sleigh Ltd., Fisons Pest Control, and J. J. R. Geigy of the United Kingdom. In addition, a number of Commonwealth Government Departments provided funds for specific research projects on their behalf.

Organization

For carrying out its research work, C.S.I.R.O. has established several Laboratories, and a number of Divisions and Sections. The four Laboratories are the National Standards Laboratory grouping three Divisions, the Chemical Research Laboratories grouping four Divisions and two Sections, the Wool Research Laboratories grouping three Divisions, and the Animal Research Laboratories grouping three Divisions. There are also 15 independent Divisions in other research fields and an additional 15 independent Sections comprising establishments which have not reached a state of development to justify their designation as Divisions.

Since the investigations extend on a Commonwealth-wide basis and many investigations—particularly those concerned with 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 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 Organization also maintains Australian Scientific Liaison Offices in London and Washington.

LABORATORIES AND DIVISIONS

National Standards Laboratory, consisting of the following three Divisions:

Metrology, Sydney;
Physics, Sydney;
Electrotechnology, Sydney.

Chemical Research Laboratories, consisting of the following four Divisions:

Chemical Physics, Melbourne;
Mineral Chemistry, Melbourne;
Physical Chemistry, Melbourne;
Organic Chemistry, Melbourne;

and the following two Sections:

Cement and Refractories, Melbourne;
Chemical Engineering, Melbourne.

The Laboratories have their headquarters in Melbourne and a branch laboratory in Sydney.

Wool Research Laboratories, consisting of the following three Divisions:

Protein Chemistry, Melbourne;
Textile Physics, Ryde, N.S.W.;
Textile Industry, Geelong, Vic.

Animal Research Laboratories, consisting of the following three Divisions:

Animal Genetics, with headquarters in Sydney, laboratories in Sydney and Rockhampton, Qld., and field stations at Badgery's Creek, N.S.W., at Rockhampton and Cunnamulla, Qld., and at Werribee, Vic.

Animal Health, with headquarters in Melbourne, laboratories in Sydney and Brisbane, and field stations at Tooradin and Werribee, Vic., and at Amberley, Qld.

Animal Physiology, with headquarters at Prospect, N.S.W., and laboratory and field station at Armidale, N.S.W.

Other Divisions are:

Plant Industry, with headquarters in Canberra and main laboratories in Canberra, regional laboratories in Perth, Hobart, and Deniliquin, N.S.W., and field stations, experimental farms, etc., at Applethorpe and Mareeba, Qld., at Kojonup, W.A., and at Canberra.

Entomology, with headquarters and main laboratories in Canberra, a small laboratory in Sydney, and field stations at Trangie, N.S.W., at Rockhampton, Qld., and at Perth.

Biochemistry and General Nutrition, with headquarters in Adelaide and field stations at O'Halloran Hill, Robe, and Brecon, S. Aust.

Soils, with headquarters and laboratories in Adelaide, and branch laboratories in Perth, Canberra, Brisbane, Melbourne, and Hobart.

Forest Products, Melbourne.

Food Preservation, with headquarters and laboratories in Sydney, branch laboratories in Brisbane and Hobart, and a minor laboratory in Gosford, N.S.W.

Fisheries and Oceanography, with headquarters and main laboratories in Cronulla, N.S.W., laboratories in Perth and Melbourne, and field stations at Hobart and Thursday Island.

Radiophysics, Sydney.
Tribophysics, Melbourne.
Building Research, Melbourne.
Mathematical Statistics, Adelaide.
Meteorological Physics, Melbourne.

Land Research and Regional Survey, with headquarters in Canberra, and field stations at Alice Springs, Katherine, and Darwin, N.T., and in the Kimberley region, W.A.

Tropical Pastures, with headquarters in Brisbane, a laboratory at Lawes, Qld., and field station at Samford, Qld.

Coal Research, Sydney.

INDEPENDENT SECTIONS

Commonwealth Research Station, Merbein, Vic. (Murray Irrigation Areas).

Irrigation Research Station, Griffith, N.S.W. (Murrumbidgee Irrigation Areas).

Fodder Conservation, Melbourne.

Ore-dressing Investigations, Melbourne, and Kalgoorlie, W.A.

Mineragraphic Investigations, Melbourne.

Dairy Research, Melbourne.

Physical Metallurgy, Melbourne.

Wildlife Survey, with headquarters in Canberra and field stations at Perth, and Albury, N.S.W.

Agricultural Research Liaison, Melbourne.

Industrial Research Liaison, Melbourne.

Soil Mechanics, Melbourne.

Upper Atmosphere, Camden, N.S.W.

Wheat Research Unit, Sydney.

Editorial and Publications, Melbourne.

Engineering, Melbourne.

REGIONAL CENTRES

These are cooperative research units staffed with officers from the appropriate specialist Divisions to attack the problems of a particular region.

Tasmanian Regional Laboratory, Hobart.

Western Australian Regional Laboratory, Perth.

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Progress in Research

This chapter consists of a brief survey of some of the more important and interesting developments arising during the year under review from the research being carried out in the Organization's laboratories and field stations. It is not intended to be comprehensive.

Technical terms have been reduced to a minimum since it is not a scientific record for use by specialists. For many of the individual projects details may be found in the scientific papers that have been published and in letters patent that have been granted during the year under review. A list of these appears in Chapter 3.

The Annual Reports of each Division and Section of C.S.I.R.O. are published individually or in group Annual Reports such as those of the Chemical Research Laboratories, the Animal Research Laboratories, and the Wool Research Laboratories. Those seeking information on specific fields of study should therefore apply directly to the Division or Section concerned. The addresses of the headquarters of each establishment are shown in Chapter 3.

A "C.S.I.R.O. Research Review" will be published at approximately five-yearly intervals. The last Research Review was for the year ending June 30, 1960.

Efficiency in Superphosphate Usage

Superphosphate valued at about £17 million is used each year by the pastoral industry. It is most important from a national point of view therefore to aim at maximum efficiency in the use of this fertilizer. Current research on pastures on the Southern Tablelands of New South Wales provides evidence that there is scope for increasing efficiency through varying the time of application and the composition of superphosphate.

A comparison of summer (December) with the traditional autumn (March) application on a phalaris–subterranean clover pasture showed that, where the level of superphosphate was critical, the summer application favoured clover and the autumn one grass. This suggests that time of application of superphosphate may be used to manage pasture composition. In one year the earlier application not only encouraged the clover but also increased the total yield of the pasture. There is a need therefore to re-examine the widely held belief that autumn top-dressing is preferable.

Experiments were undertaken to provide a direct comparison between the residual effects of sulphur and phosphorus on pastures that had received different amounts of superphosphate in previous years. These demonstrated that the effect of the phosphorus on the pasture was greater than that of the sulphur. The ideal fertilizer would require a higher phosphorus content relative to sulphur for the early years of pasture development than for later years. The results further showed that the sulphur content of superphosphate relative to the phosphorus content is more than adequate for established pastures on most of the granitic, sedimentary, and red basaltic soils in this important area on the Southern Tablelands.—*Division of Plant Industry.*

Fertility Changes in Wheat Soils

Examination of soils at Ariah Park, in the southern wheat belt of New South Wales, has revealed the extent of the changes in plant nutrients in the soil resulting from approximately 60 years of wheat cropping.

Average losses of soil organic matter equivalent to more than 3½ tons per acre have occurred in these soils, involving losses equivalent to 380 lb per acre of nitrogen, 50 lb of sulphur, 90 lb of potassium, 200 lb of calcium, and 65 lb of magnesium. A period of time under clover ley, however, is likely to restore much of these lost nutrients.

In contrast with many other areas of southern Australian wheat lands, there has been little build-up of residual available phosphate in the soils of this district. Marked responses to superphosphate application were found on all soils examined. It is clear that in this district there is no prospect of reducing current rates of superphosphate application (as has been possible in parts of South Australia and Western Australia) if wheat yields are to be maintained.—*Division of Plant Industry.*

Stimulation of Legume Seed Germination

When the seeds of many legumes have reached maturity on the parent plant they are nevertheless often incapable of immediate germination, and only emerge from this dormant condition slowly and irregularly.

This irregularity is not wholly disadvantageous agronomically, since it spreads the risk of a completely unsuccessful seedling establishment. But such delays are unwanted in experimental work, where uniform stands of seedlings are required. They are also inconvenient in seed testing for certification purposes, where large numbers of samples must be handled with minimum delay.

It has been found that exposure of water-soaked seeds of clovers (notably subterranean clover), medics, and related plants, to low concentrations of carbon dioxide rapidly dissipates the dormant condition, and permits full and uniform germination under most conditions.

This new method, which is simple and more rapid than the older method of exposing seeds to low temperatures, thus offers advantages both in further agronomic research and in routine seed testing.—*Division of Plant Industry.*

Increased Survival of Inoculum on Clover Seeds

When seeds of subterranean clover were inoculated with nodule bacteria by immersing the seeds in liquid inoculum and applying a vacuum, the bacteria survived on the seed in storage for more than 12 months, in the presence or absence of a lime coat.

The immersion-and-vacuum treatment used was based on a method of inoculation developed some years ago in the U.S.A. It was designed to force rhizobia under the seed coat. Claims have been made that lucerne seed inoculated in this way can be stored for considerable periods without the need for reinoculation, but these claims have not been generally accepted.

The evidence obtained with subterranean clover suggests that inoculum applied with the immersion-and-vacuum treatment is less effective after a few weeks' storage than inoculum applied in the normal manner immediately before sowing. However, the results show clearly that when inoculated seeds are stored before sowing, the immersion-and-vacuum treatment is much more effective than the normal method of inoculation. It is a most important finding that subterranean clover seeds can be inoculated in a way that enables rhizobia to survive for very long periods, and a study of the factors involved in this increased survival could well lead to valuable applications in the field.—*Division of Plant Industry.*

Palatability of Grasses

Although most grasses are grazed by herbivorous animals, some species and strains of grasses are grazed more readily than others. Investigations in progress show promise of explaining the reasons for the relative unpalatibility of some species and strains.

Sheep and cattle have been shown to have marked preferences for certain lines of *Phalaris arundinacea* when they are given a free grazing choice of a number of lines.

By using organic solvents a substance has been extracted from the ungrazed (unpalatable) lines which, when applied to the otherwise palatable lines, makes them unpalatable. Furthermore, after leaf material of the unpalatable lines has been extracted, the residue is palatable. Attempts are being made to identify the compound in the extracts which makes certain lines of this grass unpalatable.—*Division of Plant Industry.*

Feeding *Leucaena glauca* to Sheep

Leucaena glauca is a leguminous forage plant growing in subtropical and tropical regions, and gives very high yields of protein. When sheep were transferred from ordinary pasture to a sole diet of *L. glauca*, the whole fleece was shed after about a week. It has now been shown that this toxic effect is due to the presence of mimosine in the plant. Mimosine is partly destroyed by the action of microbes in the rumen. When sheep were fed gradually increasing amounts of *L. glauca*, they became completely resistant to the toxic substance. It is likely therefore that, with suitable husbandry, this valuable plant could be used for feeding to sheep.—*Division of Tropical Pastures and Division of Animal Physiology.*

Fodder Conservation

Hay.—Much of the serious loss of nutrients which occurs during the field curing of hay results from the high susceptibility of pasture species, particularly legumes, to mechanical damage. Recent investigations have shown that there are many sites at which damage occurs. Losses result from stem damage as well as from damage to the leaves themselves. Susceptibility to damage at the various sites differs considerably between individual plants within varieties and between varieties within species. These differences appear to be heritable characteristics, which indicates possibilities of improvement of standard varieties by selection or breeding. Potential improvements are large, and would appear to justify consideration of susceptibility to damage in breeding programs.

Silage.—It has been shown on the other hand that a basic requirement in the technique of silage making is exactly the reverse of that for hay. The lactic acid fermentation, which is essential for good silage, cannot proceed effectively until the plant cells have broken down and released their juices. Therefore, treatments which expedite cell breakdown can be very advantageous. Mechanical bruising of the plant material, such as results from the use of forage harvesters, is one way of hastening the release of plant juices.—*Fodder Conservation Section.*

Pregnancy Toxaemia in Ewes

Death of ewes and foetal lambs from pregnancy toxaemia is an immediate and obvious source of economic loss. More serious still is the fact that the occurrence of the disease often points to a potential state of undernourishment in the remainder of the breeding ewes, with insidious losses expressed particularly in neonatal mortality. It has long been known that pregnancy toxaemia is associated in some way with undernutrition, or actual fasting, during late pregnancy, but the exact nature of the disease syndrome has not yet been determined.

Recent studies have shown the importance of environmental stress in precipitating the disease. Current experiments are giving indications that the disease has the characteristics of a diabetic state, in which the endocrine change is chiefly exhibited as an excessive activity of the adrenal cortex. It is also probable that, when the disease is induced primarily by sustained undernutrition, some degree of insulin insufficiency may contribute to the endocrine imbalance.

This diabetic state is obscured in the pregnant ewe because the foetuses have such high demand for glucose. Thus a potential hyperglycaemia, characteristic of diabetes, is converted to a hypoglycaemia.—*Division of Animal Physiology.*

Control of Posthitis in Wethers

Posthitis in wethers results in serious financial losses. Experiments at Armidale have now provided a practical and economic means of controlling this disease which causes severe inflammation of the prepuce. The new procedure consists of implantation, under the skin, of small pellets of the male hormone, testosterone. The hormone is slowly absorbed from the pellets for several months and protects the animal from the

disease. The hormone is also useful, combined with local antiseptic applications, in the treatment of severely affected wethers. There are two beneficial side effects of the hormone implants: increased wool production and increased liveweight gains. An undesirable feature is that horn growth may be stimulated, but this will probably not interfere with general sheep handling.—*Division of Animal Physiology.*

Worm Parasites of Sheep and Cattle

In the better-rainfall areas of Australia, worms, especially those of the stomach and intestine, cause considerable economic losses. As eggs are passed on to the pastures in excreta, the improvement of pastures, with consequent higher stocking rates, increases the intake of larvae which hatch from the eggs. Studies are being made of factors affecting viability of eggs and worm larvae on the pastures before ingestion, of the development of larvae within the body tissues until the mature stage is reached, and of those reactions between the host and the worms that lead to host resistance to worms. These investigations are providing the foundation for recommendations for the control of these parasitic diseases.

With sheep parasites at the McMaster Laboratory in Sydney and with cattle parasites at the Veterinary Parasitology Laboratory, Yeerongpilly, Qld., much progress has recently been made in these studies. With worms from both sheep and cattle, the value of the X-ray treatment of larvae for use in vaccines is being investigated. Concurrently with such studies, new anthelmintic drugs for the treatment of worm-infested livestock are being tested. For cattle, "Neguvon" has proved to have many advantages over earlier drugs. For sheep, the drug "Thiabendazole", recently offered for test, has been found under experimental conditions to be highly effective against all the more important roundworms infesting the digestive tract. This latter finding is important because drugs commonly used to date have been very effective against some species, but have left other harmful species unaffected or only slightly reduced in numbers.—*Division of Animal Health.*

Resistant Cattle for Tick Control

Experiments at Amberley, Qld., have indicated a striking way of exploiting the well-known variation between cattle of British breeds in their susceptibility to cattle tick. Twenty-four Australian Illawarra Shorthorn heifers were grazed together from mid February to mid May 1960 while they were graded for tick susceptibility, the pasture becoming evenly seeded with a heavy infestation of tick larvae. During this period the infestations became so heavy that it was necessary to spray all the cattle with DDT on three occasions. In May, the cattle were drafted into four herds of six animals each, two herds comprising the animals which had carried the fewest ticks in the preceding three months, and the other two herds comprising the animals which had carried the greatest number of ticks. Each herd was then confined continuously to one-quarter of the area previously grazed.

In the following cattle tick season (November 1960–May 1961), one of the relatively resistant herds required only one spraying, and the other no spraying at all. On the other hand, the two relatively susceptible herds were so heavily infested that

they required spraying five and six times respectively in the November 1960–May 1961 season. The experiments suggest that the selection of cattle for their resistance to ticks may be a highly satisfactory means of minimizing losses due to tick infestation. Studies will now be initiated on the genetic basis of the phenomenon.—*Division of Entomology*.

Alpine Ecology

In water supply catchments such as the Snowy Mountains, the main objective of land management should be to obtain the maximum sustained yield of silt-free water. Measurements in the Guthega catchment between 1956 and 1960 have shown that timbered areas accumulate up to 100% more snow than deforested areas, and retain it up to 1 month longer. Trees also collect at least 10% more water from wind-blown rain, fog, and cloud. Judicious reafforestation can therefore increase water yield, in addition to assisting soil conservation.—*Division of Plant Industry*.

Control of Marsupial Damage to Eucalypt Seedlings

Browsing damage to seedlings of *Eucalyptus regnans* is severe in logged and burnt areas of rain-forest in Tasmania where these seedlings are being established as the future forest for newsprint manufacture. The culprit species are two wallabies (*Thylogale billardieri* and *Protemnodon rufogrisea*) and the brush-tailed possum (*Trichosurus vulpecula*).

Control has been effected by surrounding cut-over sections of the forest with closely spaced dry bran-pollard baits for periods of up to 1 week, followed by the laying of damp bran-pollard baits containing the poison "1080" (sodium fluoroacetate). This has resulted in a high percentage kill which has reduced browsing pressure sufficiently to enable eucalypt seedlings to pass the critical size at which browsing is most intensive and dangerous to seedling survival.—*Wildlife Survey Section*.

Higher Peanut Yields

A basic physiological study of peanuts in the tropical environment of Katherine in the Northern Territory has shown how important such a simple matter as date of harvesting can be to the prosperity of an industry. This recent work suggests that in some years the total yield of kernels can be increased more than twofold by delaying the harvest for a few days.

During the past wet season, when these studies were carried out, the rainfall was one of the lowest on record. Yields were naturally lower than usual. However, the rate of yield of kernels increased from 560 to 1400 lb/acre in the last three weeks of growth. This demonstrated the rapid development which takes place as the peanut plant matures.

With the machinery used at present, the condition of the soil has determined largely when the crop should be harvested. If this machinery were used when the

kernels were mature, approximately 30% of the crop could be left in the ground, owing to the hardness of the rapidly drying soil. Thus, new machinery specially designed for these northern conditions could increase yields of peanuts enormously.—*Division of Land Research and Regional Survey.*

Bitter Pit Response to Calcium Sprays

Bitter pit is a disorder of apples which has caused serious losses, both on the tree and in storage. Although cultural and storage methods to reduce wastage had been studied with moderate success, no information on a fundamental cause had been obtained.

Recent work in the U.S.A. on this disorder and an analagous one in tomatoes suggested that the cause might be a lack of balance between calcium and magnesium. Research has confirmed this for Tasmanian conditions, and very useful reductions in the disorder have been obtained by sprays of calcium nitrate. Experiments with ^{45}Ca have shown that the mobility of calcium in apple trees is greater than expected and, under conditions likely to produce pit, calcium can migrate from fruit to leaves.—*Division of Plant Industry.*

Changing the Time of Ripening of Apples on the Tree

During three seasons apples were hastened in their maturity by spraying the trees with 0·5% borax in summer, and were delayed in their ripening in two of the three seasons by spraying with 1% urea solution. It was shown that harvesting time could be controlled and extended so that advantage could be taken of any high-priced early market for Jonathan fruits and that a small labour force could pick a crop so treated. An orchard trial of 1½ acres of trees showed that, with borax spraying, fruit was matured 6 days earlier at the first picking, and that the trees were fully harvested 14 days earlier than the unsprayed trees. No decrease in fruit quality was observed that would affect the apples for the fresh fruit market.—*Division of Plant Industry.*

More Fruit for Less Pruning in Apple Trees

In a 20-year-old trial with Jonathan apple trees on EM.XII, Essfour, and Ivory's Double Vigour rootstocks, one set of trees was pruned annually, leaders and lateral growths being cut back. Another set was allowed to grow leading shoots unpruned for 6 years and with certain laterals unpruned to fill in the framework of the tree; thereafter shoots were pruned lightly. In the 20 years of the trial the lightly pruned trees have returned an extra 15% yield per tree. The extra crop carried by the lightly pruned trees has not caused stunting of growth by overbearing; indeed these heavy-cropping trees are somewhat larger in size as measured by trunk girth.—*Division of Plant Industry.*

New Approach to Orchard Pest Control

The control of orchard pests by purely chemical means is becoming gradually more difficult and costly. This is due to various factors, including resistance to insecticides, elimination of beneficial insects, and accumulation of toxic residues. A new approach to orchard pest control is required, and it is felt that improved methods of control should be based primarily on the suppression of favourable breeding conditions. This approach is termed "pest management" and implies deliberate manipulation of the environment of pests to limit their abundance.

Investigations using this approach have been carried out on the control of the codling moth. It was found that codling moth infestations are largely dependent on the larvae which overwinter in an orchard. The numbers of these in turn depend on the amount of cocoon shelter available in the orchard during the overwintering period. By adequate management it was possible to reduce the overwintering shelter for the larvae. This measure could also be enhanced still further by providing artificial shelters (trap bands) to which the overwintering individuals were attracted in large numbers and destroyed by special toxic deposits. Relatively few insecticidal treatments were needed in the following season as a safety factor additional to these ecological preventative measures, in order to control the codling moth at tolerable densities.

These findings point the way to a possible solution of other orchard pest problems by minimizing the favourableness of the pests' environment through adequate "pest management".—*Division of Entomology.*

Protection of Plastics from Termites

Termite damage to the plastic sheathing of power and telephone cables, and to plastic agricultural piping, occurs in many parts of Australia. The more commonly used plastics for these purposes ("Polythene" and polyvinyl chloride) have a high resistance to termite attack in their rigid form. However, the susceptibility of plastics to termite attack increases with increasing additions of plasticizer, and some degree of plasticizing is normally required for processing flexible sheathing or piping.

Laboratory tests with three species of termites have shown that such factors as surface finish, density, and intrinsic hardness have little effect on the susceptibility of plastics to attack. However, susceptibility can be decreased appreciably by (1) the use of phosphate instead of phthalate plasticizers, (2) the incorporation of 5% of certain inert fillers such as hard silica, zircon flour, or diatomaceous earth, and (3) addition of small amounts of insecticidal materials during processing, of which the most effective to date are aldrin and dieldrin.—*Division of Entomology.*

The Sealing Industry

The southern elephant seal is taken for its blubber and other products at South Georgia and Kerguelen Islands in the Southern Ocean. Heard and Macquarie Islands also have large populations which used to be similarly exploited. Earlier wasteful methods resulted in periodic devastation of these seal herds. Recent attempts to

revive sealing at the Australian islands necessitate population studies to determine rational levels and methods of harvesting that will conserve the breeding stock.

Since 1951, at Macquarie Island, 5042 elephant seal pups have been branded with combinations of letters which enable the future history of individual seals to be followed. Some cows have their first pup when 4 years old—a year older than the same species at South Georgia—and others not until their fifth, sixth, or later years. Bulls, which grow to 20 ft and 4 tons, do not possess harems until they are about 15 years old, and many must live more than 20 years.

The heavy natural mortality among first-year seals reduces both sexes to one-third of the number of pups weaned, and only one-quarter survive into their sixth year. The Macquarie Island population is estimated at 110,000 (including 30,000 pups), and that at Heard Island is about 85,000 (22,000 pups). The study of an entirely undisturbed population at Macquarie Island is not the only essential precursor to any future harvesting of the elephant seal there, but affords valuable comparison with seal populations on other islands to determine the effects of the industry on age structure and productivity.—*Wildlife Survey Section.*

Rabbit Behaviour and Control Methods

The control of a pest species as ubiquitous and aggressive as the rabbit calls for intensive research into all aspects of its biology, especially behaviour. Investigations have been carried out at two levels—what rabbits do as individual members of social groups, and what the species does to maintain itself throughout whole regions.

Rabbits are very sedentary animals, and live in a small circumscribed area or home range, which varies in size with the seasons. It is largest in summer, when pastures are dry and water is in short supply, and diminishes during the winter months. Breeding takes place from autumn to spring, when small social groups are formed which protect their individual territories from all other rabbits. When breeding ceases the groups break down and territoriality disappears.

Seasonal changes in the social structure are therefore important to the tactics of rabbit control. During the breeding season broadcast poisoning has a better chance of success than furrow poisoning since individuals are then not necessarily free to move to bait laid in furrows. During the summer no social barriers to movement exist, and both furrow and broadcast poisoning can be used effectively.

Shifts of home range occur owing to social pressures within the population and because of environmental changes, especially shortages of food and water. There are two periods of the year, spring and autumn, when large-scale movements of young rabbits ejected from social groups are likely to occur. Movements due to shortages of food and water usually occur in summer.

Regional rabbit populations distribute themselves without reference to property boundaries (unless netted). In most regions there are certain well-defined refuge areas in which rabbits live and breed year in and year out. These areas act as reservoirs from which rabbits spill out, under pressure, over better-class country during good years. Control efforts should be focused on these areas.—*Wildlife Survey Section.*

Soil Phosphate Minerals

Many soils, although naturally high in phosphorus, behave towards plants as if phosphorus-deficient. Other soils render unavailable much of the phosphorus added as fertilizer. It is probable that the naturally unavailable and the fixed phosphates are related, and a knowledge of their nature is very desirable. Specific information on soil phosphates is difficult to obtain because only very small amounts are in the soil, and these are in the very fine particle size fractions which cannot be studied by conventional methods.

By using X-ray diffraction and X-ray spectrographic techniques, it has been possible to identify some naturally occurring soil phosphates. The phosphate minerals belong to a chemically complex group which comprises aluminium phosphates with varying amounts of calcium, strontium, barium, rare earths, and other elements. Minerals of this group have been identified in a wide range of different soils. They have developed from a variety of different rocks and under a wide range of climatic conditions. These minerals appear to be common forms of phosphorus in soils and their mode of occurrence is indicative of extreme insolubility. Microbiological assays have confirmed that the phosphorus in these minerals is almost completely unavailable.

The nature of occurrence of the minerals suggests that they are formed as part of the soil profile and that they are not just residual from the parent material. A very detailed study of the origin of the phosphorus mineral in a yellow podzolic soil from the Barossa Valley area showed that it was formed from apatite (calcium phosphate) in the parent rock.

The phosphate minerals being studied may be important in other respects, since in some of the soils all of certain heavy metals (copper, chromium, and lead) are contained in the phosphate minerals and are probably unavailable.—*Division of Soils.*

Making Better Use of Nitrogen

The key role of nitrogen in improving the fertility of the soils of northern Australia is becoming increasingly evident as the results of research at Katherine, in the Northern Territory, accumulate.

Studies at Katherine have shown that nitrogen, in a form available to plants, concentrates just under the soil surface during the dry season. The greatest loss occurs during the wet season, owing to leaching by rain. As a result, crops should be sown early so that roots can intercept the greater part of the nitrogen. Another approach is to plough in plant residues (e.g. sorghum stubble) with a low nitrogen content. The nitrogen is then held in the decaying matter and released late in the wet season.

When leaching has occurred for a number of years (for example, under fallowed land), a substantial amount of the available nitrogen accumulates in the subsoil. Shallow-rooted crops such as sorghum cannot reach it, but deep-rooted crops such as bulrush millet are very efficient at retrieving it. On one experiment where the nitrogen had been leached deeply, bulrush millet yielded 180 lb/acre of nitrogen in its above-ground material, compared with 90 lb/acre from fodder sorghum.—*Division of Land Research and Regional Survey.*

Fertility Testing of Queensland Soils

Testing by glass-house and laboratory techniques of the fertility status of Queensland soils has been in progress for some years.

Black soils such as the deep alluvial black earths of the Darling Downs wheat belt have been associated traditionally with high fertility in Australian agriculture. However, recent studies have shown that some degree of chemical infertility is normal on many of the black soils overlying basalt, and is inherited from the parent material owing to the age and variability of the lava flows. Shallow black earths on the Darling Downs have shown marked response to sulphur and molybdenum, and in the Gayndah district to phosphorus also.

A significant proportion of the dairy industry in Queensland is located on red loam soils originally derived from basalt. Pot tests have shown that with these soils, apart from a general lack of nitrogen, phosphorus is the key shortage. Despite moderate to high natural phosphate contents, phosphate deficiency is severe. In one case, yield increased 400% with successive additions equivalent to 16 cwt per acre superphosphate, and the curve showed little sign of flattening off. Phosphate fixation is a very real problem. Thus small applications, as usually made by the farmers, are unlikely to be very successful. This may explain why local opinion does not entirely favour the use of superphosphate dressings on pasture.—*Division of Soils.*

Environmental Effects on Nitrogen Fixation by Legumes

An examination of the effect of both high (26–30°C) and low (5–10°C) soil temperatures on the growth of nodulated subterranean clover plants has shown that yields are reduced compared with plants grown at 18–22°C.

The effect of low root temperatures on nitrogen fixation by different varieties of the clover, nodulated by different strains of root nodule bacteria, has provided interesting information of possible agronomic importance. For example, at 5°C some plant bacteria associations fix up to four times more atmospheric nitrogen than others. Furthermore, soil temperatures of 5°C may result in total nitrogen fixation being as low as 10% of that obtained by the same variety of clover and strain of bacteria grown at 22°C. While the growth of plants receiving nitrogenous fertilizer is also reduced by low soil temperatures, it is common, but not invariable, for the growth of nodulated plants to be affected to a greater degree.

At higher root temperatures (26–30°C), marked differentiation in the effectiveness of nodulation by strains of bacteria were observed on some varieties; whereas at lower temperatures, on the same varieties, the levels of effectiveness of the strains were similar. With one variety the relative positions were reversed at soil temperatures above 20°C.

These associations of plant and bacteria provide promising material with which to increase pasture production and raise the nitrogen status of the soil. Some varieties of subterranean clover seem better adapted to forming a symbiosis with the root nodule bacteria than do others and these varieties, either in direct use or in breeding programs, may be of assistance in raising production.—*Division of Plant Industry.*

Nutrition of Tobacco Plants

At the current tobacco sales a large percentage of the offering frequently attracts only low bids due to its "flat" appearance. This type of leaf first became prominent in the Burdekin area, but it is now being produced in all districts. Experiments have shown that this condition can be induced by low levels of nitrogen nutrition. In an endeavour to produce a bright lemon leaf, growers have attempted to grow a plant that appeared yellow during growth. Plants grown thus never pass from the normal green to yellow colour associated with natural maturity, but merely change from one shade of yellow to another. As a result, at harvesting this leaf appears physically mature, but is chemically immature, and all its faults become apparent after curing. Associated with this condition there is often an increase in leaf chloride, which is undesirable. The above conditions can be prevented by a change in fertilizer practice.—*Division of Plant Industry.*

Diagnosing Nutrient Deficiency in Sultana Vines

Characteristic deficiency symptoms have been induced in sultana vines grown in nutrient solutions lacking in one of the following: nitrogen, sulphur, calcium, potassium, and magnesium. Symptoms included die-back of roots, shoot restriction, leaf chlorosis, leaf roll, marginal burning, and defoliation. Leaf symptoms were lacking in the case of phosphorus deficiency. The results of this investigation should enable diagnosis to be more readily made of nutrient deficiencies in sultana vines.—*Commonwealth Research Station, Merbein.*

Survey of the Brigalow Belt

Stretching in a great belt, averaging 100 miles wide, from the Central Highlands of Queensland at latitude 21° down into the north of New South Wales about latitude 30° is the brigalow country, well known in the past from its prickly pear infestation. The face of this vast area of 25 million acres is rapidly changing in its agriculture. A three-year survey recently completed has defined the soils associated with brigalow scrub as a major component of the zone. Four main groups of grey heavy clay soils, differing in depth, parent material, pH profiles, degree of gilgai development, and liability to seasonal flooding, have been defined in Queensland. A fifth group, of coarser-textured brown soils, occurs in the low-rainfall west Darling area in New South Wales. These soils have been mapped in some detail and their field character and fertility status worked out.

The swing to cultivated crops and to sown pastures and fodders is proceeding strongly, but the problems on the soil side need definition if production is to reach its optimum. The structure and water storage capacity of the soil have been studied and also the availability of plant nutrients. One key factor is the soil moisture regime in the annual cycle. Estimation of this presents real difficulty, even with modern equipment, owing to high shrinkage capacity of the soils and to earth movements.

The actual brigalow-bearing soils make up about 50% of the whole belt. The next stage, now being attacked, is the characterization of the fine-textured alluvial

clays and the old, leached, solodic types closely associated with the dark grey brigalow soils. A complete understanding of the soils of the brigalow belt is sought to aid expansion of arable agriculture on this potentially highly productive land.—*Division of Soils.*

Pastures for the "Wallum"

After 10 years of intensive research in fields of plant nutrition and agrostology, a solution has been found to the problem of developing stable productive pastures for the infertile coastal lowlands ("wallum") of southern Queensland. This 2,000,000 acre region of forests and heaths extends as a narrow coastal strip from northern New South Wales to Bundaberg. Some land is used for forestry, but the majority remains totally undeveloped, although it enjoys good rainfall (40–65 in. per annum), is well served by transport, and is close to markets.

Plant nutrition experiments have shown that the major soil types are amongst the poorest in the world. Supplies of nitrogen, phosphorus, potassium, sulphur, calcium, copper, zinc, and molybdenum are inadequate in these soils to produce satisfactory pasture growth. Appropriate fertilizer dressings to overcome these deficiencies have been worked out. It has now been demonstrated that when these nutrient requirements have been fulfilled, pastures can be grown on these "wallum" soils which are capable of growing and fattening cattle at stocking rates of a beast to 1½ acres, with annual liveweight increases of 300 lb per beast. These pastures are based on new tropical grasses and legumes brought in from overseas. Further research to investigate the economics of growing improved pasture in this region has been designed.—*Division of Tropical Pastures.*

Weeds Ecology

Control of weeds in pastures depends on the establishment of useful perennial species which can compete successfully with the weeds, and prevent invasion. Promising results have been obtained over the last three years with Brignoles cocksfoot as a competing species in the control of Scotch thistle (*Onopordum* sp.). Both Hunter River lucerne and *Phalaris tuberosa* have proved effective in the control of variegated thistle (*Silybum marianum*), especially if the seedling thistles are suppressed during establishment of the pasture by spraying with the sodium salt of 2,4-DB(2,4-dichlorophenoxybutyric acid).

In the control of soursob (*Oxalis pes-caprae*), results to date suggest that, in heavily infested areas, reduction of the population of bulbs by cultivation is necessary before chemical treatment can be effective. Using a combination of cultivation and chemical treatments, a control program extending over a two-year period is being tested. Two cultivations (late May–early June, and late July–early August) are to be followed by the sowing of a cereal crop. In the second year the area will be sprayed with 2,4,5-TP (2,4,5-trichlorophenoxypropionic acid). This will be followed one month later by a cultivation and the sowing of cereals or fodder crops, or the establishment of pasture.—*Division of Plant Industry.*

Medics

The naturalized medics are particularly important as pasture legumes in the subhumid to semi-arid regions of New South Wales, but many species are at the same time largely responsible for vegetable fault in wool. Current investigations are aimed at replacing undesirable types with species and strains which are efficient in nitrogen fixation and produce a large bulk of feed, but do not cause vegetable fault in wool. A survey of the Macquarie region has shown that the various species of *Medicago* show well-marked preferences for certain soil types. The first trial which has been made to replace an undesirable species (*M. minima*) with desirable types has given promising results. Selected strains of *M. tribuloides* (barrel medic) and *M. turbinata* have been successfully introduced into a stand of *M. minima* at Crooble, in the Namoi region, on a black earth, after normal cultivation for wheat, and without addition of fertilizers.

It is yet too early to say whether these better species will persist in the area to which they have been introduced under normal farm management conditions, involving cultivation for wheat, and grazing by sheep.—*Division of Plant Industry.*

Cobalt Deficiency in a Plant

Following a recent discovery overseas that the element cobalt is necessary for nitrogen fixation in legumes, C.S.I.R.O. officers in Western Australia have obtained a response to cobalt in the legume subterranean clover in the field. The cobalt content of affected plants—0·02–0·03 p.p.m.—is remarkably low.

No response to cobalt was detected in the presence of applied nitrogen fertilizer, which provides support for the function of cobalt in nitrogen fixation. Further studies are planned.—*Division of Plant Industry.*

Role of Manganese in Photosynthesis

Photosynthesis is the process whereby plants convert the energy of sunlight into chemical energy, and in turn utilize this to synthesize carbohydrates, such as starch, from carbon dioxide and water.

Studies on the role of elements in plants have shown that manganese deficiency inhibits a reaction involved in the evolution of oxygen during photosynthesis, and hence seriously reduces the photosynthetic capacity of chloroplasts. The reactions of photosynthesis occur mainly in the green particles (chloroplasts) in the plant leaf. In this study, chloroplasts were isolated from healthy and from manganese-deficient plants, and a comparison was made of the capacity of these isolated chloroplasts to carry out various reactions which contribute to the overall process of photosynthesis.

The manganese was found to be specifically concerned with reactions which lead to the evolution of oxygen, and not with reactions in which light energy is trapped and converted into chemical energy.

In accordance with these findings, the work has also shown that manganese is a constituent of normal chloroplasts, and that where insufficient manganese is present the photochemical activity of isolated chloroplasts is proportional to their manganese content.—*Division of Plant Industry.*

Antifungal Porphyrins

Some new synthetic porphyrins have been found to have striking activity against certain fungi, including those causing brown rot in stone fruits and blue mould in tobacco. These compounds are derivatives of *meso*-tetra-(4-pyridyl)porphin. They are water soluble, and are not toxic to plants. Their activity depends upon the balance between their solubilities in oil and in water. There are many opportunities to seek increased activity by structural variations. The best compounds so far obtained are already effective *in vitro* in concentrations of 1 p.p.m. or less. The development of these antifungal compounds for possible industrial use is already being carried out in commercial laboratories, which are also screening the compounds for a wide range of other biological activities.—*Division of Plant Industry.*

Plants Causing Liver Disease in Stock

While *Heliotropium europaeum* ("potato weed", "wild heliotrope") constitutes a problem to graziers in certain areas of New South Wales, Victoria, and South Australia, another heliotrope species, *H. amplexicaule* has come under suspicion of causing liver damage to sheep in southern Queensland. Chemical and toxicological studies have therefore been undertaken on the alkaloids of this plant. The alkaloid content, mostly *N*-oxide, is high and the principal component, a previously unknown alkaloid, has been shown to produce in rats liver damage with megalocytosis typical of that caused by pyrrolizidine alkaloids. Another alkaloid, indicine, known to be capable of producing liver damage, has been isolated from another species of heliotrope, *H. indicum*, which also occurs in Queensland. Determination of its structure has now shown indicine to be related to the *H. europaeum* group of alkaloids.—*Division of Animal Health and Division of Organic Chemistry.*

Digestion in Zebu, Zebu Cross, and Hereford Cattle

Experiments have been carried out with Brahman, first cross Brahman × Shorthorn, first cross Afrikander × Hereford, and Hereford steers, comparing the digestive efficiency of the breed groups for plant protein. The experiments were performed with the aid of specially designed metabolism cages. This apparatus permits the separate collection of faeces and urine, without loss. In each experiment the animals were fed equivalent amounts of feed according to their body weight, the feed consisting of chaffed spear grass or blue grass hay, alone or in combination with various proportions of lucerne hay.

In each experiment the Brahmans, Brahman × Shorthorns, and Afrikander × Herefords did not differ in the apparent digestibility of nitrogen, i.e. in the ratio of faecal nitrogen to feed nitrogen. The Herefords, however, excreted in the faeces significantly more than the other breeds.

In each group of experiments the Herefords excreted about 0·05 g of nitrogen per 100 g of dry feed more than the other breed groups. In terms of body weight, this could lead to a difference of 125–175 lb between Brahman × Shorthorn and Hereford steers at 2½ years of age. This is approximately one-half the difference found in the field at the National Cattle Breeding Station near Rockhampton.—*Division of Animal Genetics.*

Virus Diseases of Livestock

Australia, in the past, has been kept free from some devastating virus diseases such as smallpox in man and foot-and-mouth disease in cattle, sheep, and pigs.

Virus diseases already established here cause sickness and suffering in man, and in livestock are responsible for much ill health, which greatly reduces the national yield of animal products. Although much research has been devoted to virology in the field of human medicine in Australia, it is only within the last three years that a special research centre has been established for the investigation of virus diseases in livestock. At the Animal Health Research Laboratory, Melbourne, the work of this small unit has already revealed, for the first time in Australia, the occurrence of several new virus infections of cattle. One of these causes sporadic encephalomyelitis, a disease with a high case mortality rate, which has now been diagnosed in Victoria, South Australia, and New South Wales. Recently, there was evidence that a disease new to Australia, and probably introduced from overseas, swept through herds of cattle in all States. It was a type of epidemic diarrhoea, probably due to a virus, which caused much temporary economic loss in the dairy industry.

During the autumn of 1961, isolated outbreaks of pneumonia of unknown origin in sheep have been reported from three States. Viruses have been isolated from the lungs but have not yet been fully tested to determine whether they are the cause of the disease. Viruses isolated from diseased pigs also await further testing.—*Division of Animal Health.*

Mutant Sheep as Research "Tools"

Apparently all living things occasionally produce "mutants". These are the result of sudden permanent changes which occur during the reproductive processes; examples are white kangaroos and dwarf cattle. The sheep is no exception, and mutations occur perhaps as frequently as one in every half-million births. Several of these mutant-type sheep have proved valuable as experimental animals. Sheep without sweat glands in the skin have been used for studying heat loss and neonatal mortality in lambs, while a mutant ram aids experiments on fertility and temperature regulation of the testicles. "Lustre-mutants" grow wool which is devoid of crimp. Since crimp is considered to be one of the most important attributes of the fleece, this lustre wool is valuable for research on the role of crimp in textile processes.—*Division of Animal Physiology.*

Snails

Snails in the suburban garden are easily seen and their powers of destruction are well known. But a freshwater snail, so small as to be easily missed by the naked eye, causes destruction indirectly because it is the essential intermediate host of the liver fluke of sheep and cattle. This fluke may be the cause of death due to liver damage. It may also provide conditions suitable for the growth of the germ which kills sheep and cattle from black disease. Alternatively it may only cause damage to livers, which cannot then be passed for human consumption. If these snails could be eliminated the liver fluke would cease to exist.

For these reasons, research on this snail is important. Although it had been thought that there were different species of small snails involved in different parts of Australasia, work at the McMaster Laboratory, Sydney, has shown that there is only one species involved. When snails of different appearance were gathered from different areas and were bred under standard laboratory conditions, the offspring rapidly assumed a uniform appearance. Thus work directed against one species will meet all practical requirements.

Studies on the life habits of this snail (*Lymnea tomentosa*) which infests grazing lands have revealed great difficulties in the application of effective control measures. For example, it has been shown that individual snails from a dense population carry only a few intermediate-stage liver flukes, but if the population is drastically reduced then each surviving snail will harbour so many flukes that the end result may be similar. It has also been shown that this snail can live in dried mud for up to 11 months and then, after rain, emerge and repopulate the environment immediately.—*Division of Animal Health.*

Improved Wool from Selected Sheep

Selection for high clean wool weight at "Gilruth Plains" produced in 8 years a difference of 1 lb per head in clean wool weight between the selected and the control group. This represented a difference of about 20%. Since those measurements were taken, the property has been in a severe drought, lambs born in 1959 being weaned early and hand fed for some months before the rains came and there was grass on the paddocks. It is of interest that, even under these severe conditions, the selected group still produced approximately 20% more wool than the control group. This was so even with the young rams, which at approximately 12 months of age weighed only 42 lb.

Losses amongst the breeding ewes in the selected group were no higher than in the control, even though the ewes were fed on mulga for some months of the year.

Processing trials have been carried out on wool from the selected animals. It was desirable to know whether the processing performance of the wool had been changed in any way. Tests in which the wool was taken right through carding, combing, spinning, and weaving have shown that the wool, if anything, has been improved in its performance. There has been less waste in processing, and stronger yarn and fabric were produced from the selected wool when compared with wool from unselected control animals.—*Division of Animal Genetics and Division of Textile Industry.*

Bushfire Research

Field studies have progressed to the stage where the problems associated with bushfires are at least recognized. The data collected are now sufficient to allow the design of laboratory models to give some insight into the mechanism of flame propagation. In addition to the field work, two laboratory projects are now in progress. One, whose object is to study the variation of the moisture content of natural fuels with changing atmospheric conditions, has already shown that some current methods of predicting fire hazard may be seriously in error. The long-range objective of the other project is to find new firefighting and fireproofing materials for use against bushfires. Although in its infancy, this research has yielded valuable information, particularly about the nature of the combustible products formed from natural fuels.—*Division of Physical Chemistry.*

Discoloration of Dressed Beef and Mutton Carcasses

Over a period of 40 years a grey-brown discoloration has appeared intermittently on beef and mutton carcasses held in many chilling rooms after slaughter. The cause of these outbreaks has now been discovered, and preventive measures have been applied.

The discoloration on beef forequarters appeared as a grey-brown colour in place of the expected bright red on the surface layer of the exposed eye muscle, and as a greyish white bleached colour in the adjacent fatty tissue. It was caused by drops of condensed water containing nitrite salts dripping on to the muscle from the chiller ceilings. Lamb and mutton carcasses often suffered a diffuse greying and bleaching over the whole carcass when stored in "hold-over" rooms. The meat from the stained carcasses could be used but in the case of beef forequarters trimming was needed and mutton was down-graded in quality.

The nitrite was found to be produced by a soil-inhabiting microorganism belonging to the *Nitrosomonas* genus which had invaded the walls, ceilings, and water cooling systems. In the soil, *Nitrosomonas* produces nitrite from the ammonia formed by decaying animal and vegetable proteins, but is always accompanied by *Nitrobacter* species which convert the nitrite formed to nitrate. In this way no nitrite accumulates in the soil. In meatworks, *Nitrosomonas* acts on traces of ammonia gas released from the refrigeration system, but only in rare cases is the nitrite that it produces converted to nitrate. Control of *Nitrosomonas* was obtained by washing the ceilings with solutions of chlorine and by adding up to 30 p.p.m. of this gas to the liquid cooling systems.—*Division of Food Preservation.*

Food Pigments

Previous procedures for the identification of anthocyanins, the pigments responsible for the deep red and blue colours of fruits and berries, have depended on large-scale chemical degradation or on chromatographic comparison with known pigments. The former method is time consuming and requires a large amount of material;

the latter method is not only unreliable but the necessary comparison materials are frequently difficult to obtain. A procedure has now been evolved for the identification of anthocyanins without recourse to reference pigments. This is based on several selective oxidative and hydrolytic reactions, which have been adapted to a microscale by application of paper chromatography, so that the identification requires only 10 mg of pigment, either in the solid or solution form. This procedure will greatly simplify the study of the pigments in fresh foods and their behaviour during processing and storage.—*Division of Food Preservation.*

Prevention of Spoilage in High-Moisture Content Prunes

Australia produces a dried prune crop which averages about 3000 tons per annum. The majority is sold as a high-moisture, soft-textured product which is processed in 7 lb cans and distributed in 8–16 oz lots through grocers and health food shops. The moist prunes from the can may support microbial growth, and buyers of the small lots either store in a refrigerator, or use them within 2–3 weeks of purchase.

The increasing trend toward self-service stores and supermarkets is closing many of the retail outlets for this commodity with the result that in early 1960 much of the 1959 prune crop was still unsold. In addition, some of Australia's canned prune exports were being displaced by competitors who supplied prunes in flexible film containers holding 12–16 oz of moist-pack prunes. The contents of such packages were sterilized by including fumigants in the package, but these additives were not allowable under Australian Pure Food laws. Small-size cans of prunes marketed previously had not sold well chiefly on the grounds of expense. The demand existed then for a 12–16 oz pack of moist prunes in a flexible film pouch, but without added fungicides.

A process has now been developed in which the prunes are hot-filled into laminate bags, and some processors have been using the method successfully for 6 months. Rising sales of the new pack are reported. Care is needed by the operator to ensure that reinfection does not occur before sealing of the package.

Further work is in progress to improve the process when better heat-resistant films become available in Australia. It is hoped that some films will be able to withstand immersion in boiling water or low pressure steam so that a completely safe processing method can be recommended.—*Division of Food Preservation.*

Air-Tight Silos Protect Grain

Countries that import cereal grains are insisting on progressively higher standards of freedom from weevils and their damage. It is indisputable that the majority of weevil infestations are initiated while the grain is in store in the exporting countries, and in Australia large quantities of fumigants and contact insecticides are used in attempts to control the insects.

The most promising approach is to try to provide storage structures with built-in features which make the grain mass unsuited to insect development, thus eliminating the need for large-scale chemical control with its inherent dangers and disadvantages.

Research has been carried out on a system whereby grain is stored in silos that can be made air-tight. Any insects or other pests that may be present in the grain use up the oxygen in the silo atmosphere and soon asphyxiate themselves. This method is best applied to new silo construction that is specially designed for the purpose.—*Division of Entomology.*

Grain Aeration

When there is little possibility of rendering existing silos air-tight, a technique known as grain aeration may present an alternative method of reducing insect attack on the stored products. Newly harvested grain is generally warm at the time of intake and therefore very suitable for rapid insect development. If cool outside air is drawn through the grain in the silo by means of a low-power fan under the control of a thermostat, the temperature of the grain mass is reduced, which makes it progressively less suitable for insect development. Ideally the temperature may be reduced to a point at which some vital insect activity, such as egg laying, is prevented. Large bulks of grain that have been cooled in this manner during the weeks or months following harvest remain cool during the following summer owing to the low heat conductivity of grain. A great deal of the Commonwealth's existing grain storage capacity may be suitable for grain aeration and research is continuing on this new technique.—*Division of Entomology.*

Wheat Quality

The quality of baked goods is very dependent on the precise nature and properties of the gluten complex of the flour used in their preparation. The application of refined chromatographic methods by the Wheat Research Unit in collaboration with Dr. Simmonds, late of the Waite Agricultural Research Institute, has demonstrated the presence of at least 11 recognizable protein fractions in the gluten flour, four of which have been obtained in a well-purified state. It has been shown that while all 11 proteins occur in the glutens of all the flours so far examined, their proportion varies from variety to variety of wheat. This variation appears sufficiently marked and reproducible to enable wheats to be classified into hard, soft, or durum on the basis of their gluten fractionation patterns alone.

There seems little reason to doubt that the further exploitation of this technique will lead to a much clearer understanding of the basis of wheat quality. The results promise to be of direct interest to the plant breeder, and may well be of practical importance as a guide to the miller in blending wheats for specific purposes.—*Wheat Research Unit.*

Mineral Particles in Wheat Dust

Microscopic examinations of wheat dusts collected during loading operations and from dust extraction points at the Geelong silos, have revealed appreciable quantities of mineral particles, including various forms of opal phytoliths (plant opal).

Some phytoliths and fragments broken from them are small enough to become airborne, and to be inhaled by workers handling the wheat. The size, shape, hardness, and other characteristics of opal phytoliths are such as to warrant their consideration as possible causes in some of the skin, eye, and respiratory symptoms noted by grain handlers working under conditions where significant volumes of dust are created.

The particles revealed include numerous sharp-pointed, serrated, and needle-like forms of opal phytoliths, together with slender slivers and minute fragments (down to 0·5 micron in size). Some of these could readily be inhaled into the broncho-pulmonary system, or penetrate into exposed skin surfaces. Some of the spinose, "prickly", or barbed forms are such that they would not readily be removed once they had been inhaled.—*Mineragraphic Investigations.*

Radiant Cooling

The problem of providing comfortable living and working conditions in a hot climate is assuming an increasing importance with the development of the northern part of the continent. The report of the Interdepartmental Committee on Equipment in Tropical Houses published in December 1957 drew attention to this, and a long-term study was commenced of methods of reducing human environmental stress in the tropics.

The human body normally maintains a heat balance by losing heat to its surroundings. This is accomplished by the three heat transfer processes—radiation, convection, and evaporation. However, when the ambient temperature is equal to that of the body there can be no loss by radiation and convection, and if at the same time the humidity is high, the evaporation of sweat is very difficult. The subject then becomes uncomfortable.

If, however, a heat sink can be provided to which the body can radiate sufficient heat a condition of comfort can be maintained.

Applying this principle of radiant cooling, research is in progress to provide a heat sink in the environment when the humidity is high. The problem is that cold surfaces exposed to the air inside a room will have moisture condensing on them, which, apart from the obvious disadvantage, is an added load on the cooling system. It is necessary, therefore, to eliminate condensation and to reduce the convection heat transfer as much as possible.

A workable arrangement has been evolved using a number of refrigerated panels, each of which is covered by one or more layers of "Polythene" and sealed to prevent room air coming in contact with the cold panel. The "Polythene" is transparent to the long wavelength radiation from the body, which therefore can radiate through it to the cold panel which forms the heat sink.

Measurements using an artificial body and three 6 by 4 ft panels have confirmed that at 92°F dry bulb and 84°F wet bulb a heat transfer of 350 B.t.u./hr is possible by radiation alone.

Work is now proceeding on the physiological effects of radiant cooling on human subjects and the influence of the reflectance of the walls and ceiling for various panel arrangements.—*Engineering Section.*

Cement Manufacture

Correct proportioning of the mixture of limestone, shale, iron oxide, and allied raw materials fed to cement kilns is essential if consistent quality is to be maintained in the product. A secondary check on the composition of the materials leaving the firing and grinding sections of the process is also required. Chemical analyses of a relatively high degree of precision must be continually performed with as little delay as possible, in view of the great quantities of material passing through the system.

At the suggestion of the Cement and Concrete Association of Australia attention has been directed towards the development of a rapid analytical method suitable for control purposes in the industry, and a successful scheme is now available. In this method modern instrumental techniques replace difficult and tedious orthodox chemical operations. Local cement companies now using the procedure report that all major elements in cement and raw materials may be determined with satisfactory precision within 1 hr of receipt of sample. Overseas demand for details of the method has been particularly strong.—*Cement and Refractories Section.*

Mineral Matter in Australian Coals

All coals contain inorganic constituents in varying amounts. These may give rise to serious industrial problems such as deposits and slags in gas producers and steam-raising plant, corrosion of refractories, and contamination of metals during blast furnace or cupola operation. It is essential to solve some problems specific to Victorian brown coals to ensure that full use can be made of the very large reserves. It has been established that sodium in Morwell coal (0·1–0·4% in amount) is primarily responsible for the deposit problems associated with the combustion of this coal, and appears to be present in part as sodium chloride and in part ionically bound to the organic coal substance. Both of these forms of sodium appear equally active in the initial formation of the deposits, but do not form a fused matrix in them.

The difference in behaviour between Morwell and Yallourn coal is largely one of degree rather than of kind. A full knowledge of the nature and behaviour of inorganic constituents in these coals will be of the greatest value to Victorian authorities in elucidating problems associated with large-scale generation of electricity, and the utilization of brown coal briquettes.—*Division of Coal Research.*

Measurement of Wool Regain

During the distribution and manufacture of wool and wool products it is frequently necessary to know the amount of moisture in the wool. When moisture is expressed as a percentage of the dry weight of the wool it is called regain. The regain of wool at moderate relative humidities is about 15%, but it can vary from 0 to 33% when dried or nearly saturated. Regain values may be needed for the control of the amount of material passing through machinery or for invoice purposes. When high accuracy is required it is common practice to use determinations made by a testing authority or conditioning house; but there are many instances where a quick method of moderate accuracy is required. To meet this need a direct reading regain tester has

been developed. It consists of a hot air blower to dry the wool and a balance which indicates regain directly. The blower has a much larger airflow and efficiency of drying than has been achieved in previous commercial models—it dries the sample in 5 min. The balance is a new invention which eliminates calculation of percentages by the operator and also permits the sample to have any weight between 150 and 400 g. A number of experimental models are being tried in Australian mills. They are being used in the mill by the machine operators and not in the mill laboratory. This is an interesting departure from normal practice, which holds out hope of more speedy corrective action when the regain is away from the desired value. Preliminary reports show satisfactory performance of the instrument and a very encouraging response from mill management.—*Division of Textile Physics.*

Relaxation Shrinkage of Cloth

Wool cloth often shrinks when dried after wetting or steaming. This is called relaxation shrinkage. If it is too great it causes difficulties in cutting and fitting during garment manufacture, because the various parts of a garment are steam-pressed before sewing. Furthermore, relaxation shrinkage in the finished garments can be great enough to annoy customers who are likely to confuse this type of shrinkage with felting shrinkage, against which the goods have been satisfactorily shrinkproofed. Relaxation shrinkage is quite different from felting shrinkage. The latter is caused by the relative movement of fibres, which occurs when unshrinkproofed cloth is washed with mechanical agitation. Relaxation shrinkage has become more prominent as a disadvantage of wool cloth since cloth has come on the market made from other fibres having a much smaller change of dimensions with wetting and drying. The incidence and causes of relaxation shrinkage have been studied. The shrinkage is due to unrelieved strains in the cloth put in inadvertently during the finishing operations of cloth manufacture. Too much tension on cloth when entering certain finishing machinery has been found to be the major cause. Cloths of different constructions can tolerate different tensions. It now appears possible to predict how much relaxation shrinkage a certain cloth will have after passing through a particular machine. In very many situations this knowledge alone will be sufficient for manufacturers to avoid excessive relaxation shrinkage. The information is being passed to manufacturers and made widely known by publication.—*Division of Textile Physics.*

Lightweight Aggregates

The world-wide trend to lighter building construction has increased the demand for lightweight aggregates for concrete by the use of which considerable savings may be achieved in the structural framework and foundations of multi-storey buildings. For several years the Division of Building Research has been investigating the potentialities of the Australian resources of raw materials for the manufacture of lightweight clay and shale aggregate, and has studied methods of producing the aggregate. This work has come to fruition with the establishment of three commercial lightweight aggregate plants, two near Sydney and one near Melbourne.

To provide information on the performance of lightweight aggregate concrete structures and structural members, for use by design engineers, several scale models representing one storey of flat plate buildings have been erected at Highett, largely with the assistance of commercial firms. These models are being subjected to various types of load and their behaviour is being observed.—*Division of Building Research.*

Expansion of Clay Bricks

Many instances of cracking, bulging, and shearing of long clay brick walls and displacement of brickwork and adjoining structures, particularly around Melbourne, have been observed from time to time. Although it has long been known that ceramic bodies expand permanently when exposed to moisture, it was not realized until the problem was examined by C.S.I.R.O. that the defects were caused by the bricks themselves starting to expand as soon as they were exposed to the atmosphere after leaving the kiln. Investigations on both bricks and the clays from which they are made are in progress to find the cause of expansion, and a means of overcoming it. In the meantime, precautions to be taken in the construction of new brick buildings, which enable damage to be prevented, have been recommended.—*Division of Building Research.*

Finger Jointing of Timber

Much of the waste wood from the sawmilling industry is of high quality but in short lengths. Other material, notably the sawn products from softwood plantation thinnings, contains numerous blemishes, the removal of which results in unpopular short lengths. Finger jointing techniques have been investigated which join "shorts" into a continuous ribbon of timber, thus saving waste and facilitating production of "cut to length" timber. Joint profiles have been investigated for Australian eucalypts and indigenous and plantation-grown softwoods, cutters have been designed, assembly conditions examined, and a range of glues studied to attain joints of satisfactory strength. Because of gluing difficulties the process is applicable only to dry wood, but present research is directed at extending the technique to unseasoned building timbers. A rapid skin drying laboratory process has been developed which permits gluing of green material.—*Division of Forest Products.*

Phytochemical Survey

For a number of years the Division of Organic Chemistry has been conducting a survey of the alkaloidal constituents of the Australian flora, particularly that of Queensland. As the work developed from the initial qualitative screening carried out by the Division of Plant Industry to more detailed chemical structural work in the Organic Chemistry laboratories, the need became more pressing for concomitant pharmacological testing on the widest possible basis. No firm in Australia was able to provide adequate testing facilities, but a three-year project with Smith, Kline, and French Laboratories of Philadelphia has just been completed in which the firm undertook the screening of plant materials and in addition made an annual grant of £6000

towards the cost of the investigation. Although no plant species yet examined has warranted commercial exploitation, the possibilities are such that the collaboration is being extended by Smith, Kline, and French who are increasing their grant to £10,000 per annum. This will enable the work to be carried on in New Guinea while maintaining the Australian survey.

The main emphasis has been placed on a search for alkaloids, these being a readily recognized group of substances commonly showing marked pharmacological activity. Intensification of the survey work and its extension further away from laboratory facilities has led to the need to combine plant collection and chemical testing in the field. On a recent trial run of 3 weeks in central Queensland, some hundreds of species of plants were collected and tested, about 20% warranting further examination. Elimination of negative materials in this way in the field greatly reduces problems of collecting, drying, and transporting to the main laboratories, problems which will be met in an intensified form when the project is extended to New Guinea.—*Division of Organic Chemistry.*

Diffraction Gratings

In industry and in chemical, metallurgical, biological, and medical research, spectroscopic instruments are being used to an increasing extent for chemical analysis. These instruments incorporate a means for splitting radiation into its component wavelengths. A diffraction grating, which consists of a highly finished surface, usually of aluminium, and which has a very large number of fine, parallel, equally spaced grooves ruled upon it, is often employed for this purpose.

There are very few machines in the world capable of producing satisfactory diffraction gratings, since the permissible errors amount only to a few millionths of an inch. In the past most diffraction gratings have been produced in the U.S.A.

A machine developed in the Division of Chemical Physics, which is still undergoing tests but has nevertheless already produced useful gratings of high quality, has been built to supply the special gratings required for spectroscopic research within C.S.I.R.O. It is hoped that the success of this machine will encourage local manufacture of spectroscopic instruments incorporating Australian diffraction gratings.—*Division of Chemical Physics.*

Atomic Absorption Spectroscopy

Methods of chemical analysis based on atomic absorption spectroscopy, first developed by the Division of Chemical Physics, are being used by a rapidly increasing number of laboratories throughout the world. During the past year new models of atomic absorption equipment produced by firms in Great Britain, the United States of America, and Italy were exhibited, and these are now in production under licence to C.S.I.R.O. In addition, many of the vital components are manufactured in Australia for export to overseas manufacturers.

Analysis of more than 30 elements can now be made by this new technique, which has been applied to the determination of such diverse materials as blood, urine, saliva, soils, plants, photographic sensitizers, lubricants, venoms, ore concentrates, metals,

and alloys. The speed, sensitivity, and simplicity of the method are such that it seems certain to be applied to an ever-widening range of analytical problems. In particular, recent research has indicated the possibility of developing satisfactory methods for the direct analysis of metals and alloys without the necessity of first dissolving the sample in suitable liquids. The equipment required for such atomic absorption methods is much cheaper and simpler than that required for conventional emission methods of spectrochemical analysis.—*Division of Chemical Physics.*

Freezing Nuclei and Rainmaking

Interesting evidence has been obtained on the possible origin of freezing nuclei—those minute, mysterious, and so far, unidentified particles whose presence in the atmosphere is vital to the formation of rain from supercooled cloud. This has resulted from a study of samples collected at high altitudes by U-2 aircraft operated by the U.S. Air Force from a base near Sale, Vic. Thanks to the generous cooperation of the U.S. authorities, special dust-collecting filters prepared by the Division of Radiophysics were fitted to the U-2 aircraft. Samples of freezing nuclei present at heights of 50,000–60,000 ft were obtained from ocean areas well to the south of Australia. The filters were always installed in pairs but only one of them was exposed to the airstream when the aircraft reached the desired height, the other (unexposed) filter acting as a control.

The results show unmistakably that substantial numbers of freezing nuclei occur at these high altitudes—very many more than can be accounted for if they all come from the Earth's surface. Support is thus given to a theory first advanced by Dr. E. G. Bowen in 1953 that a powerful source of freezing nuclei is the meteor dust which the Earth picks up, in the course of its annual journey round the Sun, as it intersects the orbits of the various well-known streams of meteors. This meteoritic dust takes some 30 days to sink to the cloud-bearing levels of the atmosphere, and stimulates heavy rainfall when it arrives there if meteorological conditions happen to be favourable.

Samples of the dust present at high altitudes were also collected and submitted to various tests in an attempt to determine its nature, and hence, probable origin. The quantities available proved too small for definitive analysis, however, but the results obtained are consistent with an extraterrestrial origin for the dust.—*Division of Radiophysics.*

Long Period Field Recorder

For recording field data, especially in remote localities, it is necessary to have an instrument capable of unattended operation for long periods. Work has been completed on a recorder, designed to operate for periods up to 12 months, to provide continuous records of water level in streams, dams, or bores for gauging purposes; alternatively, of rainfall, temperature, humidity, wind speed, or evaporation. Many other uses can be envisaged. The Sumner Recorder has been tested in Australia and New Zealand by interested authorities under various operating conditions. These proving trials have served to reveal desirable improvements which have been incorporated in the final model, which is now in commercial production in Australia. Some orders have already been received for export.—*Division of Meteorological Physics.*

Pure Metals from Carbides

Since impurities markedly change the properties of many metals, increasing emphasis is being placed on their production in a pure state. With thorium there is, in addition, a world-wide interest in its potential use as a material for generation of nuclear power.

For production of pure thorium a process has been devised which combines the advantages of the early Van Arkel–de Boer refining process for crude metals with the advantages of a cheaply preparable raw material. This material, thorium carbide, is first converted to volatile thorium iodide and very pure thorium metal is deposited from this vapour onto a heated surface. Iodine liberated is allowed to attack fresh thorium carbide. Most impurities not volatilized during the high temperature preparation of thorium carbide are removed in the deposition stage.

The process can be used to prepare dilute alloys of uranium in thorium, and, in modified form, to prepare several other metals. Steps have been taken to test it on a larger scale. Preliminary estimates show that the cost of production compares favourably with that of much inferior grades of thorium made by other processes.—*Division of Mineral Chemistry.*

Particle Size Analysis

In many scientific and industrial processes it is necessary to separate ground or particulate material into fractions of known size ranges, and also to determine the proportions of the original material which are present in the various fractions. Standard sieving devices are available for separating fractions down to approximately 50 micron, but below this size sieving is not reliable. A new cyclone elutriator, the "Cyclosizer", has been developed for precise separation of solid particles in the subsieve ranges. The new instrument is based on the stable flow patterns and high centrifugal forces obtainable in hydraulic cyclones of suitable dimensions. It is operated on a batch principle and each cyclone is fitted with an underflow container in which the selected fraction is collected for subsequent removal. Separations can be made at selected intervals, e.g. within the range 8–44 micron (for a material of specific gravity 2·7). Control and operation are very simple and the instrument should find wide use in size analysis.—*Chemical Engineering Section.*

Flotation of Beryl

Beryl, which is a comparatively rare mineral, is a basic source of supply of beryllium, a metal which has assumed a new importance in atomic reactors.

Following earlier work carried out for Northwest Tantalum N.L. on the flotation of beryl from a Western Australian pegmatite, a more fundamental investigation has been sponsored by that company and Consolidated Zinc Pty. Ltd. This is concerned with the separation of beryl from felspar by flotation with anionic collectors.

By using the "bubble-pickup" technique, it has been found that beryl responds to alkyl sulphonates, sulphates, and carboxylates, but most readily to the sulphonates. Response is greatest in acid solutions, with a maximum at about pH 4, and decreases

to zero in the region of pH 7–9. Mixed albite-microcline felspar, which it was desired to leave unfloated, did not respond to the sulphonate collectors, except in the presence of certain activating ions.

Sodium fluoride is a beryl depressant when alkyl sulphonate collectors are used. It is not yet known whether the species responsible for depression is the F^- or the HF_2^- group. This system is being studied at the present time. The conditions under which iron-activated felspar is depressed by sodium fluoride will also be investigated.

It is hoped that continuation of these studies will lead to a better understanding of the conditions necessary for satisfactory concentration of beryl ores.—*Ore-dressing Laboratory (Melbourne).*

Beneficiation of Cement Rock

Australian Cement Limited has large reserves near Geelong, Vic., of cement rock containing over 80% of calcium carbonate ($CaCO_3$) which can be used directly in their plant. In addition there are large quantities of lower-grade material beneath the high grade rock. Taking a long-range view, the company has financed an investigation of the concentration of this lower-grade material by flotation.

Separation can be achieved either by floating the limestone from the silica or *vice versa*. Since there is less silica, the latter method is preferred, although the cationic flotation reagents necessary have a higher unit cost. Methods by which reagent costs may be reduced to a satisfactory level have been evolved, and it has been shown that there is a possibility of controlling the flotation separation process automatically. The following are typical results:

$CaCO_3$ in Raw Material	$CaCO_3$ in Concentrated Product	Recovery of $CaCO_3$
40%	83%	86%
60%	87%	88%
70%	90%	91%

Should it become necessary it would therefore be possible to install a full-scale flotation plant to use the large reserves of low-grade cement rock.—*Ore-dressing Laboratory (Melbourne).*

Electrical Standards and Measurements

Several improvements have been made during the year in electrical standards and measurement techniques. In particular, a thorough investigation has been made of resistance measurements to establish clearly the possible limits of accuracy using both direct current and low frequency alternating current. Sensitivities equal to the theoretical limits have been achieved with alternating current.

The characteristics of resistors have been measured over a wide range of frequencies. Special types of resistors have also been developed which are required to establish precisely the relationship between the standard ohm and the new calculable capacitor recently designed and constructed at the National Standards Laboratory as a step in determining the absolute value of the ohm.—*Division of Electrotechnology.*

Wavelength Standards

The photoelectric recording Fabry-Perot interferometer using mechanical scanning techniques has been used to study the quality of the orange-red radiation from krypton 86, which has now become the primary standard of length. Precise measurements have been made of small wavelength shifts arising from changes in operating conditions of the lamp producing this radiation. Spectral quality and wavelengths of other radiations have been measured by using the primary standard as a reference. This work was reported at the General Conference of the International Committee of Weights and Measures in 1960 at which the new optical definition of the metre was adopted. The interferometer system has been further developed so that the detection system is able to measure small wavelength changes of 1 part in 3×10^9. A theoretical analysis has been made of the maximum setting sensitivity possible, and conditions for maximum sensitivity have been determined experimentally. A more exact study is now being made of the effect of pressure, temperature, and current density in the krypton 86 lamp and of the performance of mercury 198 and cadmium 114 lamps.—*Division of Metrology.*

Thermal Expansions at Low Temperatures

Interesting scientific data about the thermal expansion and contraction of solid materials have emerged by applying recently developed electrical techniques to the problem of measuring length changes. The technique of determining small electrical capacities very accurately has made it possible to detect changes as small as a thousand-millionth part of an inch. In turn this has made possible the measurement of small thermal expansions occurring at low temperatures in materials such as iron, lead, copper, and aluminium, and has shown for the first time that, in these metals, the electrons present do contribute to the processes of expansion. These findings are important in the basic understanding of the physics of metals.—*Division of Physics.*

Path of Movement of Liquids through Wood

A knowledge of the way in which liquids penetrate timber is important in relation to problems of preservation and pulping. In preservation processes it partly determines the site of the preservative, and in pulping operations it determines the point of initial attack on the fibre wall, culminating in the separation of fibres as pulp. Fundamental investigations of cell wall organization of the tissue elements of wood and of the pits between them have been extended to a consideration of how this organization is involved in the movement of liquids through wood. It has been demonstrated that in hardwoods the initial penetration path is through the vessels and then via the pits to the rays and adjacent fibres or vertical parenchyma. In softwoods the path is from tracheid to tracheid, or tracheid to parenchyma, through the pits. In both hardwoods and softwoods lateral movement takes place through the rays. After the filling of the cell lumen, by a reagent, diffusion takes place through the cell wall to the middle lamella. It has been shown that the structure of the pit and the submicroscopic

texture of the middle lamella precludes this structure as the site of initial attack by pulping media as previously supposed. From the path of movement demonstrated it follows that the last region of the cell wall to be reached by the pulping medium is the lignin-rich middle lamella. At least in the initial stages of pulping this would result in considerable gradients of reagent concentration through the cell wall. These factors, as well as the organization of the fibre wall, govern the differences in the manner of separation of fibres during pulping by chemical and semi-chemical processes. Further implications of these conclusions are being studied in current investigations.—*Division of Forest Products.*

Submicroscopic Structure of Wool

Previous research in the Division of Protein Chemistry had shown that if wool fibres were embedded in araldite resin, ultrathin sections of the wool could be cut which were suitable for examination under the electron microscope. With this method the presence of microfibrils, approximately 70 Å in diameter, could be demonstrated in an amorphous matrix, if the disulphide bonds in the wool proteins were partially reduced with thioglycollate before staining with osmic acid. The lightly stained microfibrils of wool were shown to be arranged in sheets against the dark-stained matrix.

A notable advance in the metal staining technique for the electron microscopy of wool has now revealed further structural details within the microfibrils. Each microfibril is apparently a composite structure of protofibrils approximately 20 Å in diameter. Although the number and arrangement of protofibrils cannot be determined with certainty it seems likely that nine protofibrils are arranged around the periphery of each microfibril with two protofibrils in the centre—an arrangement previously reported for large flagella and cilia on some living organisms.

These minute protofibrils of wool are the actual protein molecules with which dyestuffs and other chemicals used in textile processing combine. Their inner structure is beyond the power of resolution with the electron microscope, but the shape of the constituent chains of amino acids is being established by application of the technique of X-ray diffraction.—*Division of Protein Chemistry.*

Hydroxy Acids in Brain

The method of analysis of mixtures of long chain alcohols and acids, developed in recent years for the identification of the aliphatic components of wool wax, should have extensive application to biological problems. α-Hydroxy acids, which represent about 30% of the total acids of wool wax, were known to occur in nervous tissue as cerebrosides, from which three or four of these acids had been identified. Conversion to hydrocarbons, followed by gas chromatographic analysis of the mixture, has shown that the α-hydroxy acids of sheep brain are all straight chain acids. Further, the structures of 13 component α-hydroxy acids have now been established. This example illustrates the potentiality of this method of analysis as a "research tool" in the evaluation of lipids.—*Division of Organic Chemistry.*

High Resolution Mass Spectroscopy and Structural Analyses

One problem that recurs continuously in chemical research is the identification of unknown substances. Mass spectrometers have been employed for this in the past, but without great success. The mass spectrometer can be used to establish the molecular weight of the unknown, the kinds of atoms present, and the way in which they are combined in the molecule. The use of the mass spectrometer for this purpose is limited by its resolution, which is a measure of the ability of the instrument to distinguish between atoms or molecular fragments of differing molecular weights. Until recently this resolution had been no higher than 1 in 250, so that results were often ambiguous because several combinations of different atoms can have the same nominal molecular weight.

Developments in technique have enabled mass resolutions to be greatly increased, and in an instrument constructed recently at the Chemical Research Laboratories, the resolution achieved is 1 in 4000. This high resolution often removes the ambiguities entirely and permits the unequivocal identification of the number and kinds of atoms in a given molecule. A study of the way in which the molecule breaks up under electron bombardment and the identification of the fragments give in some cases the complete structure of the unknown substance, of which 5 μg is an adequate amount.

The present instrument has proved so successful in the identification of taint compounds in dairy products that a second is in process of construction for the Dairy Research Section and will be devoted entirely to problems of interest to the dairying industry.—*Division of Chemical Physics.*

Electron-Optical Images and the Scattering of Electrons

In recent years the technique of electron microscopy has advanced to the stage where it is almost possible to obtain pictures of small molecules or groups of atoms when they are arranged on a regular lattice, as in a crystal, and it is possible to see the individual lattice defects which are of great importance in determining the mechanical and electrical properties of solids. However, the way in which such pictures are formed by electrons is not simple. An intuitive interpretation can lead to serious error, and the conventional theory of the electron-scattering process is no more reliable. To deal with this situation an entirely new approach has been made to the theory of the scattering of electrons in matter. This new theory has provided relatively simple and direct methods for interpreting the contrast in electron micrographs and so has opened the way to further advances in this field. It has also assisted in the development of the methods developed in the Division of Chemical Physics for analysing the structure of submicroscopic particles by electron-diffraction microprobe techniques.—*Division of Chemical Physics.*

Organic Chemicals from Lurgi Brown Coal Tar

The composition of the light tar from the Morwell plant of the Gas and Fuel Corporation of Victoria is being investigated to determine the amounts and identities of

the compounds present. This will show how they differ from those present in black coal tar and will enable an estimate to be made of the potential economic value of the tar. The tar has been separated into a number of fractions by a combination of separation methods, and the individual components present in the fractions have been further separated and identified by gas chromatography. In the lower boiling part of the tar, over 180 compounds of six main types have been found and about 20 of these may be of economic importance in the organic chemical industry. Work on the higher boiling part of the tar is in progress.—*Division of Organic Chemistry and Division of Physical Chemistry.*

Mechanism of Coal Carbonization

Advances have been made in research into the important mechanism of softening and pyrolysis of coal during carbonization. The phenomenon of fluidity has been related to that of decomposition for many Australian coals of widely varying rank and petrographic composition. From this it was found that, unlike the later stages of fluidity and solidification, the early stage of softening is a physical process, almost independent of rank. The melting of coals, which is very sensitive to temperature variation, was shown to be reversible with rise and fall in temperature, provided no active decomposition takes place.

Changes in the optical properties of vitrinite during carbonization have been observed, including loss of optical anisotropy as the vitrinite become plastic, followed by the formation and enlargement of fine spherical bodies.

The final stage in the development of these optical properties coincides with the resolidification of the coal.

Measurements of the electrical resistance of coals during carbonization up to 900°C showed that the resistivity depended almost solely on carbonizing temperature and not on the rank of the coal.

An understanding of the above phenomena is essential in developing improved methods for controlling the coking process and for manufacturing carbons for special purposes.—*Division of Coal Research.*

Vertical Velocities in the Solar Chromosphere

The Sun is the only star whose surface can be observed in detail from the Earth, and study of the Sun has yielded information on astrophysical processes which would otherwise be completely unsuspected from the study of distant stars. Knowledge of the Sun has therefore become an increasingly important aspect of astronomy.

New techniques involving a very narrow bandwidth optical filter ($\frac{1}{8}$ Å) have now enabled photographs to be obtained showing the velocity distribution in selected areas of the solar chromosphere. As compared with conventional spectrographic methods, this has the advantage of enabling an extended region to be studied, rather than a single line across the Sun's surface. It has been shown that bright chromospheric granules are almost invariably rising, and dark ones falling. The physical

significance of such studies, which are being extended to include velocities in the photosphere, is that velocities play a basic role in determining the behaviour of the whole of the outermost solar layers.—*Division of Physics.*

New Method of Paramagnetic Resonance

In the post-war years a completely new technique known as electron spin resonance has become available to scientists for determining in detail the internal structure of solids. Research at the National Standards Laboratory has made a recent contribution to this study of spinning electrons.

It is now possible to dispense with the adjustable magnetic field formerly applied, by adjusting instead the frequency of waves passed through the material. For the science of physics the new method provides a more direct measurement of the interactions between atoms. For applications, the advantage is that well-formed single crystals are no longer obligatory. Potential new applications are possible to the study of materials which are not uniformly oriented, such as rocks, glasses, liquids, and living tissues.—*Division of Physics.*

Atmospheric Discontinuities

The long straight coasts of Australia and the strong heating inland favour development of penetrating sea-breeze circulations and fronts, the latter having many features in common with the larger-scale discontinuities so important in day-to-day weather. The Bureau of Meteorology maintains the routine network of observations, but at times this network is too open to provide sufficiently detailed information and understanding of the phenomena. Voluntary observers have been enrolled to report certain sudden changes. Expeditions have also been made to suitable areas of southern Australia, culminating in a major expedition centred on Coonalpyn Downs in January 1961. This expedition made measurements of wind, temperature, and humidity through the discontinuities at the surface and aloft, up to 100 miles inland. These programs have been supported by theoretical work, and the timing and multiple structure of the frontal squalls and pressure jumps can now be more closely related to the coastline, the depth of the surge of cold air, and the strength of the heating inland.—*Division of Meteorological Physics.*

Atomic Structure of Crystal Surfaces

Many industrially important chemical processes rely on the adsorption and subsequent reaction of gases or liquids on the surface of solid substances (catalysts) which otherwise play no part in the reaction. Any explanation of the mechanism of catalysis requires first of all a knowledge of the atomic configuration of the surface of the catalyst, and of the free bonds available at its surface.

In most of the previous work, catalysts had the form of powders or ordinary specimens containing many crystals. In order to deal with a well-defined surface

without the disturbances due to crystal boundaries, single crystals are being used for this catalytic work. On the theoretical side the first step has been to study the structure of an "atomically flat" surface obtained when a crystal is cut by a plane. Such a surface consists of flat areas separated by monatomic steps. The distribution of such steps (and of kinks on the edges of the steps) can now be calculated for any crystal cut by a plane in an arbitrary orientation. Models can, therefore, be constructed of any surface, and typical examples employing balls to represent atoms for the simple crystal structures often found in metals have been made.

Additional information of importance in adsorption and catalysis is the surface concentration and type of atoms with unsaturated chemical bonds. Surface atoms have different numbers of broken bonds depending on their position, such as on the edge of a step, in the face of a step, and a kink position. The surface concentrations of these different types of atoms can now, in principle, be calculated for any orientation in any type of crystal structure, and detailed results have been produced for the simpler crystal structures. Predictions have been made about the reactivity of surfaces of different orientations and these are being tested by experiment.—*Division of Tribophysics.*

The Composition of Suint

"Suint", which may be loosely described as the dried sweat of the sheep, comprises about 5–10% of the total fleece weight. The amount potentially available from the Australian wool clip is therefore of the order 50,000 tons per year. Suint consists mainly of water-soluble potassium salts of organic acids and so could represent a large source of such acids. An analysis of the suint acids has therefore been made to investigate possible uses for its constituents. Gas chromatographic examination of the methyl esters revealed that the mixture is much more complex than previously supposed—the presence of at least 50 acids has been demonstrated and over half of these have been identified.—*Division of Organic Chemistry.*

Fracture in Metals

Failure of metals and alloys by fracture along the boundaries between crystals can be a limitation to the efficiency and durability of nuclear reactors. These high-temperature fractures are typical of "creep" conditions (slow stretching at relatively high temperatures). Fracture cracks grow from small cavities which form by bodily sliding of one crystal over another.

The behaviour of specimens containing only one special boundary between crystals is being studied, and the two crystals used in the technique are very large (about 6 by 3 by $\frac{1}{8}$ in. compared with 8×10^{-4} in. in a normal piece of lead). The crystals are so soft that they cannot be cut with mechanical methods, but instead they are shaped by a terylene thread which conveys acid to the specimen and so chemically cuts through it.

Other measurements concern the small steps produced by the sliding between crystals in metal specimens containing normally sized grains. These are about 10^{-4} cm (4×10^{-5} in.) in height and many hundreds are measured to indicate their average

behaviour. Very sensitive microscopical methods are used, including the use of interference fringes which give a "contour map" of the specimen. By comparing aspects of sliding in relation to temperature, stress, and type of metal, hypotheses on the mechanism of failure are being tested and improved.

This investigation is contributing to the basis which will underlie the future use of metals in nuclear reactors and other engineering systems.—*Physical Metallurgy Section.*

3

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CEMENT AND REFRACTORIES SECTION

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CHEMICAL RESEARCH LABORATORIES

GENERAL

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4

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STAFF

The following is a list of the professional staff of the Organization as at June 30, 1961

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Headquarters: 314 *Albert Street, East Melbourne, Vic.*

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Member of the Executive—S. H. Bastow, D.S.O., B.Sc., Ph.D.
Member of the Executive—R. N. Robertson, Ph.D., D.Sc., F.A.A., F.R.S.
Member of the Executive—C. S. Christian, B.Agr.Sc., M.S.
Member of the Executive—I. W. Wark, Ph.D., D.Sc., F.A.A.
Secretary—G. B. Gresford, B.Sc., A.R.M.T.C.
Executive Officer—W. Ives, M.Ec.
Secretary (Finance and Supplies)—M. G. Grace, A.A.S.A.
Research Secretary—F. G. Nicholls, M.Sc. (*on leave*)
Assistant Secretary—D. T. C. Gillespie, M.Sc.
Assistant Secretary—P. F. Butler, M.Ag.Sc.
Chief Research Officer—F. Penman, M.Sc.
Senior Principal Research Officer—J. E. Cummins, M.Sc.
Senior Experimental Officer—W. M. Balding, B.Sc.
Senior Experimental Officer—W. F. Evans, B.Sc.
Experimental Officer—C. D. Kimpton, B.Agr.Sc. (Hons.)
Experimental Officer—A. K. Klingender, B.Sc.
Experimental Officer—L. G. Wilson, M.Sc.

Library

Chief Librarian—Miss B. C. L. Doubleday, M.A.
Scientific Librarian—Miss M. L. Cameron, B.Sc.
Scientific Librarian—Miss J. A. Conochie, B.Sc.
Scientific Librarian—Miss L. J. Davey, B.Sc.
Librarian—Mrs. P. Cronshaw, F.L.A.
Librarian—Miss P. D. Prendergast, B.A.
Experimental Officer—Miss M. J. Dunstone, B.Sc., Dip.Ed.

Accounts

Accountant—D. J. Bryant, A.A.S.A.

Finance

Assistant Secretary (Finance and Supplies)—R. W. Viney, A.A.S.A., A.C.I.S.

Stock Records

J. M. Short, A.A.S.A., A.C.I.S.

Orders and Transport

V. H. Leonard, J.P.

Staff

Staff Relations Officer—L. G. Peres, B.Ec.
Senior Staff Officer—J. Coombe
Senior Registry Officer—P. Knuckey
Safety Officer—J. M. Bray, B.Sc.

Records

J. W. Graham (*acting*)

Publishing Section

T. R. Hunter

Liaison Overseas:

London

Chief Scientific Liaison Officer—E. J. Drake, F.R.A.C.I.
Principal Research Officer—F. Wilson

Washington

Chief Scientific Liaison Officer—T. B. Paltridge, B.Sc.(Hons.)

Translation Section

Translator-in-Charge—A. L. Gunn
Translator—E. Feigl, Ph.D.
Translator—Miss M. J. Hardy, B.A.(Hons.) (*on leave*)
Translator—Mrs. M. C. Godfrey, M.A.
Translator—P. A. Kazakov, LL.B. (*at Sydney*)
Translator—Mrs. M. Slade
Translator—C. Wouters, Ph.D.(Lit.) (*at Sydney*)

Film Unit

Senior Experimental Officer—S. T. Evans, B.Sc.

Architects' Office

Architect—W. R. Ferguson, B.E.
Experimental Officer—A. S. Bhogal, F.R.M.T.C.

SECRETARIES OF STATE COMMITTEES

New South Wales

A. J. Higgs, B.Sc.(Hons.), Division of Radiophysics, University of Sydney

Victoria

J. P. Shelton, M.Sc., A.B.S.M., 314 Albert St. East Melbourne, Vic.

Queensland

W. W. Bryan, M.Sc.Agr., Cunningham Laboratory, Mill Road, St. Lucia, S.W.6, Qld.

South Australia

A. W. Peirce, D.Sc., Division of Biochemistry and General Nutrition, University of Adelaide

Western Australia

R. P. Roberts, M.Sc.(Agric.), Department of Agriculture, Perth

Tasmania

D. Martin, D.Sc., "Stowell", Stowell Avenue, Hobart

AGRICULTURAL RESEARCH LIAISON SECTION

Headquarters: 314 *Albert Street, East Melbourne, Vic.*

At Headquarters, East Melbourne

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Divisional Administrative Officer—K. L. Wells, B.A.
Principal Research Liaison Officer—K. Loftus Hills, M.Agr.Sc.
Senior Research Liaison Officer—R. N. Farquhar, B.Agr.Sc., M.S., Ed.D.
Senior Research Liaison Officer—E. A. Jackson, B.Ag.Sc.
Research Liaison Officer—J. J. Lenaghan, B.Agr.Sc., M.S.
Research Liaison Officer—G. F. Smith, M.A. (*on study leave*)
Experimental Officer—H. S. Hawkins, B.Ag.Sc. (Hons.)
Experimental Officer—H. A. Nix, B.Agr.Sc., Q.D.A. (Hons.)
Experimental Officer—Mrs. J. Tully, B.Sc.(Hons.), Ph.D. (*seconded to University of New England, Armidale*)
Experimental Officer—N. L. Tyshing, B.Agr.Sc.
Librarian—Miss I. W. McNamara, B.A.

At Canberra

Senior Experimental Officer—D. V. Walters, M.Agr.Sc.

At Sydney

Senior Experimental Officer—R. E. Churchward, B.V.Sc., H.D.A.

ANIMAL RESEARCH LABORATORIES

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I. W. McDonald, B.V.Sc., B.Sc., Ph.D.
A. Packham, B.V.Sc., A.A.S.A. (*Secretary*)

DIVISION OF ANIMAL GENETICS

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Assistant to the Chief—A. Packham, B.V.Sc., A.A.S.A.
Assistant Divisional Secretary—A. B. Hackwell, B.Agr.Sc.

At Animal Genetics Laboratory, Sydney

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Senior Research Officer—A. A. Dunlop, M.Agr.Sc., Ph.D.
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At National Field Station, "Gilruth Plains", Cunnamulla, Qld.

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Experimental Officer—M. T. Carpenter, B.Agr.Sc.

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At Poultry Research Centre, Werribee, Vic.

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Experimental Officer—Miss L. W. Bobr, M.Sc.(Agr.) (*on study leave*)

DIVISION OF ANIMAL HEALTH

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At Animal Health Laboratory, Melbourne

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Librarian—Miss M. Frost, B.A.

At Brisbane

William McIlrath Fellow in Animal Husbandry—M. C. Franklin, M.Sc.(Hons.), Ph.D.

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Experimental Officer—D. R. Lang, B.Sc., M.S.

At Institute of Agriculture, University of Western Australia, Nedlands, W.A.

Senior Research Officer — E. Munch-Petersen, M.Sc., B.A.

DIVISION OF BIOCHEMISTRY AND GENERAL NUTRITION

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Principal Research Officer—F. V. Gray, M.Sc.
Principal Research Officer—I. G. Jarrett, M.Sc.
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Senior Research Officer—R. M. Smith, M.Sc.

Senior Research Officer—R. A. Weller, B.Sc.
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Experimental Officer—A. C. Blaskett, B.Sc.
Experimental Officer—O. H. Filsell, B.Sc.
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Experimental Officer—N. F. Henschke, B.Sc.
Experimental Officer—R. Hewett Jones, R.D.A.
Experimental Officer—W. S. Osborne-White, B.Sc.
Experimental Officer—V. A. Stephen
Administrative Officer—B. W. Bartlett

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Headquarters: Graham Rd., Highett, Vic.

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Technical Secretary—J. R. Barned, B.Sc.
Divisional Editor—I. C. H. Croll, B.Sc.

Information and Library

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Experimental Officer—E. M. Coulter, M.Ag.Sc.

Mechanics and Physics of Materials

Principal Research Officer—F. A. Blakey, B.E. (Hons.), Ph.D.
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Research Officer—Miss S. W. Jeffrey, M.Sc., Ph.D.
Research Officer—H. R. Jitts, B.Sc.
Research Officer—D. E. Kurth, B.Sc.(Hons.), Ph.D.
Research Officer—W. J. R. Lanzing, D.Sc.
Research Officer—R. J. MacIntyre, M.Sc., Ph.D.
Research Officer.—W. B. Malcolm, B.Sc., Ph.D.
Research Officer—B. S. Newell, M.Sc.
Research Officer—J. P. Robins, B.Sc.
Research Officer—D. J. Tranter, M.Sc.
Experimental Officer—N. L. Brown, A.S.T.C. (*overseas*)
Experimental Officer—A. D. Crooks, B.Sc.

At Melbourne

Senior Research Officer—T. R. Cowper, B.Sc. (Hons.)
Experimental Officer—B. W. Wilson, B.Sc.

At Perth

Senior Research Officer—K. Sheard, D.Sc.

At Hobart

Principal Research Officer—A. G. Nicholls, B.Sc. (Hons.), Ph.D.
Senior Research Officer—A. M. Olsen, M.Sc.

FODDER CONSERVATION SECTION

Headquarters: Graham Road, Highett, Vic.

Officer-in-Charge—W. L. Greenhill, M.E.
Principal Research Officer—G. W. Lanigan, M.Sc.
Senior Research Officer—Mrs. J. F. Melvin, M.Sc.
Research Officer—W. Shepherd, B.Sc., B.Agr.Sc.
Research Officer — Dr. Beulah Simpson, B.Sc. (Hons.), Ph.D.
Experimental Officer—C. J. Brady, M.Sc.Agr.
Experimental Officer—V. R. Catchpoole, M.Agr.Sc.
Experimental Officer—J. de Freitas, F.R.M.T.C.

DIVISION OF FOOD PRESERVATION

Headquarters: Delhi Road, North Ryde, N.S.W.

At North Ryde, N.S.W.:

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Assistant Chief—W. J. Scott, B.Agr.Sc., D.Sc.
Technical Secretary—R. B. Withers, M.Sc., Dip.Ed.

Scientific Services

Senior Research Officer—Miss J. M. Bain, M.Sc. (*overseas*)
Scientific Librarian—Miss B. E. Johnston, B.Sc.
Experimental Officer—Miss E. M. Christie, B.Sc.
Experimental Officer—I. A. Rey, A.S.T.C.

Physics and Transport Section

Senior Research Officer—H. L. Evans, M.Sc., Ph.D.
Experimental Officer — Miss J. D. Hayhurst, A.S.T.C.
Experimental Officer—J. D. Mellor
Experimental Officer—Mrs. W. Szulmayer, Dipl. Phys.

Microbiology Section

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Senior Research Officer—J. H. B. Christian, B.Sc.Agr.(Hons.), Ph.D.
Senior Research Officer—W. G. Murrell, B.Sc.Agr., D.Phil.
Research Officer—B. J. Bloomfield, M.Sc.
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Experimental Officer — Miss B. J. Marshall, A.S.T.C.
Experimental Officer—Miss J. A. Waltho, A.S.T.C., B.Sc.
Experimental Officer—A. D. Warth, M.Sc.

General Chemistry Group

Principal Research Officer—F. E. Huelin, B.Sc. (Hons.), Ph.D.
Principal Research Officer—K. E. Murray, B.Sc. (Hons.)
Senior Research Officer—J. B. Davenport, M.Sc. (*overseas*)
Experimental Officer—I. M. Coggiola, B.Sc.
Experimental Officer—B. H. Kennett, A.S.T.C.

Muscle Biochemistry Investigations

Principal Research Officer—R. P. Newbold, M.Sc., Ph.D.
Experimental Officer—C. A. Lee, B.Sc.

Organic Chemistry Investigations

Principal Research Officer—Miss T. M. Reynolds, M.Sc., D.Phil.
Senior Research Officer—E. F. L. J. Anet, M.Sc., Ph.D.
Senior Research Officer—D. L. Ingles, M.Sc., Ph.D.
Experimental Officer — Miss D. E. Fenwick, A.S.T.C.

Fruit and Vegetable Storage Section

Principal Research Officer—E. G. Hall, B.Sc.Agr. (Hons.)

Canning and Fruit Products Section

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Senior Principal Research Officer—J. F. Kefford, M.Sc.
Senior Research Officer—P. W. Board, B.Sc.(Hons.)
Senior Research Officer—B. V. Chandler, B.Sc. (Hons.), Ph.D.
Senior Research Officer—E. G. Davis, B.Sc. (Hons.)
Senior Research Officer—R. S. Mitchell, M.Sc.Agr.
Research Officer—D. J. Casimir, M.Sc., Dip.Ed.
Experimental Officer—R. G. P. Elbourne, B.Sc., A.S.T.C.
Experimental Officer—K. A. Harper, M.Sc., A.S.T.C.

Dried Fruits Section

Senior Research Officer—D. McG. McBean, B.Sc.
Experimental Officer—A. A. Johnson, A.S.T.C.

Freezing of Fruit and Vegetables

Senior Research Officer—J. Shipton, B.Sc.Agr.

Research Officer—G. C. Walker, B.Sc., Ph.D.
Experimental Officer—J. H. Last, A.S.T.C.

Animal Products Section
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Senior Research Officer—A. R. Prater, B.Sc.Agr.
Experimental Officer — W. A. Montgomery, A.S.T.C.
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At Botany School, University of Sydney:

Plant Physiology Investigations
Senior Principal Research Officer—D. D. Davies, B.Sc., Ph.D.
Principal Research Officer—J. F. Turner, M.Sc., Ph.D. (*overseas*)
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At Biochemistry School, University of Sydney:

Physical Chemistry Section
Experimental Officer—Miss J. F. Back, B.Sc., Dip.Ed.
Experimental Officer—M. B. Smith, A.S.A.S.M., M.Sc.

At Atomic Energy Research Establishment, Lucas Heights, N.S.W.:

Food Irradiation Investigations
Research Officer—J. J. Macfarlane, M.Sc.

At Tasmanian Regional Laboratory, Hobart:

Processing of Fruit and Vegetables
Senior Experimental Officer—S. M. Sykes, B.Sc. Agr.
Experimental Officer—R. A. Gallop, M.S., A.S.T.C. (*on leave*)

At Cannon Hill, Qld.:

Meat Investigations
Principal Research Officer (Officer-in-Charge)—A. Howard, M.Sc.
Senior Research Officer—G. Kaess, Dr.Ing.
Experimental Officer—P. E. Bouton, B.Sc.
Experimental Officer—L. E. Brownlie, B.Sc.Agr.
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DIVISION OF FOREST PRODUCTS

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Technical Secretary—F. A. Priest, A.S.A.S.M.
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Scientific Librarian—Miss M. I. Hulme
Librarian—Miss A. Forbes
Librarian—Mrs. J. H. Henderson
Senior Experimental Officer—L. Santer, M.Mech. E., Dip.Ing.

Special Investigations
Senior Principal Research Officer—W. E. Cohen, D.Sc.

Wood and Fibre Structure Section
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Senior Research Officer—G. Scurfield, B.Sc., Ph.D.
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Experimental Officer — F. J. Christensen, A.R.M.T.C.
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Experimental Officer—P. J. Moglia, Dip.Mech.E.
Experimental Officer—A. Stashevski, Dip.For.Eng.

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Senior Experimental Officer—J. F. H. Wright, B.Sc.
Experimental Officer—J. D. Dover, A.S.T.C.

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Research Officer—D. McE. Alexander, B.Sc.
Research Officer—A. F. Bird, M.Sc., Ph.D. (*at University of Adelaide*)
Research Officer—S. F. Bridley, B.Ag.Sc.
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Experimental Officer—H. C. Haskew, B.Ag.Sc.
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At Irrigation Research Station, Griffith, N.S.W. (Murrumbidgee Irrigation Areas)

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Senior Research Officer—E. T. Linacre, M.A., M.Sc.
Senior Research Officer—J. H. Palmer, B.Sc., Ph.D.
Senior Research Officer—T. Talsma, Ir.Agr.
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Research Officer—F. Cope, B.Sc.(Hons.), M.Ag.Sc.
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Research Officer—I. D. J. Phillips, B.Sc., Ph.D.
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Experimental Officer—F. Lenz, B.Ag.Sc., Ph.D.
Experimental Officer—W. A. Muirhead, B.Sc.Agr.
Experimental Officer—J. E. Saunt, M.Sc.
Administrative Officer—J. F. Donovan, B.Ec.
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DIVISION OF LAND RESEARCH AND REGIONAL SURVEY

Headquarters: Canberra

At Canberra:

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Assistant to the Chief—A. F. Gurnett-Smith, B.Agr.Sc.
Technical Secretary—Miss M. M. Mills, B.Sc. (Hons.)
Administrative Officer—P. C. Rawlinson, J.P.
Principal Research Officer—H. Hirst, Agric.Dip., M.S.
Principal Research Officer—E. Phillis, Ph.D., D.Sc.
Senior Research Officer—M. J. T. Norman, B.Sc. (Hons.), Ph.D.
Research Officer—R. Wetselaar, Ing.Agr.
Experimental Officer—K. D. Woodyer, B.Sc.Agr.

Regional Land Surveys
Principal Research Officer—R. A. Perry, M.Sc.

Ecology and Forest Botany
Senior Research Officer—N. H. Speck, Ph.D., M.Sc., B.A.
Senior Research Officer—R. Story, D.Sc.
Experimental Officer—J. C. Saunders, B.Sc.Agr.

Geomorphology
Principal Research Officer—J. A. Mabbutt, M.A. (Hons.)
Research Officer—M. J. J. Bik, D.Sc.
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Research Officer—R. L. Wright, M.Sc.

Pedology
Principal Research Officer—H. A. Haantjens, Ing.Agr.
Research Officer—G. K. Rutherford, M.Sc., Ph.D.
Research Officer—R. H. M. van de Graaff, Ing.Agr.

Systematic Botany
Senior Research Officer—R. D. Hoogland, D.Sc.
Experimental Officer—M. Lazarides, Q.D.A.
Experimental Officer—R. Schodde, B.Sc.(Hons.)

Climatology
Principal Research Officer—R. O. Slatyer, D.Sc. (Agric.)
Research Officer—H. D. Barrs, B.Sc., Ph.D.
Research Officer—W. R. Stern, M.Sc.Agr., Ph.D.

Agricultural Ecology
Senior Research Officer—J. J. Basinski, B.Sc., M.A.
Research Officer—B. R. Davidson, M.Ag.Sc., Ph.D.

At Brisbane

Senior Research Officer—W. Arndt, M.Sc.Agr.

At Newcastle

Senior Research Officer—T. G. Chapman, B.Sc. (Hons.), Ph.D.

Regional Research Stations:

At Alice Springs, N.T.
Acting Officer in Charge—R. E. Winkworth, B.Sc. (Hons.)

At Katherine Research Station, N.T.
Acting Officer in Charge—L. J. Phillips, Q.D.D.

At Kimberley Research Station, W.A.
Research Officer—P. J. van Rijn, Ing.Agr.
Experimental Officer—A. L. Chapman, B.Agr.Sc.
Experimental Officer—N. J. P. Thomson, B.Agr.Sc.

At Coastal Plains Research Station
Director—Principal Research Officer—K. Wilson-Jones, M.Sc.
Experimental Officer—E. C. B. Langfield
Divisional Administrative Officer—J. R. Warwick, B.A.

DIVISION OF MATHEMATICAL STATISTICS

Headquarters: University of Adelaide

At University of Adelaide

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Senior Research Officer—N. S. Stenhouse, M.Sc.
Senior Research Officer—G. N. Wilkinson, M.Sc.
Research Officer—A. G. Constantine, B.Sc.(Hons.) (*on overseas studentship*)
Experimental Officer—K. M. Cellier, B.Sc.
Experimental Officer—Miss M. J. Evans, B.A.
Experimental Officer—J. P. Penny, M.Sc.
Experimental Officer—L. G. Veitch, B.Sc.

At Division of Animal Physiology, Prospect, N.S.W.

Senior Research Officer—H. Weiler, Lic.ès.Sc., M.Sc.

At Division of Building Research, Highett, Vic.

Senior Research Officer—R. Birtwistle, B.Sc.

At Division of Fisheries, Cronulla, N.S.W.

Experimental Officer—A. E. Stark, B.A.

At Division of Food Preservation, Ryde, N.S.W.

Principal Research Officer—G. G. Coote, B.A., B.Sc.
Experimental Officer—E. A. Roberts, B.Sc.Agr.

At Division of Forest Products, Melbourne

Research Officer—W. R. Flower, B.Sc., B.A.(Hons.)
Experimental Officer—Miss N. Ditchburne

At National Standards Laboratory, Chippendale, N.S.W.

Principal Research Officer—R. T. Leslie, B.Sc., M.A., Ph.D.

At Division of Plant Industry, Canberra

Senior Principal Research Officer—G. A. McIntyre, B.Sc.(Hons.), Dip.Ed.
Principal Research Officer—E. J. Williams, B.Com., D.Sc.
Research Officer—M. L. Dudzinski, B.Sc., B.Ec. (Hons.)

At Pastoral Research Laboratory, Armidale, N.S.W.

Research Officer—P. F. May, B.Sc.Agr.(Hons.)

At Division of Tropical Pastures, St. Lucia, Qld.

Research Officer—K. P. Haydock, B.Sc.(Hons.)

At University of Melbourne, School of Agriculture

Research Officer—A. M. W. Verhagen, Cand. Nat.Phil., B.A.(Hons.)

At University of Melbourne, Computation Laboratory

Principal Research Officer—T. Pearcey, B.Sc.
Senior Research Officer—G. W. Hill, M.Sc.

At Western Australian Regional Laboratory, Perth

Experimental Officer—C. A. P. Boundy, B.E.

At Wool Research Laboratories: Division of Protein Chemistry, Melbourne

Research Officer—W. B. Hall, B.A.

DIVISION OF METEOROLOGICAL PHYSICS

Headquarters: Station Street, Aspendale, Vic.

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Senior Principal Research Officer—W. C. Swinbank, M.Sc.
Senior Principal Research Officer—E. L. Deacon, B.Sc.
Principal Research Officer—A. F. A. Berson, Dr. Phil.
Principal Research Officer—R. J. Taylor, M.Sc.
Senior Research Officer—F. K. Ball, B.Sc.(Hons.)
Senior Research Officer—R. H. Clarke, B.A., B.Sc.
Senior Research Officer—A. J. Dyer, M.Sc., Ph.D.
Senior Research Officer—I. C. McIlroy, B.Sc.
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Research Officer—J. P. Funk, Dr.Phil.
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Experimental Officer—F. J. Maher, A.R.M.T.C.
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Administrative Officer—F. Tighe

DIVISION OF METROLOGY

See National Standards Laboratory

MINERAGRAPHIC INVESTIGATIONS

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Principal Research Officer—J. McAndrew, M.Sc., Ph.D.
Research Officer—I. M. Threadgold, B.Sc. (*overseas*)
Experimental Officer—A. W. Hounslow, B.Sc., A.R.M.T.C.
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DIVISION OF MINERAL CHEMISTRY

See Chemical Research Laboratories

NATIONAL STANDARDS LABORATORY

Headquarters: University Grounds, Chippendale, N.S.W.

Director—N. A. Esserman, B.Sc.

National Standards Laboratory Committee

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The services shown hereunder are common to the Divisions of Electrotechnology, Metrology, and Physics, which are housed at the University of Sydney

Clerical

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Accountant—T. C. Clark, A.A.S.A.

Library

Scientific Librarian—Miss M. McKechnie, B.A.
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Research Officer—E. G. Thwaite, B.Sc.
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Experimental Officer—J. W. Bell
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Experimental Officer—J. W. Humphries, B.Sc.

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Senior Research Officer—H. J. Ritter, Dr.rer.nat. math.
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ORE-DRESSING INVESTIGATIONS, MELBOURNE

Headquarters: University of Melbourne

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DIVISION OF PHYSICS

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Assistant to Chief—A. Shavitsky, B.Agr.Sc.
Assistant Technical Secretary—J. H. E. Mackay, B.Sc.Agr.
Administrative Officer—D. W. Banyard
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Genetics and Plant Breeding
Senior Principal Research Officer—J. B. Griffing, M.S., Ph.D. (*Section Chairman*)
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Senior Research Officer—C. A. Neal-Smith, B.Agr.Sc.

Experimental Officer—P. Broué, B.Sc.Agr.
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General Botany
Principal Research Officer—C. Barnard, D.Sc.

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Senior Research Officer—J. V. Possingham, B.Agr. Sc.(Hons.), M.Sc., D.Phil.
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Senior Research Officer—K. Spencer, B.Sc.Agr. (Hons.), M.S.
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Senior Research Officer—P. A. Trudinger, B.Sc. (Hons.), Ph.D. (*overseas*)
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Experimental Officer—L. J. Ludwig, B.Agr.Sc., M.Sc.
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Research Officer—G. W. Arnold, M.Sc.Agr. (*overseas*)
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Experimental Officer—N. T. Clark, B.Rur.Sc.

At Wagga Agricultural Research Institute (New South Wales Department of Agriculture):

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Research Officer—K. Hoen, M.Sc., Ph.D.
Research Officer—R. N. Oram, B.Agr.Sc.(Hons.), Ph.D.

At Regional Laboratory, Armidale, N.S.W.:

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Principal Research Officer—R. Roe, B.Sc.Agr.
Research Officer—N. J. Barrow, M.Agr.Sc., Ph.D. (*overseas*)
Experimental Officer—R. E. Mottershead, B.Sc.

At Regional Laboratory, Deniliquin, N.S.W.:

Pasture Investigations
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Research Officer—Miss J. M. Anderson, M.Sc., Ph.D.
Research Officer—J. L. Davidson, M.Agr.Sc. (*overseas*)
Research Officer—C. R. Kleinig, M.Agr.Sc.(Hons.)
Research Officer—R. H. Sedgley, M.Agr.Sc.
Experimental Officer—R. H. Crockford, A.R.M.T.C.
Experimental Officer—B. D. Millar, B.Sc.Agr.

Genetics
Experimental Officer—Miss V. E. Rogers, B.A. (Hons.)

At Regional Laboratory, Perth:

Pasture Investigations
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Senior Research Officer—A. B. Beck, M.Sc.
Senior Research Officer—A. W. Humphries, B.Sc. Agr.(Hons.)
Senior Research Officer—P. G. Ozanne, B.Sc.Agr.
Research Officer—H. L. Davies, B.Sc.Agr.(Hons.)
Research Officer—E. A. N. Greenwood, D.D.A., B.Agr.Sc., Ph.D.
Research Officer—F. J. Roberts, B.Sc.Agr.(Hons.)
Experimental Officer—D. J. Kirton, B.Sc.Agr.
Experimental Officer—T. C. Shaw, B.Sc.
Experimental Officer—G. B. Taylor, B.Agr.Sc.
Experimental Officer—Z. V. Titmanis, Dip.Chem.
Experimental Officer—J. Walker, B.Sc.(Agric.)

Plant Introduction
Senior Research Officer—E. T. Bailey, B.Sc.(Hons.)

At "Glen Lossie" Field Station, Kojonup, W.A.:

Pasture Investigations
Senior Research Officer—E. R. Watson, M.Sc.Agr.
Experimental Officer—D. Bennett, B.Agr.Sc.(Hons.)
Experimental Officer—P. Lapins, Dip. Agronom., M.Ag.Sc.

At University of Queensland:

Rain Forest Ecology
Principal Research Officer—L. J. Webb, M.Sc., Ph.D.

At Cunningham Laboratory, Brisbane:

Plant Introduction
Research Officer—R. J. Williams, M.Sc.

At "Stowell", Hobart:

Fruit Investigations
Principal Research Officer—D. Martin, D.Sc.
Research Officer—T. L. Lewis, M.Sc., Ph.D. (*overseas*)
Experimental Officer—J. Cerny, Dr.Tech.Sc.

At Applethorpe, Qld:

Fruit Investigations
Principal Research Officer—L. A. Thomas, M.Sc.

At University of Melbourne:

Mineral Nutrition Investigations
Principal Research Officer—L. H. P. Jones, B.Agr. Sc., Ph.D.
Experimental Officer—K. A. Handreck, B.Sc.
Hon. Research Associate—Angela A. Milne, B.Sc., Ph.D.

At Tobacco Research Institute, Mareeba, Qld.:

Tobacco Investigations
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Senior Research Officer—G. P. H. W. Geisler, Ph.D.(Ag.Sc.)
Senior Research Officer—W. J. Lovett, M.Agr.Sc.

Senior Research Officer—N. K. Matheson, M.Sc., Ph.D.
Senior Research Officer—D. C. Wark, M.Agr.Sc.
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Experimental Officer—J. M. Wheatley, B.Agr.Sc.

DIVISION OF PROTEIN CHEMISTRY

See Wool Research Laboratories

DIVISION OF RADIOPHYSICS

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Assistant Chief—J. L. Pawsey, M.Sc., Ph.D., D.Sc., F.A.A., F.R.S.
Technical Secretary—A. J. Higgs, B.Sc.(Hons.)
Principal Research Officer—L. L. McCready, B.Sc., B.E.

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Senior Research Officer—S. C. Mossop, M.Sc., D.Phil.
Senior Research Officer—J. W. Telford, B.Sc. (Hons.)
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Experimental Officer—L. Gruner, B.E.E.
Experimental Officer—M. B. Mackey, B.Sc., B.E.
Experimental Officer—D. K. Milne, A.S.T.C.
Experimental Officer—W. J. Payten, A.S.T.C.
Experimental Officer—F. G. Tonking, A.S.T.C.

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Experimental Officer—P. T. Hedges, A.S.T.C.

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Experimental Officer—G. A. Wells, A.S.T.C.

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Experimental Officer—G. A. Chandler, M.E.
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Senior Research Officer—D. Lafeber, D.Sc.
Research Officer—I. B. Donald, B.C.E., M.Eng.Sc., D.I.C., Ph.D.
Research Officer—N. C. Donovan, Ph.D., M.S.E., B.E.
Research Officer—R. B. Ellwood, B.Sc., Ph.D.
Research Officer—B. B. Metcalf, B.Sc., Ph.D.
Experimental Officer—B. G. Richards, B.E.(Hons.)
Administrative Officer—K. T. Wenham

DIVISION OF SOILS

Headquarters: Waite Road, Urrbrae, S.A.

At Adelaide:

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Administrative Officer—F. W. Blanksby
Librarian—P. H. Dawe

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Principal Research Officer—G. Blackburn, B.Ag.Sc.
Principal Research Officer—K. H. Northcote, B.Ag.Sc.
Senior Research Officer—R. W. Jessup, M.Sc. (*seconded from Division of Plant Industry*)
Research Officer—G. G. Beckmann, M.Sc. (*overseas*)
Research Officer—W. H. Litchfield, B.Sc.Agr. (*at Alice Springs*)
Research Officer—W. T. Ward, B.Sc.
Research Officer—C. B. Wells, M.Ag.Sc. (*overseas*)

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Principal Research Officer—A. C. Oertel, M.Sc.
Principal Research Officer—J. T. Hutton, B.Sc., A.S.A.S.M.
Senior Research Officer—M. Raupach, M.Sc.
Senior Research Officer—H. C. T. Stace, M.Sc.
Senior Research Officer—B. M. Tucker, B.A., M.Sc.
Research Officer—A. W. Fordham, M.Sc., D.Phil.
Research Officer—K. G. Tiller, M.Sc., Ph.D.
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Experimental Officer—A. R. P. Clarke, B.Tech.
Experimental Officer—J. B. Giles, B.Sc.
Experimental Officer—R. M. McKenzie, B.Tech.
Experimental Officer—M. P. C. de Vries (l.i.)

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Senior Research Officer—W. W. Emerson, B.A., Ph.D.
Senior Research Officer—E. L. Greacen, B.Sc.Agr., Ph.D.
Senior Research Officer—J. W. Holmes, M.Sc.
Research Officer—J. S. Colville, M.Sc.
Research Officer—C. G. Gurr, B.Sc.

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Senior Research Officer—A. D. Rovira, B.Ag.Sc., Ph.D.
Research Officer—G. D. Bowen, B.Sc.
Research Officer—J. N. Ladd, M.Sc., Ph.D.
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Experimental Officer—J. H. A. Butler, B.Sc.
Experimental Officer—Mrs. J. I. Rogasch, B.Sc.

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Research Officer—J. A. Rausell Colom, D.Sc.
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Experimental Officer—R. M. Taylor, B.Sc.

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Research Officer—R. F. Isbell, M.Sc.
Research Officer—C. J. de Mooy (l.i.)
Experimental Officer—C. H. Thompson, Q.D.A.

Soil Physics Section
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Experimental Officer—R. E. Prebble, B.Sc.

Soil Chemistry Section
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Senior Research Officer—R. S. Beckwith, B.Sc.
Experimental Officer—I. F. Fergus, B.Sc.
Experimental Officer—I. P. Little, B.Sc.Agr.
Experimental Officer—R. Reeve, Dip.Ind.Chem.
Experimental Officer—P. J. Ross, B.Sc.

At Canberra:

Soil Survey and Pedology Section
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Senior Research Officer—D. C. van Dijk, Ing. Agr., D.Sc.
Senior Research Officer—W. M. McArthur, B.Sc. (*at Armidale*)
Research Officer—J. A. Beattie, B.Sc.Agr. (*study leave*)
Research Officer—J. Loveday, M.Ag.Sc., Ph.D. (*at Griffith*)
Research Officer—P. H. Walker, M.Sc.Agr.

Soil Chemistry Section
Senior Research Officer—J. D. Colwell, B.Sc.Agr., Ph.D.
Experimental Officer—H. J. Beatty, Dip.Ind.Chem.

Soil Physics Section
Senior Research Officer—D. S. McIntyre, M.Sc., Ph.D.

Soil Micropedology Section
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Senior Research Officer—J. R. Sleeman, B.Ag.Sc.
Experimental Officer—Miss M. P. Green, B.Sc.
Experimental Officer—R. J. Hunter, B.Sc.

At Hobart:

Soil Survey and Pedology Section
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Research Officer—G. M. Dimmock, B.Sc.

Soil Chemistry Section
Experimental Officer—A. M. Graley, B.Sc.
Experimental Officer—J. L. Honeysett, B.Sc.

At Perth:

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Research Officer—H. M. Churchward, M.Sc.Agr.
Experimental Officer—E. Bettenay, M.Sc.(Agric.)

Soil Chemistry Section
Experimental Officer—A. G. Turton, B.Sc.
Experimental Officer—F. J. Hingston, M.Sc.

Soil Physics Section
Research Officer—A. V. Blackmore, M.Sc., Ph.D.

Soil Microbiology Section
Research Officer—K. C. Marshall, M.Sc., Ph.D.

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DIVISION OF TEXTILE PHYSICS

See Wool Research Laboratories

DIVISION OF TRIBOPHYSICS

Headquarters: University of Melbourne

Chief—W. Boas, D.Ing., M.Sc., F.A.A.
Principal Research Officer—L. M. Clarebrough, Ph.D., B.Met.E., M.Eng.Sc.
Principal Research Officer—M. E. Hargreaves, Ph.D., B.Met.E.
Principal Research Officer—A. K. Head, Ph.D., B.A.(Hons.), B.Sc.
Principal Research Officer—J. K. Mackenzie, Ph.D., B.A.(Hons.), B.Sc.
Principal Research Officer—D. Michell, B.E.E.
Principal Research Officer—A. J. W. Moore, Ph.D., B.Sc.
Principal Research Officer—G. W. West, B.E.E., B.Sc.
Senior Research Officer—A. J. Davis, B.Eng.
Senior Research Officer—J. F. Nicholas, B.A.(Hons.), B.Sc.
Senior Research Officer—G. J. Ogilvie, Ph.D., B.Met.E., M.Eng.Sc.
Senior Research Officer—J. V. Sanders, Ph.D., B.Sc.(Hons.)
Senior Research Officer—J. A. Spink, M.Sc.
Research Officer—J. G. Allpress, M.Sc.
Research Officer—J. Bagg, Ph.D., B.Sc.
Research Officer—P. G. Fox, Ph.D., B.Sc.
Research Officer—R. K. Ham, Ph.D., B.A.Sc.
Research Officer—M. H. Loretto, B.Met.(Hons.)
Research Officer—H. G. Scott, Ph.D., B.A.
Experimental Officer—H. Jaeger, A.R.A.C.I.
Experimental Officer—R. R. Johnson, Dip.Appl.Chem., B.Sc.
Experimental Officer—R. M. Lowe, B.Sc.
Experimental Officer—G. R. Perger, F.R.M.T.C.
Experimental Officer—Miss N. G. Sharpe, B.Sc.
Experimental Officer—R. G. Sherwood, A.R.M.T.C
Experimental Officer—A. A. Thomson, A.R.M.T.C.
Experimental Officer—A. J. White, A.R.M.T.C.

DIVISION OF TROPICAL PASTURES

Headquarters: Cunningham Laboratory, St. Lucia, Brisbane

Chief—J. Griffiths Davies, Ph.D., D.Sc.
Laboratory Secretary—A. G. Eyles, B.Sc.(Agric.)
Administrative Officer—D. B. Thomas

Agrostology
Chief of the Division—J. Griffiths Davies, Ph.D., D.Sc.
Principal Research Officer—W. W. Bryan, M.Agr.Sc.
Principal Research Officer—N. H. Shaw, B.Agr.Sc.(Hons.)
Research Officer—L. A. Edye, B.Agr.Sc.(Hons.)
Research Officer—R. J. Jones, B.Sc.(Agric.)(Hons.)
Research Officer—L. 't Mannetje, Ir.(Wageningen)
Research Officer—J. J. Yates, B.Sc.(Agric.)(Hons.), Ph.D.
Experimental Officer—T. R. Evans, B.Sc.(Agric.), D.T.A.

Plant Breeding and Genetics
Senior Principal Research Officer—E. M. Hutton, B.Agr.Sc., D.Sc.
Research Officer—A. J. Pritchard, B.Sc.(Hons.)
Experimental Officer—D. E. Byth, B.Agr.Sc.
Experimental Officer—S. G. Gray, M.Sc.Agr.

Plant Nutrition and Soil Fertility
Principal Research Officer—O. S. Andrew, M.Agr.Sc.
Research Officer—E. F. Henzell, B.Agr.Sc.(Hons.), Ph.D.

Plant Physiology
Principal Research Officer—C. T. Gates, M.Sc.(Agric.)
Senior Research Officer—R. G. Coleman, B.Sc.Agric., D.I.C., Ph.D.

Plant Chemistry
Research Officer—M. P. Hegarty, M.Sc., Ph.D.
Experimental Officer—R. D. Court, B.Sc.
Experimental Officer—M. F. Robins, B.Sc.(Agric.)

Ecology
Principal Research Officer—J. E. Coaldrake, M.Sc.
Experimental Officer—W. F. Ridley, M.Sc.

Legume Bacteriology
Senior Principal Research Officer—D. O. Norris, D.Sc.(Agric.)

Pasture Evaluation and Animal Nutrition
Research Officer—R. Milford, B.Agr.Sc.(Hons.)

UPPER ATMOSPHERE SECTION

Headquarters: Harben Vale, Camden, N.S.W.

Chief Officer-in-Charge—D. F. Martyn, Ph.D., D.Sc, F.A.A., F.R.S.
Research Officer—R. A. Duncan, B.Sc.(Hons.)
Experimental Officer—D. G. Cartwright, B.Sc. (Hons.)
Experimental Officer—T. W. Davidson, M.Sc.

WESTERN AUSTRALIAN REGIONAL LABORATORY

Headquarters: University Grounds, Nedlands, W.A. The services of this office are common to Divisions and Sections represented in Western Australia

Officer-in-Charge—R. C. Rossiter, B.Sc.Agr., D.Sc. (Agric.)
Administrative Officer—J. P. Brophy
Scientific Librarian—Miss J. C. Kahan, B.Sc.

WHEAT RESEARCH UNIT

Headquarters: Delhi Rd, North Ryde, N.S.W.

Officer-in-Charge—E. E. Bond, A.R.M.T.C.
Leader of Unit—M. V. Tracey, M.A.
Senior Research Officer—J. Wilson Lee, B.Sc. (Hons.), Ph.D.
Research Officer—D. J. Winzor, B.Sc.(Hons.), Ph.D.
Experimental Officer—Miss P. M. Bell, B.Sc.
Experimental Officer—J. K. Raison, B.Sc.(Hons.) (*on leave*)
Experimental Officer—C. W. Wrigley, M.Sc.

WILDLIFE SURVEY SECTION

Headquarters: Canberra

At Canberra

Officer-in-Charge—H. J. Frith, B.Sc.Agr.
Senior Principal Research Officer—R. Carrick, B.Sc.(Hons.), Ph.D.
Sectional Secretary—F. N. Robinson, B.A.
Administrative Officer—P. Magi
Principal Research Officer—M. E. Griffiths, D.Sc.
Senior Research Officer—J. H. Calaby, Dip.App. Chem.
Senior Research Officer—A. L. Dyce, B.Sc.Agr. (Hons.)
Research Officer—R. Mykytowycz, D.V.M.
Research Officer—I. C. R. Rowley, B.Agr.Sc.
Experimental Officer—Miss S. E. Ingham, B.A. (Hons.)
Experimental Officer—J. M. MacLennan, M.A., B.Sc., Ph.D.
Scientific Librarian—Mrs. E. M. Wylie, B.Sc.

At Perth

Principal Research Officer—D. L. Serventy, B.Sc. (Hons.), Ph.D.
Experimental Officer—S. J. J. Davies, B.A.(Hons.)

At Albury, N.S.W.

Research Officer—W. E. Poole, B.Sc.(Hons.)

At Armidale, N.S.W.

Senior Research Officer—B. V. Fennessy, B.Agr.Sc.
Experimental Officer—J. E. Bromell, B.Agr.Sc.

At Hobart

Senior Research Officer—M. G. Ridpath, B.Sc. (Hons.)

At Adelaide

Senior Research Officer—K. Myers, B.Sc.(Hons.)

WOOL RESEARCH LABORATORIES

Wool Textile Research Committee

F. G. Lennox, D.Sc. (*Chairman*)
V. D. Burgmann, B.Sc., B.E.
M. Lipson, B.Sc., Ph.D.
C. Garrow, B.Com., D.P.A. (*Secretary*)

DIVISION OF PROTEIN CHEMISTRY

Headquarters: 343 *Royal Parade, Parkville, Vic.*

Chief—F. G. Lennox, D.Sc.
Laboratory Secretary—C. Garrow, B.Com., D.P.A.
Senior Principal Research Officer—W. G. Crewther, M.Sc.
Senior Principal Research Officer—H. Lindley, B.A., Ph.D.
Principal Research Officer—W. F. Forbes, B.Sc., Ph.D.
Principal Research Officer—R. D. B. Fraser, Ph.D., D.Sc.
Principal Research Officer—J. M. Gillespie, M.Sc.
Principal Research Officer—M. A. Jermyn, M.Sc., Ph.D.
Principal Research Officer—S. J. Leach, B.Sc. Tech., Ph.D.
Principal Research Officer—T. A. Pressley, B.Sc.
Principal Research Officer—E. O. P. Thompson, M.Sc., Dip.Ed., Ph.D.
Principal Research Officer—E. F. Woods, M.Sc., A.R.M.T.C.
Senior Research Officer—B. S. Harrap, Ph.D.

Senior Research Officer—A. S. Inglis, M.Sc.
Senior Research Officer—J. A. Maclaren, Ph.D.
Senior Research Officer—T. P. MacRae, M.Sc.
Senior Research Officer—I. J. O'Donnell, M.Sc.
Senior Research Officer—G. E. Rogers, M.Sc., Ph.D.
Senior Research Officer—W. E. Savige, Ph.D.
Research Officer—B. Milligan, Ph.D.
Research Officer—C. M. Roxburgh, Ph.D.
Research Officer—P. H. Springell, M.A., Ph.D. (*abroad*)
Research Officer—J. R. Yates, Ph.D.
Research Officer—G. Youatt, Ph.D.
Senior Experimental Officer—J. P. E. Human, Ph.D.
Experimental Officer—A. K. Allen, B.Sc.
Experimental Officer—L. M. Dowling, B.Sc.
Experimental Officer—B. K. Filshie, B.Sc.
Experimental Officer—G. F. Flanagan, F.R.M.T.C.
Experimental Officer—A. B. McQuade, B.Sc.
Experimental Officer—T. C. Morton, Dip.Chem.
Experimental Officer—D. E. Rivett, A.B.T.C.
Experimental Officer—R. J. Rowlands, B.Sc.
Experimental Officer—I. W. Stapleton, Dip.Chem., B.Sc.
Experimental Officer—D. J. Tucker, A.G.Inst.Tech.
Experimental Officer—K. I. Wood, A.R.M.T.C.

DIVISION OF TEXTILE INDUSTRY

Headquarters: Geelong, Vic.

Chief—M. Lipson, B.Sc., Ph.D.
Administrative Officer—J. H. G. Watson, A.A.S.A.
Principal Research Officer—A. J. Farnworth, M.B.E., M.Sc., Ph.D., A.G.Inst.Tech.
Principal Research Officer—G. W. Walls, B.Sc.
Principal Research Officer—G. F. Wood, B.Sc., Ph.D.
Senior Research Officer—C. A. Anderson, B.Sc., Ph.D.
Senior Research Officer—R. E. Belin, M.Sc.
Senior Research Officer—J. R. McPhee, B.Sc., Ph.D.
Senior Research Officer—D. S. Taylor, B.A.,B.Sc., Ph.D.
Research Officer—J. Delmenico, B.Sc. (*overseas*)
Research Officer—D. E. Henshaw, B.Sc.
Research Officer—R. Pearcy, M.Sc.
Research Officer—V. A. Williams, B.Sc., Ph.D.
Experimental Officer—B. B. Beard, A.G.Inst.Tech.
Experimental Officer—H. J. Katz, B.Sc., Ph.D.
Experimental Officer—K. I. M. Kelaart, A.G.Inst. Tech.
Experimental Officer—B. O. Lavery, Nat.Cert. in Mech.Eng.
Experimental Officer—A. R. W. Lee, B.Sc., Dip.Ed.
Experimental Officer—J. D. Leeder, A.G.Inst.Tech.
Experimental Officer—F. S. Niezgodka, A.G.Inst. Tech.
Experimental Officer—I. J. Poulter, B.Sc.
Experimental Officer—D. C. Shaw, B.Sc. (*overseas*)
Experimental Officer—G. C. West, A.G.Inst.Tech.

DIVISION OF TEXTILE PHYSICS

Headquarters: 338 *Blaxland Road, Ryde, N.S.W.*

Chief—V. D. Burgmann, B.Sc., B.E.
Administrative Officer—J. I. Platt, B.Sc.(Econ.)
Principal Research Officer—J. G. Downes, B.Sc.
Principal Research Officer—M. Feughelman, M.Sc., A.S.T.C.
Principal Research Officer—N. F. Roberts, M.Sc.
Senior Research Officer—E. G. Bendit, B.Sc.(Eng.), M.Sc.
Senior Research Officer—H. W. Holdaway, B.Sc., B.E.
Senior Research Officer—Mrs. K. R. Makinson, B.A.
Senior Research Officer—I. C. Watt, M.Sc., Ph.D.
Research Officer—M. W. Andrews, B.Sc., Ph.D.
Research Officer—K. Baird, M.Sc., Ph.D.
Research Officer—E. F. Denby, B.Sc., Ph.D., D.I.C.
Research Officer—A. R. Haly, M.Sc.
Research Officer—J. F. P. James, M.Sc.
Research Officer—D. T. Liddy, B.Sc.
Research Officer—P. Nordon, B.Sc., A.S.T.C., Ph.D.
Research Officer—B. J. Rigby, M.Sc., A.S.T.C.
Research Officer—I. M. Stuart, M.Sc.
Experimental Officer—J. E. Algie, B.E., A.S.T.C., M.Sc.
Experimental Officer—Miss J. C. Griffith, M.Sc., A.S.T.C.
Experimental Officer—H. W. M. Lunney, B.Sc., B.E.
Experimental Officer—B. H. Mackay, B.Sc., A.S.T.C.
Experimental Officer—G. B. McMahon, B.Sc.
Experimental Officer—T. W. Mitchell, A.S.T.C.
Experimental Officer—R. M. Rabbidge, A.S.T.C.
Experimental Officer—D. Ross, A.S.T.C.
Experimental Officer—L. J. Smith, A.S.T.C.
Experimental Officer—G. L. Stott, A.S.T.C.
Librarian—Miss H. G. Barr, B.A.(Hons.)

UNATTACHED OFFICERS

Senior Principal Research Officer—G. H. Munro, D.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Principal Research Officer—J. C. M. Fornachon, B.Agr.Sc., M.Sc. (*seconded to Australian Wine Research Institute*)
Experimental Officer—L. Heisler, B.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Experimental Officer—J. N. Stephens, M.A. (*on leave*)
Experimental Officer—P. R. Strutt, B.Sc. (*on leave*)
Experimental Officer—J. A. Thompson, B.Sc. (*on leave*)

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Finance

A summary of the Organization's receipts and expenditure from July 1, 1960, to June 30, 1961, has been given on page 24. Details are given below:

Expenditure

	£	£	£
Salaries and Contingencies*			**373,024**
Investigations			
Animal Research Laboratories		1,058,246	
LESS contributions from—			
Wool Research Trust Fund	492,916		
Australian Dairy Produce Board	1,472		
Dairy Produce Research Trust Account	5,580		
United Graziers' Association of Queensland	2,018		
Ian McMaster Bequest	3,957		
Alexander Fraser Memorial Fund	399		
W. McIlrath Fellowship	1,125		
Burdekin Bequest (Drought feeding)	1,900		
The Population Council Inc.	3,488		
Merck, Sharp & Dohme (Aust.) Pty. Ltd.	1,264		
Special Revenue Funds—			
"Belmont" Field Station	8,767	522,886	535,360
Plant Research—			
Plant Industry		886,518	
LESS contributions from—			
Wheat Research Trust Account	9,070		
Brown Rot Trust Fund	2,500		
Rockefeller Foundation	7,288		
International Atomic Energy Agency	721		
Wool Research Trust Fund	203,696		
River Murray Commission	1,875		
Fisons Pest Control and J. R. Geigy	953	226,103	660,415

* The main items of expenditure under this heading are salaries of the administrative staff at Head Office; salaries and expenses of officers at the Liaison Offices in London and Washington; staff and upkeep of State Committees; travelling expenses of Head Office staff; and general office expenditure.

	£	£	£
Tropical Pastures		175,144	
LESS contributions from—			
Rockefeller Foundation	8,382		
Special Revenue Fund—			
Samford Farm	714	9,096	166,048
Suspense (Overseas transactions)			1,400
			827,863
Entomology		360,372	
LESS contributions from—			
Department of Primary Industry	2,002		
Wheat Research Trust Account	5,088		
U.S.A. Department of Health	1,826		
Dairy Produce Research Trust Account	3,203		
River Murray Commission and Snowy Mountains Hydro-Electric Authority	2,407	14,526	345,846
Soils and Irrigation—			
Soils		316,791	
LESS contributions from—			
Wool Research Trust Fund	2,308		
Australian Mineral Industries Research Association	687		
S. Aust. Woods and Forests Department	2,153		
Ruminant Fertilizers Fund	594		
Wheat Research Trust Account	2,963		
Australian Petroleum Exploration Association Ltd.	1,622		
Commonwealth Fertilisers & Chemicals Ltd., Aust. Fertilisers Ltd., Cuming Smith and Mt. Lyell Farmers Fertilisers Ltd.	971	11,298	305,493
Soils Mechanics		68,609	
LESS contributions from—			
Department of the Army	8,958		
Various Contributors—Subgrade Moisture Investigations	1,103		
Launceston City Council	2,435		
Broken Hill Pty. Ltd.	632		
Various Contributors—Research on Building Foundations	2,490		
Tasmanian Department of Health	64	15,682	52,927
Commonwealth Research Station, Merbein		88,692	
LESS contributions from—			
Dried Fruits Control Board	1,029		
Packing Companies and Co-operative Dried Fruit Sales Pty. Ltd.	514	1,543	87,149

	£	£	£
Irrigation Research Station, Griffith		94,170	
LESS contributions from—			
N.S.W. Water Conservation and Irrigation Commission	4,571		
Special Revenue Fund—			
Griffith Research Station	3,604	8,175	85,995
Suspense (Overseas transactions)			3,025
			534,589
Food Preservation		334,613	
LESS contributions from—			
N.S.W. Department of Agriculture	2,564		
Metropolitan Meat Industry Board	417		
Queensland Meat Industry Board	1,275		
Australian Meat Board	4,530		
Australian Egg Board	132		
Department of Primary Industry	3,389		
Various Contributors	3,185		
Egg Producers' Council	1,233		
Australian Dried Fruits Association	72		
Broken Hill Pty. Ltd.	2,152	18,949	315,664
Forest Products		396,600	
LESS contributions from—			
Australian Paper Manufacturers Ltd. Associated Pulp and Paper Mills Ltd. Australian Newsprint Mills .. New Zealand Forest Products Ltd. ..	6,428		
Department of Territories	5,179		
General Donations	4,115		
Australian Plywood Board	8,584		
Department of Forestry, Fiji	541	24,847	371,753
Mining and Metallurgy		61,537	
LESS contributions from—			
Australasian Institute of Mining and Metallurgy ..	526		
Consolidated Zinc Pty. Ltd., Northwest Tantalum N.L.	1,498		
General Donations	4,582	6,606	54,931
Radio Research—			
Upper Atmosphere Section		29,984	
Radio Research Board Activities	35,709		
LESS contributions from—			
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission	20,509	15,200	
Suspense (Overseas transactions)		33	45,217

	£	£	£
Research Services		428,018	
LESS contributions from—			
Wool Research Trust Fund	29,708		
Wheat Research Trust Account	9,816		
Department of Works and Department of Labour and National Service	1,108	40,632	387,386
Chemical Research Laboratories		856,192	
LESS contributions from—			
Cement and Concrete Association of Australia	546		
State Electricity Commission of Victoria, Gas and Fuel Corporation of Victoria, and Australian Paper Manufacturers Ltd.	815		
Various Contributors	3		
Smith, Kline, and French Laboratories (U.S.A.)	4,792		
Commonwealth Aluminium Corporation	2,601		
Chamber of Mines (W.A.) Inc.	1,240		
The Population Council Inc.	1,037		
Consolidated Zinc Pty. Ltd.	139		
Wool Research Trust Fund	37,879		
Union Carbide Aust. Ltd.	13,981		
Colonial Sugar Refining Co. Ltd.	1,475	64,508	791,684
Fisheries and Oceanography		246,683	
LESS contributions from—			
Department of the Navy	5,059		
Department of Primary Industry	2,060		
N.S.W. State Fisheries Department	35	7,154	239,529
Mathematical Statistics			88,838
National Standards Laboratory		767,705	
LESS contributions from—			
Department of Supply	2,289		
General Donations	28	2,317	765,388
Tribophysics		120,138	
LESS contributions from—			
H. C. Sleigh Ltd.	1,505		
Union Carbide Aust. Ltd.	225		
General Donations Account	184	1,914	118,224
Building Research		191,335	
LESS contributions from—			
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries Ltd., and Colonial Sugar Refining Co. Ltd.	3,823		
State Electricity Commission	504		
Cement and Concrete Association of Australia	1,032		
General Donations Account	178		
Jayworth Besser Ltd.	61	5,598	185,737

	£	£	£
Biochemistry and General Nutrition		163,566	
LESS contributions from—			
Wool Research Trust Fund	61,430		
Australian Wool Board (old grant)	138		
Consolidated Zinc Pty. Ltd. and Electrolytic Zinc Co. of Australasia Ltd.	750	62,318	101,248
Fodder Conservation			36,255
Radiophysics		451,278	
LESS contribution from—			
Department of Civil Aviation	1,592	1,592	449,686
Metallurgical Research			15,010
Tobacco Research		62,857	
LESS contributions from—			
Tobacco Research Trust	59,474		
Tobacco Growers' Association in Burdekin Valley	3,383	62,857	NIL
Meteorological Physics		118,275	
LESS contribution from—			
Tobacco Research Trust	1,709	1,709	116,566
Dairy Research		144,112	
LESS contributions from—			
Australian Dairy Produce Board	408		
Dairy Produce Research Trust Account	50,965		
General Donations Account	149	51,522	92,590
Wool Research		574,252	
LESS contributions from—			
Wool Research Trust Fund	555,959		
Wool Buying and Selling Account	3,904		
Australian Wool Bureau	496	560,359	13,893
Fuel Research		280,904	
LESS contributions from—			
General Donations Account	7,405		
State Electricity Commission	12,522	19,927	260,977
Wildlife Survey		165,502	
LESS contributions from—			
Wool Research Trust Fund	48,001		
Australian Newsprint Mills Pty. Ltd.	1,836		
Petfoods Ltd.	15		
Altona Survey Group	163	50,015	115,487

	£	£	£
Land Research and Regional Survey		333,237	
LESS contributions from—			
Department of National Development	7,935		
Department of Territories	85,489	93,424	239,813
Miscellaneous—			
Biophysical Research		2,275	
Patent Fees		5,531	
Extra-mural Investigations		24,223	
Furlough and Compensation		38,947	
Wheat Research		24,396	
Second International Wool Textile Research Conference ..		534	
Various		32,664	
		128,570	
LESS contributions from—			
Science and Industry Endowment Fund	2,507		
Wheat Research Trust Account	24,396		
Wool Research Trust Fund	534		
Mining Research Association	2,009		
Commonwealth Bank	1,160	30,606	97,964
TOTAL Investigations			**7,147,498**
Grants			
Research Associations—			
Leather Research Association	2,140		
Bread Research Institute	15,560		
Wine Research Institute	3,500		
Tobacco Research Trust	10,500		
Coal Association (Research) Ltd.	20,000	51,700	
Overseas Research Studentships		95,069	
		146,769	
LESS contributions from—			
Wool Research Trust Fund	4,906		
Science and Industry Endowment Fund	1,332	6,238	**140,531**
TOTAL Salaries and Contingencies, Investigations, and Grants			**7,661,053**
LESS receipts from sales of equipment, publications, etc., and revenue earned by Divisions and Sections, details of which are shown on page 148 ..			89,949
			7,571,104

Contributions

This Section shows receipts and disbursements during the year 1960–61 of the funds provided by contributors and recorded in a special account entitled "Specific Research Trust Fund". It includes transactions financed from wool funds, details of which appear on pages 146–8. Of the total expenditure of £2,425,771 recorded in this Fund, £1,942,910 refers to normal research activities and £482,861 to capital works.

The following table summarizes the sources of these funds and the activities on which they were expended.

SOURCE OF FUNDS	ACTIVITY *Investigations* £	*Capital Works* £	TOTAL £
Wool Research Trust Fund	1,437,336	333,031	1,770,367
Contributions (in addition to Wool)	505,574	149,830	655,404
	1,942,910	482,861	**2,425,771**

The details are as follows:

	Receipts 1960–61 & *Balances brought forward* 1959–60 £	*Expenditure* 1960–61 £
Wool Research Trust Fund (*details are shown on pages* 146–8)	1,768,000	1,770,367*
Australian Dairy Produce Board—*Mastitis Investigations* ..	66	66
W. McIlrath Research Fellowship Fund—*Expenses of Fellowship, Animal Husbandry*	1,125	1,125
General Donations (Animal Genetics)	532	NIL
Dairy Produce Research Trust Account—*Infertility in Dairy Cattle*	6,254	5,580
Alexander Fraser Memorial Fund (Animal Research Laboratories)	445	399
Australian Dairy Produce Board—*Virus Diseases of Dairy Cattle*	876	723
Estate of the late Captain Ian McMaster (Animal Research Laboratories)	4,251	3,957
Australian Dairy Produce Board—*Endoparasites of Dairy Cattle*	700	683
Burdekin Bequest—*Drought Feeding Investigations* ..	3,635	1,900
Merck, Sharp & Dohme (Aust.) Pty. Ltd.—*Anthelmintics Research*	2,500	1,264
Special Revenue Fund—"*Belmont*" *Field Station, Rockhampton, Qld.* (Animal Research Laboratories)	18,200	8,767
Beef Cattle Nutrition Account (Animal Physiology) ..	89	NIL
General Donations (Animal Research Laboratories) ..	3	NIL
Special Revenue Fund—*Burdekin Bequest* (Animal Research Laboratories)	3,005	NIL
United Graziers' Association of Queensland (Animal Research Laboratories)	2,028	2,018
The Population Council Inc.—*Studies on Induced Infertility* ..	8,433	4,525
Trust Fund Brown Rot Investigations—*Brown Rot Survey* (Plant Industry)	2,702	2,500

* Expenditure on this work in excess of receipts will be recovered in 1961–62.

	Receipts 1960–61 & *Balance brought forward* 1959–60	*Expenditure* 1960–61
	£	£
General Donations (Plant Industry)	50	NIL
Western Australian Golf Association (Plant Industry)	50	NIL
British Conference Account (Soil Mechanics Investigations)	10	NIL
Fertilizer Sales Ltd.—*Research on Ruminant Fertilizers* (Soils Investigations)	1,500	594
S. Aust. Woods and Forests Department (Soils Investigations)	6,050	2,153
Australian Minerals Research Association—*Purchase of X-Ray Spectrograph* (Soils Investigations)	4,225	687
Commonwealth Fertilisers and Chemicals Ltd., Cuming Smith & Mt. Lyell Farmers Fertilisers Ltd., and Australian Fertilisers Ltd. (Soils Investigations)	2,657	971
Dairy Produce Research Trust Account—*Moisture Balance of Soils on Lower Murray Swamps*	350	NIL
Various Contributors—*Building Foundations in South Australia* (Soil Mechanics Investigations)	6,285	2,490
Tasmanian Department of Health—*Foundation Investigations in Tasmania*	1,400	64
Launceston City Council—*Landslip Investigations* (Soil Mechanics Investigations)	2,146	2,435*
Broken Hill Pty. Ltd.—*Jaspalite Benefication Project*	7,000	632
General Donations (Entomology)	123	NIL
Snowy Mountains Hydro-Electric Authority and River Murray Commission (Entomology)	3,500	2,407
Australian Dairy Produce Board—*Black Beetle Investigations* (Entomology)	103	NIL
Department of the Army (Soil Mechanics Investigations)	23,225	8,958
Department of Works and the States' Roads Boards—*Subgrade Moisture Investigation* (Soil Mechanics Investigations)	3,005	1,103
General Donations (Soil Mechanics Investigations)	16	NIL
Australian Petroleum Exploration Association Ltd.—*Microbiological Prospecting for Oil* (Soils Investigations)	805	1,622*
World Health Organization—*Insecticide Resistance in the Cattle Tick*	2,678	NIL
Packing Companies and Cooperative Dried Fruits Sales Ltd.—*Dried Vine Fruit Investigations* (Merbein)	2,729	514
N.S.W. Water Conservation and Irrigation Commission (Griffith Research Station)	8,000	4,571
Dried Fruits Control Board—*Dried Fruits Investigations*	2,612	1,029
Nyah-Woorinen Dried Fruits Inquiry Committee—*Dried Fruits Investigations*	525	NIL
Special Revenue Fund—*Citricultural Investigations* (Griffith Research Station)	14,483	14,935*
Australian Meat Board (Meat Investigations)	4,649	4,530
Metropolitan Meat Industry Board of New South Wales (Meat Investigations)	501	417
Queensland Meat Industry Board (Meat Investigations)	1,275	1,275
Department of Primary Industry—*Fruit Fly Investigations, Food Investigations*	3,241	3,191
Apple and Pear Board—*Food Investigations*	918	NIL
Dairy Produce Research Trust Account (Entomology)	3,588	3,203

* Expenditure on this work in excess of receipts will be recovered in 1961–62.

	Receipts 1960–61 & *Balances brought forward* 1959–60 £	*Expenditure* 1960–61 £
North Queensland Tobacco Growers' Coop. Association Ltd.—*Investigations in Burdekin Valley*	1,500	3,383*
River Murray Commission (Plant Industry)	1,875	1,875
Estate of J. O. Holston—*Alpine Ecology*	500	NIL
Australian Tobacco Research Trust—*Tobacco Investigations*	64,818	61,183
Special Revenue Fund—*Cattle Tick Investigations, Ingham*	2,000	NIL
Rockefeller Foundation (Plant Industry)	7,288	7,288
International Atomic Energy Agency—*Movement of Strontium 90*	1,049	721
Rockefeller Foundation (Tropical Pastures)	8,382	8,382
Fisons Pest Control and J. R. Geigy—*Chemical and Plant Anti-Fungal Investigations*	9,250	953
Special Revenue Fund—*Grazing Trials, Samford Farm* (Tropical Pastures)	1,683	714
A.C.F. and Shirleys Fertilizers—*Clearing Land at Beerwah*	500	500
Various Contributors—*Soybean Harvester* (Tropical Pastures)	221	NIL
Department of Primary Industry—*Fruit Fly Investigations* (Entomology)	1,994	2,002*
U.S.A. Department of Health, Education, and Welfare—*Multiplication of an Insect Polyhedron Virus* (Entomology)	3,207	1,826
Egg Producers' Council (Food Preservation)	1,500	1,233
Australian Dried Fruits Association—*Mould Attack on Prunes*	250	72
Various Contributors (Food Preservation)	12,952	3,185
Broken Hill Pty. Ltd.—*Research on Tinplate Containers*	6,000	2,152
Australian Egg Board—*Egg Investigations* (Food Preservation)	891	132
Department of Primary Industry—*Spray Residue Investigations* (Food Preservation)	520	198
N.S.W. Department of Agriculture—*Fruit Storage Investigations* (Food Preservation)	2,693	2,564
Paper Companies and New Zealand Forest Products—*Paper Pulp Investigations*	8,792	6,428
Sundry Contributors—*Forest Products Investigations*	5,991	4,115
Department of Territories—*Development of Pulp and Paper Industry in New Guinea*	4,306	4,191
Department of Territories—*Timber Utilization in New Guinea*	NIL	988†
Australian Plywood Board—*Veneer, Gluing, and Plywood Research* (Forest Products)	11,597	8,584
Government of Fiji—*Timber Research in Fiji*	2,498	541
Australasian Institute of Mining and Metallurgy (Mineragraphic Investigations)	2,603	526
General Donations (Ore-dressing Investigations)	4,857	4,582
Northwest Tantalum N.L. and Consolidated Zinc Pty. Ltd. (Ore-dressing Investigations)	1,500	1,498
State Electricity Commission of Victoria—*Geological Consultations* (Mineragraphic Investigations)	1,870	NIL
Miscellaneous Contributors (Mineragraphic Investigations)	137	NIL
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission—*Radio Research Board Activities*	21,383	20,509

* Expenditure on this work in excess of receipts will be recovered in 1961–62.
† Expenditure on this work will be recovered in 1961–62.

	Receipts 1960–61 & *Balances brought forward* 1959–60 £	*Expenditure* 1960–61 £
General Donations (Engineering Section)	200	NIL
Consolidated Zinc Pty. Ltd. (Chemical Research Laboratories)	236	139
Department of Works and Department of Labour and National Service—*Film on Building Research in Australia*	1,250	1,108
Miscellaneous Contributors (Chemical Research Laboratories)	6,829	3
State Electricity Commission, Gas and Fuel Corporation, and Australian Paper Manufacturers Ltd.—*Clinkering of Brown Coal Ash* (Chemical Research Laboratories)	2,364	815
Commonwealth Aluminium Corporation—*C.Z. Project* (Chemical Research Laboratories)	2,854	2,601
Western Australia Chamber of Mines (Inc.)—*Cyanidation of Gold* (Chemical Research Laboratories)	7,036	1,240
Union Carbide (Aust.) Ltd.—*Semi Polymers*	12,000	13,981*
Cement and Concrete Association of Australia—*Cement Investigations* (Chemical Research Laboratories)	11,258	546
Colonial Sugar Refining Co.—*Sugar Research*	2,500	1,475
Smith, Kline, and French Laboratories, U.S.A.—*Phytological Survey and Drug Plant Collection* (Chemical Research Laboratories)	15,466	4,792
N.S.W. Government—*Fisheries Investigations*	375	35
Department of the Navy—*Marine Fouling Investigations* (Fisheries and Oceanography)	5,792	5,059
Department of Primary Industry—*Pearl Shell Survey* (Fisheries and Oceanography)	938	937
Fisheries Development Trust Fund—*Barracouta Investigations* (Fisheries and Oceanography)	1,123	1,123
Department of Supply—*Examination of Gauges* (Metrology)	2,289	2,289
University of Western Australia (Mathematical Statistics)	200	NIL
General Donations (Physics)	40	NIL
General Donations (Metrology)	860	28
Machinability Donations Account (Metrology)	114	NIL
General Donations (Electrotechnology)	38	NIL
General Donations (Tribophysics)	349	184
Union Carbide (Aust.) Ltd.—*Catalytic Oxidation of Olefins*	3,000	225
H. C. Sleigh Ltd.—*Research on Solid Lubricants* (Tribophysics)	2,653	1,505
State Electricity Commission—*Design and Use of Briquette Space Heaters* (Building Research)	504	504
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries, and Colonial Sugar Refining Co. Ltd.—*Fibrous Plaster Research* (Building Research)	4,372	3,823
Paint Manufacturers' Association—*Paint Research on Plaster Surfaces* (Building Research)	140	NIL
General Donations (Building Research)	4,999	178
Cement and Concrete Association of Australia (Building Research)	1,404	1,032
Jayworth Besser Ltd.—*Efflorescence on Concrete Blocks* (Building Research)	1,000	61
Australian Wool Board—*Balance of Old Grant, Sheep Research* (Biochemistry and General Nutrition)	138	138
Various Contributors (Biochemistry and General Nutrition)	750	750

* Expenditure on this work in excess of receipts will be recovered in 1961–62.

	Receipts 1960–61 & *Balance brought forward* 1959–60	*Expenditure* 1960–61
	£	£
Radio Astronomy Trust (Radiophysics)	138,000	138,000
Department of Civil Aviation—*Radio Navigational Aids* (Radiophysics)	8,944	1,592
General Donations (Radiophysics)	200	NIL
Various Contributors—*Rain and Cloud Physics Research* (Radiophysics)	8,000	NIL
Dairy Produce Research Trust Account (Dairy Research)	54,507	50,965
Australian Dairy Produce Board—*Studentship in Dairy Chemistry* (Dairy Research)	408	408
General Donations (Dairy Research)	270	149
James Bell Machinery Pty. Ltd.—*Mechanization of Cheese Manufacture* (Dairy Research)	15	NIL
Wool Buying and Selling Account (Wool Research)	7,415	3,904
Donations for Worsted Processing Research (Wool Research)	1,414	NIL
Shell (Chemical) Aust. Pty. Ltd.—*Mothproofing Investigations* (Wool Research)	27	NIL
Associated Woollen Worsted Textile Manufacturers of Australia (Wool Research)	2,032	NIL
Various Contributors—*International Wool Textile Research Conference*	50	NIL
Wool Research Development Fund—*Research Development and Industrial Liaison* (Wool Research)	11	29*
General Donations (Wool Research)	31	NIL
Princeton Institute, U.S.A.—*Princeton Wool Project* (Wool Research)	2	NIL
Second International Wool Textile Research Conference	477	467
General Donations—*Coal Investigations*	7,522	7,405
Petfoods Ltd.—*Food for Budgerigars* (Wildlife Investigations)	93	15
Colonial Sugar Refining Co. Ltd.—*Purchase of Special Equipment* (Coal Research)	250	NIL
State Electricity Commission—*Brown Coal Investigations* (Coal Research)	15,000	12,522
Altona Survey Group—*Banding Stormy Petrels* (Wildlife Investigations)	200	163
Australian Newsprint Mills Pty. Ltd.—*Effect of Native Fauna on Eucalypt Regeneration* (Wildlife Investigations)	1,831	1,836*
Department of National Development—*Kimberley Research Station* (Land Research and Regional Survey)	8,174	7,935
Department of Territories—*Resources Survey in Papua and New Guinea* (Land Research and Regional Survey)	42,411	36,796
Australian Meat Board—*Pasture Development in Central Australia* (Land Research and Regional Survey)	5	NIL
Northern Territory Administration—*Rice Research* (Land Research and Regional Survey)	49,527	48,693
Sundry Contributors (Commonwealth Scientific and Industrial Research Organization)	175	NIL
Science and Industry Endowment Fund	3,682	3,839*
Wheat Research Trust Account	53,453	51,333
Australian Minerals Industry Research Association—*Geological Microbiology*	4,100	2,009

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	Receipts 1960–61 & *Balances brought forward* 1959–60	*Expenditure* 1960–61
	£	£
Commonwealth Bank—*Visit of Dr. Slykhuis*	1,250	1,160
	2,627,697	**2,425,771**

Wool Research Trust Fund

Details of transactions during 1960–61 are as follows:

	£	£	£
RECEIPTS			
Balance brought forward from 1959–60		39,220	
Received from Department of Primary Industry during 1960–61		1,728,780	**1,768,000**
EXPENDITURE 1960–1961			
Investigations			
Biological Research—			
Animal Research Laboratories—			
Division of Animal Physiology, Animal Physiology Laboratory	268,231		
Regional Laboratory and "Chiswick" Field Station, Armidale, N.S.W.	72,387	340,618	
Division of Animal Health, McMaster Laboratory	35,972		
Tooradin, Vic.	7,539	43,511	
Division of Animal Genetics			
Sheep Breeding, Cunnamulla, Qld.	42,399		
Animal Genetics Investigations, Sydney	44,437		
Sheep Breeding, McMaster Laboratory, McMaster Field Station, Armidale and Deniliquin, N.S.W. ..	21,391	108,227	
Suspense (Overseas transactions)		560	492,916
Plant Industry—			
Headquarters, Canberra	80,429		
Regional Pastoral Laboratory, Falkiner Memorial Field Station, Deniliquin, N.S.W.	26,766		
Field Investigations, Armidale, N.S.W.	35,318		
Western Australian Investigations	61,184	203,697	203,697
Division of Soils—			
Cobalt Work in Tasmania		2,308	2,308
Research Services—			
Agricultural Research Liaison Section		17,308	
Wool Publications		12,400	29,708

	£	£	£
Division of Biochemistery and General Nutrition—			
Nutrition Laboratory, Adelaide		38,653	
Field Studies at Glenthorne, Robe, and Brecon, S. Aust.		22,776	61,429
Wildlife Survey Section—			
Wildlife Investigations		48,001	48,001
Overseas Studentships		4,860	4,860
			842,919
Wool Research—			
Wool Research Laboratories—			
Protein Chemistry, Melbourne	168,325		
Textile Physics, Sydney	166,288		
Textile Industry, Geelong, Vic.	219,365		
Suspense (Overseas transactions)	1,980	555,958	
Chemical Research Laboratories—			
Chemical Physics	17,726		
Physical Chemistry	5,549		
Organic Chemistry	14,443		
Suspense (Overseas transactions)	161	37,879	
Overseas Studentships		46	
Second International Wool Textile Research Conference		534	594,417
TOTAL Investigations			**1,437,336**
Capital Works			
C.S.I.R.O. EXPENDITURE			
Biological Research—			
Animal Research Laboratories—			
Laboratory Equipment	11,825		
Plant Industry—			
Laboratory Equipment	2,139	13,964	
Wool Research—			
Wool Research Laboratories—			
Laboratory Equipment	32,480		
Textile Machinery	71,810	104,290	
		118,254	

	£	£	£
EXPENDITURE ON C.S.I.R.O. BUILDINGS BY DEPARTMENT OF WORKS			
Biological Research	46,575		
Wool Research	25,409	71,984	
EXPENDITURE ON BUILDINGS BY C.S.I.R.O.			
Wool Research		142,793	
		333,031	
TOTAL Capital Works			**333,031**
TOTAL Expenditure			**1,770,367**
LESS Balance to be provided from Wool Research Trust Fund			**2,367**
			1,768,000

During the year £99,970 was received from sales of sheep, wool, and other produce from C.S.I.R.O. Field Stations and Laboratories financed from wool funds. This amount was paid to the Department of Primary Industry for credit to the Wool Research Trust Fund.

Miscellaneous Receipts

During 1960–61 miscellaneous receipts amounted to £89,949. Details of the receipts are as follows:

	£	£
Sale of Publications	11,069	
Sale of Equipment Purchased in Former Years, and Other Receipts	15,179	
Sale of Produce by Field Stations and Laboratories	36,926	
Royalties from Patents	3,089	
Testing Fees	18,223	
Sale of Animals	3,279	
Miscellaneous	2,184	**89,949**

The receipts from the sale of produce represent revenue earned by Divisions and Sections apart from the Special Revenue included under Contributions.

The amount of £89,949 was credited to the Treasury appropriation and consequently reduced the requirements from the Treasury by that amount (*see* Expenditure).

Works Projects (under Control of C.S.I.R.O.)

Treasury expenditure on works projects financed from funds made available directly to C.S.I.R.O. is as follows:

	£	£	£
Animal Health			
Werribee Field Station	1,650		
Veterinary Parasitology Laboratory, Yeerongpilly	888	2,538	
Plant Industry			
Canberra Laboratories	4,268		
Ginninderra Experiment Station	10,027		
Development of the Phytotron	109,730		
Western Australian Laboratories	1,678		
Deniliquin Laboratory	1,400	127,103	
Tropical Pastures			
Cooper Laboratory	1,296		
Cunningham Laboratory	557		
Samford Farm	2,750	4,603	
Merbein Research Station			
Coomealla	1,833	1,833	
Griffith Research Station	1,717	1,717	
Soil Mechanics			
Syndal Laboratory	1,666	1,666	
Food Preservation			
Homebush Laboratory	2,366		
Cannon Hill Laboratory	470	2,836	
Chemical Research Laboratories			
Site at Monash University	12,481		
Sugar Research Laboratory	2,100	14,581	
Fisheries and Oceanography			
Cronulla Laboratory	2,713		
Construction of *Thyrsites*	1,797	4,510	

	£	£	£
National Standards Laboratory			
Cafeteria	115	115	
Meteorological Physics			
Lysimeter Project, Aspendale	2,797	2,797	
Dairy Research Section	570	570	
Fuel Research			
Coal Research Laboratory	4,150	4,150	
Radiophysics			
Giant Radio Telescope	195,023	195,023	
TOTAL Treasury Expenditure			**364,042**

Miscellaneous Services

	£
Contribution to Commonwealth Agricultural Bureaux	49,711
Grant to Standards Association of Australia	86,500
Contribution to Chair of Aeronautics at University of Sydney (establishment and maintenance)	5,000
Grant to National Association of Testing Authorities	17,800
National Institute of Oceanography	6,269
Minor International Associations	1,920
	167,200