CSIRO

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

Annual Report

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1961-62

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Fourteenth Annual Report

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COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

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This report on the work of the Commonwealth Scientific and Industrial Research Organization for the year ending June 30, 1962, has been prepared for presentation to the Parliament of the Commonwealth of Australia, as required by Section 30 of the Science and Industry Research Act 1959.

Important administrative matters, a number of policy aspects of the Organization's work, and items of general interest are recorded in Chapter 1. Significant research developments in the programs of a number of Divisions and Sections are given in Chapter 2. The remainder of the report lists scientific papers reporting facets of the research being undertaken, committees, professional and senior administrative staff, and financial details.

Detailed information about the Organization's research program is available from individual reports issued by each Division and Section. These may be obtained by direct application to the Chief or Officer-in-Charge of the Division or Section.

The Executive gratefully acknowledges the valuable assistance that C.S.I.R.O. has received from Commonwealth and State Government departments and instrumentalities, the Australian universities, members of the primary and secondary industries, and private individuals. Considerable help has also been received from many overseas establishments.

The Executive also wishes to thank those who have made their knowledge and experience freely available to the Organization through C.S.I.R.O. committees and by personal advice.

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General Review

The Annual Report for 1960–61 drew attention to the belief of C.S.I.R.O. that balanced national development and an increased export income demand among other things a rapid growth of Australian manufacturing industries which must be competitive by world standards. These ends cannot easily be achieved without adequate investment, of skilled manpower and money, in scientific and industrial research.

The basic conception of the role to be played by C.S.I.R.O. is that of assisting the development of industry, and the original statute establishing C.S.I.R. and the subsequent legislation which provided continuity with C.S.I.R.O. specified the first of its functions as "the initiation and carrying out of scientific researches and investigations in connexion with, or for the promotion of, primary and secondary industries . . .".

Australian manufacturing industry now produces a wide variety of materials, commodities, plant, machinery, buildings, food, and clothing, the value of which is now approximately twice that of the production of primary agricultural industries. The nature of the scientific research which must be done to sustain and develop these secondary industries is correspondingly diversified.

In the public mind C.S.I.R.O. is often associated more frequently with research for primary industry than with that for manufacturing industry, although approximately one half of its resources are now being devoted to work in this area. It is difficult, however, without close scrutiny to see the pattern of these developments as a whole, and it seems desirable in this report to review briefly the overall design of this phase of the Organization's activities. This shows them to be increasingly in harmony with the great development of Australian industry in recent years.

One important sector of Australian production is concerned with processing indigenous materials, and the associated industries must look to local research to provide advanced technology and background knowledge. Conspicuous examples are the pulp and paper industry based on native hardwoods, and the technical advance of the food preservation industry where local research has been of basic importance. More recently established programs in the chemical and physical sciences have materially assisted the development of specific industries and provided the scientific background against which further industrial development can occur. Industries associated with coal, wool, textiles, cement, refractories, bricks and clay products, plaster, timber, and paint are among those which have benefited.

The discovery and exploitation of minerals is of great national importance particularly in Australia where this field is today one of great promise. The minerals industry and C.S.I.R.O. have been closely associated for many years and the Organization has recently intensified its activities in those sciences important to the

industry. Since a mineral resource is only as valuable as the useful material which can be extracted from it, the beneficiation of minerals and the purification of their products is of great importance. Research can often result in the recovery of materials which were lost or were not amenable to treatment by conventional processes. The chemical approach to the recovery of valuable components, pioneered by C.S.I.R.O., is now widely accepted. The Australian mining industry can gain an economic advantage over overseas competitors if it is provided with improved methods of treatment which will enable products to be exported in an advanced state of processing.

Another area of C.S.I.R.O. activity is that of providing a general background of scientific knowledge essential for the maintenance and development of even the most advanced industries. At its highest level this activity is beyond the capacity of industry and the responsibility properly falls on government. For example, through its National Standards Laboratory it provides standards for precise and uniform methods of physical measurement essential for modern industry; its chemical and physical laboratories make available information on a wide variety of basic techniques—crystallization, distillation, catalysis, chromatography, spectroscopy, and many others—essential for advanced development in the chemical industries.

There is today, emerging from many C.S.I.R.O. laboratories, a considerable range of new processes, new plant, instruments, chemicals, techniques, and knowledge which are available for development and exploitation by Australian industry. It is the policy of the Organization to patent inventions where this is necessary to encourage their development or to protect Australian industry.

There is a growing interest in scientific research on the part of industry itself and more firms in Australia are undertaking research to improve their technology. This indicates a movement away from complete dependence on overseas technology and is welcomed by C.S.I.R.O. It also helps to ensure a closer integration of science with industrial development and a diffusion through industry of up-to-date scientific and technical knowledge. There appears, however, to be still far too few men with advanced technical training employed in industry.

For this new attitude of industry to be fully effective it is important to ensure that any new resources becoming available for research be used in the most effective way. In some secondary industries in Australia, where the size of the individual firm is small, it is unlikely that each firm will itself be in a position to support a viable research group. In such cases a means must be found, to suit Australian conditions, for either financing relevant research in existing research organizations, or in some cases for establishing new research groups.

The engineering industries in Australia, for example, would benefit significantly if the body of Australian technology could be increased both by research and by the application of existing knowledge. Except in isolated instances it is at present difficult to envisage such work being undertaken other than in government establishments—with support from the industry itself in much the same way as the primary industries are supporting research. On the other hand, in those industries composed of larger units e.g., the chemical industry, it has been possible for some firms to establish strong research groups. In this case C.S.I.R.O. plays its part by providing a background of new scientific knowledge.

The solution of these general problems is of great importance to Australia.

Minister-in-Charge of C.S.I.R.O.

Senator the Hon. J. G. Gorton, who is also Minister-in-Charge of the Navy, succeeded Dr. the Hon. D. A. Cameron as Minister-in-Charge of C.S.I.R.O. on February 15, 1962.

Executive

Dr. R. N. Robertson resigned as a Member of the Executive on his appointment as Professor of Botany at the University of Adelaide.

Dr. O. H. Frankel, Chief, Division of Plant Industry, was appointed a full-time Member of the Executive for a period of 5 years, to fill the vacancy created by the resignation of Dr. R. N. Robertson.

Dr. J. Melville was reappointed a part-time Member of the Executive for a period of 3 years.

Sir Arthur Coles was also reappointed a part-time Member of the Executive for a period of 3 years.

The complete list of Members of the Executive is now:

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

Advisory Council

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

W. W. Killough, O.B.E.
Sir Lionel Hooke, Kt.

The following members retired from the Council:

Professor N. S. Bayliss, C.B.E., B.A., B.Sc., Ph.D., F.A.A. (*Chairman, Western Australian State Committee*)

Professor H. R. Carne, D.V.Sc. (*Chairman, New South Wales State Committee*)

E. M. Schroder (*Chairman, South Australian State Committee*)

Professor J. S. Turner, M.A., M.Sc., Ph.D., F.A.A. (*Chairman, Victorian State Committee*)

The following new members were appointed to the Council:

Sir Lance Brisbane, Kt., M.B.E.
F. C. Elsworth, B.Sc.
Professor C. W. Emmens, D.Sc., Ph.D., F.A.A.
W. M. Morgan, B.E.
Professor E. A. Rudd, A.M., B.Sc. (*Chairman, South Australian State Committee*)

The following coopted members of the Council were appointed as Chairmen of State Committees and will continue as members of the Council in their new office:

E. H. Lee-Steere (*Western Australia*)

W. Sloan (*New South Wales*)

L. W. Weickhardt, M.Sc. (*Victoria*)

The Council met twice during the year—in November 1961 at Melbourne, and in May 1962 at Brisbane.

State Committees

State Committees are appointed for a term of 3 years and the term of the existing Committees ended on December 31, 1961. Some changes in membership occurred when the Committees were appointed for the 3 year period ending on December 31, 1964.

The following members were appointed as Chairmen of State Committees:

New South Wales:	W. Sloan
Queensland:	R. S. Wilson
South Australia:	Professor E. A. Rudd, A.M., B.Sc.
Tasmania:	Professor H. N. Barber, M.A., Ph.D., F.A.A.
Victoria:	L. W. Weickhardt, M.Sc.
Western Australia:	E. H. Lee-Steere

The following new members were appointed:

New South Wales:	F. C. Elsworth, B.Sc.
	Professor C. W. Emmens, D.Sc., Ph.D., F.A.A.
	K. L. Sutherland, Ph.D., D.Sc., F.A.A.
Queensland:	C. B. P. Bell
	Professor J. F. A. Sprent, Ph.D., D.Sc.
	S. A. Trout, M.Sc., Ph.D.
South Australia:	C. W. Corbin, B.E.
	N. H. Giles
	H. H. Harvey
	Brigadier J. G. McKinna, D.S.O., E.D.
	H. O. Moore, B.Sc.
	R. S. Turner, F.C.A., A.U.A.(Com.)
	H. Wilckens, F.A.I.B., I.O.B.London, F.A.I.M.
Victoria:	A. Dunbavin Butcher, M.Sc.
	R. G. Downes, M.Agr.Sc.
	P. S. Lang, B.Agr.Sc., Ph.D.
	A. O. P. Lawrence, B.Sc., Dip.For.(Oxon. and Canberra)
	W. M. Morgan, B.E.
	F. M. Read, M.Agr.Sc.

	Professor R. Street, M.Sc., Ph.D.
	Professor V. M. Trikojus, D.Sc., D.Phil., F.A.A.
	Professor M. J. D. White, D.Sc., F.A.A.
Western Australia:	Sir Lance Brisbane, Kt., M.B.E.

The following members resigned during the year:

New South Wales:	W. R. Hebblewhite, B.E.
	Sir Lionel Hooke, Kt.
	W. W. Pettingell, O.B.E., B.Sc.
Queensland:	J. F. Meynink, C.M.G.
South Australia:	R. N. McCulloch, M.B.E., B.Sc., D.Sc.Agr.
	The Hon. Sir Frank Perry, Kt., M.B.E., M.L.C.
Tasmania:	F. H. Foster, B.C.E.
	The Hon. Sir Rupert Shoobridge, Kt.
Victoria:	D. T. Boyd, C.M.G.
	P. Ryan, I.S.O., B.Agr.Sc.
	L. J. Weatherley, M.A.
Western Australia:	A. J. Fraser

Organizational Changes

National Standards Laboratory

Following the retirement of N. A. Esserman, B.Sc., as Chief of the Division of Metrology and Director of the National Standards Laboratory, the Divisions of Metrology and Electrotechnology were amalgamated to form the Division of Applied Physics. The Chief of the Division of Electrotechnology, F. J. Lehany, M.Sc., was appointed Chief of the new Division. Mr. Lehany was also appointed Chairman of the National Standards Laboratory Committee.

Foundry Sands Investigations

The Foundry Sands unit of the Chemical Research Laboratories which has since 1939 been associated with the Metallurgy, Mining, and Geology Department of the Royal Melbourne Institute of Technology, has been incorporated within the Cement and Refractories Section and will be transferred to the Chemical Research Laboratories at Fishermen's Bend.

Obituary

Allan Walkley, M.A., Ph.D., D.Sc., Chief Research Officer, Division of Mineral Chemistry, died suddenly on October 9, 1961. He had joined the Division of Soils in 1933, and in 1942 transferred to the Division of Industrial Chemistry. He made important contributions in a number of fields of research including soil chemistry, hydrometallurgy, and electrochemistry.

Retirements and Resignations

N. A. Esserman, B.Sc., retired as Chief of the Division of Metrology and as Director of the National Standards Laboratory. Mr. Esserman had been associated with C.S.I.R.O. since 1939 when the Laboratory was established, and played a major part in building an international reputation for the Laboratory in work on physical standards of measurement. Its achievements were formally acknowledged when, in 1961, it was given representation on four of the specialist consultative committees of the International Committee of Weights and Measures.

J. M. Cowley, D.Sc., Ph.D., F.A.A., of the Division of Chemical Physics, resigned from C.S.I.R.O. to accept appointment to the Chamber of Manufactures' Chair of Physics in the University of Melbourne.

D. F. Dowling, B.V.Sc., B.Sc., Ph.D., of the Division of Animal Genetics, resigned from C.S.I.R.O. to accept appointment to the Chair of Animal Husbandry at the University of Queensland.

E. J. Drake, F.R.A.C.I., formerly Chief Scientific Liaison Officer in London and in Washington, retired from C.S.I.R.O. after 24 years' service with the Organization.

New Chiefs and Officers-in-Charge

F. J. Lehany, M.Sc., Chief of the Division of Electrotechnology, was appointed Chief of the new Division of Applied Physics.

I. E. Newnham, M.B.E., M.Sc., a Senior Principal Research Officer in the Division of Mineral Chemistry, was appointed Chief of the Division.

J. V. Possingham, B.Agr.Sc.(Hons.), M.Sc., Ph.D., Senior Research Officer, Division of Plant Industry, was appointed Officer-in-Charge of the Irrigation Research Station, Merbein.

Decorations

The Chairman, Sir Frederick White, was appointed a Knight Commander of the Most Excellent Order of the British Empire in the Queen's Birthday Honours.

Dr. E. G. Bowen, Chief, Division of Radiophysics, was appointed a Commander of the Most Excellent Order of the British Empire in the New Year's Honours List.

Honours and Awards

Officers who received honours and awards during the year were:

Sir Frederick White, Chairman: Member of the Council of Monash University.

Dr. O. H. Frankel, Member of the Executive: 1962 Farrer Memorial Medal of the Farrer Memorial Trust.

Dr. R. N. Robertson, Member of the Executive: Member of the Council of the Australian Academy of Science.

Dr. I. W. Wark, Member of the Executive: Reappointed Treasurer of the Australian Academy of Science.

Dr. W. Boas, Chief, Division of Tribophysics: President of the Australian Institute of Metals.

Dr. H. E. Dadswell, Chief, Division of Forest Products: President of the Royal Australian Chemical Institute.

Dr. R. G. Giovanelli, Chief, Division of Physics: Fellow of the Australian Academy of Science.

Mr. F. J. Lehany, Chief, Division of Applied Physics: Member of the International Committee of the Organization of Legal Metrology.

Dr. A. L. G. Rees, Chief, Division of Chemical Physics: Member of the Commission on Physico-chemical Data and Standards, International Union of Pure and Applied Chemistry.

Dr. D. F. Martyn, Officer-in-Charge, Upper Atmosphere Section: Chairman of the Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, and Fellow of the International Academy of Astronautics.

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

Dr. L. M. Clarebrough, Senior Principal Research Officer, Division of Tribophysics: David Syme Research Prize (shared).

Miss B. C. L. Doubleday, Chief Librarian: President of the Library Association of Australia.

Dr. C. H. Gallagher, Principal Research Officer, Division of Animal Health: Payne Exhibition of the University of Melbourne.

Dr. M. E. Hargreaves, Senior Principal Research Officer, Division of Tribophysics: David Syme Research Prize (shared).

Dr. F. J. Kerr, Principal Research Officer, Division of Radiophysics: Doctor of Science, University of Melbourne.

Mr. M. H. Loretto, Research Officer, Division of Tribophysics: David Syme Research Prize (shared).

Mr. L. J. Lynch, Senior Principal Research Officer, Division of Food Preservation: 1962 International Award of the Institute of Food Technologists.

Dr. I. M. MacKerras, Senior Research Fellow, Division of Entomology: Mueller Medal of A.N.Z.A.A.S.

Dr. A. McL. Mathieson, Senior Principal Research Officer, Division of Chemical Physics: Member of the Commission on Structure Reports, International Union of Crystallography.

Dr. J. D. Morrison, Senior Principal Research Officer, Division of Chemical Physics: H. G. Smith Memorial Medal of the Royal Australian Chemical Institute.

Miss H. Newton Turner, Senior Principal Research Officer, Division of Animal Genetics: President of the Australian Society of Animal Production.

Dr. A. J. Nicholson, Senior Research Fellow, Division of Entomology: Honorary Fellow of the Royal Entomological Society of London.

Dr. R. O. Slatyer, Principal Research Officer, Division of Land Research and Regional Survey: Edgeworth David Medal of the Royal Society of New South Wales.

Dr. C. G. Stephens, Senior Principal Research Officer, Division of Soils: Member of the UNESCO World Soil Map Committee with responsibility for Australia, New Guinea, and the S.W. Pacific region.

Mr. H. A. Stephens, Senior Research Officer, Foundry Sands Investigations: Oliver Stubbs Medal of the Institute of British Foundrymen.

Mr. A. J. Watson, Senior Research Officer, Division of Forest Products: President of the Australian Pulp and Paper Industry Technical Association.

Mr. J. P. Wild, Chief Research Officer, Division of Radiophysics: Honorary Foreign Membership of the American Academy of Arts and Sciences, and member of the American Philosophical Society.

Dr. J. B. Willis, Principal Research Officer, Division of Chemical Physics: Doctor of Science, University of London.

Overseas Visits

C.S.I.R.O. officers received invitations to participate in numerous overseas scientific conferences. The conferences included the International Union Conference on Crystallography, Japan; the Fourth International Conference on the Source of Coal, Le Touquet, France; the Symposium of British Paper and Board Makers' Association Research Committee, U.K.; the International Statistics Conference, Paris, France; the International Symposium on Fundamental Problems and their relation to Geophysics, Marseilles, France; the Meeting of the Committee of the International Association for Meteorology and Atmospheric Physics, Marseilles, France; the International Astronomical Union Meeting, Berkeley, U.S.A.; the Solar Corona Symposium, Berkeley, U.S.A.; the Meeting of the American Dairy Science Association, U.S.A.; the 13th International Ornithological Congress, New York, U.S.A.; the Conference of European Meat Workers, Warsaw, Poland; the 10th Pacific Science Congress, Honolulu, Hawaii; the Symposium on Low Temperature Microbiology, New Jersey, U.S.A.; the Meeting of the Special Committee on Antarctic Research, New Zealand; the 10th National Clay Minerals Conference, Texas, U.S.A.; the Second World Eucalyptus Conference, Sao Paulo, Brazil; a Symposium on Problems of Extragalactic Research, Santa Barbara, California, U.S.A.; a Meeting of the International Union of Pure and Applied Chemistry, Montreal, Canada; the Meeting of the Photometry Consultative Committee of the International Bureau of Weights and Measures, Paris, France.

The Chairman, Sir Frederick White, accepted an invitation from the South African Wool Board to visit South Africa to advise on textile research.

Dr. W. Boas, Chief, Division of Tribophysics, attended an international colloquium on the Impact of Physical Metallurgy on Technology, at San Carlos de Bariloche, at the invitation of the Argentinian Atomic Energy Commission.

Dr. E. G. Bowen, Chief, Division of Radiophysics, delivered a decennial lecture at the Lincoln Laboratory of the Massachusetts Institute of Technology, and a Maxwell centenary lecture at King's College of the University of London. He also visited Chile, at the invitation of the Chilean Government, to advise on the possible application of cloud-seeding techniques as a means of increasing water available for irrigation in that country.

Mr. H. R. Brown, Chief, Division of Coal Research, accepted an invitation to visit New Zealand in connexion with a collaborative project with the Kembla Coal and Coke Co.

Dr. H. E. Dadswell, Chief, Division of Forest Products, accepted an invitation from the Auckland Provincial Section of APPITA to be guest speaker at their First Annual Meeting. He also visited research establishments in New Zealand.

Dr. J. Griffiths Davies, Chief, Division of Tropical Pastures, visited Taiwan at the invitation of the Joint Council of Rural Reconstruction to advise on problems of pasture development.

Mr. H. J. Frith, Officer-in-Charge, Wildlife Survey Section, attended the conference sponsored by UNESCO on Conservation of Nature and Natural Resources in Tropical South-east Asia, Bogor, Indonesia, as an Australian delegate.

Dr. R. G. Giovanelli, Chief, Division of Physics, attended the 11th Meeting of the International Astronomical Union, Berkeley, California, and also participated in the Conference on Optical Instruments and Techniques in London.

Mr. G. B. Gresford, Secretary, attended the Second UNESCO Regional Meeting of Representatives of National Scientific Research Organizations, in Hong Kong.

Mr. E. R. Hoare, Officer-in-Charge, Irrigation Research Station, Griffith, attended the Africa and Irrigation Symposium at Salisbury, Southern Rhodesia.

Dr. G. F. Humphrey, Chief, Division of Fisheries and Oceanography, attended three meetings of the Special Committee on Oceanographic Research in India, in Monaco, and at Hamburg, Germany. He also attended a meeting of the Intergovernmental Oceanographic Commission in London.

Dr. G. L. Kesteven, Assistant Chief, Division of Fisheries and Oceanography, attended a Fisheries Technical Meeting in Noumea at the invitation of the South Pacific Commission.

Dr. D. F. Martyn, Officer-in-Charge, Upper Atmosphere Section, was the guest of the International Union of Geodesy and Geophysics at a Symposium on Magnetic and Ionospheric Earth Storms, Japan. He also led the Australian delegation to the meeting of COSPAR (International Committee on Space Research) in Washington, and later chaired the Scientific and Technical Subcommittee sessions of the United Nations Committee on the Peaceful Uses of Outer Space at Geneva.

Dr. I. W. McDonald, Chief, Division of Animal Physiology, attended the F.A.O. Expert Panel Meeting in Washington, U.S.A. He visited research institutions in the U.S.A., the U.K., and Europe. He also visited New Zealand at the invitation of the New Zealand Veterinary Services Council.

Mr. R. N. Morse, Officer-in-Charge, Engineering Section, visited the U.S.A., the U.K., Europe, India, and Malaya. He attended the U.N. Conference on New Sources of Energy.

Dr. J. L. Pawsey, Assistant Chief, Division of Radiophysics, attended the General Assembly of the International Astronomical Union at Berkeley, California, and also a special conference on The Physics of the Solar System and Re-entry Dynamics held at Blacksburg, Virginia.

Dr. H. R. C. Pratt, Officer-in-Charge, Chemical Engineering Section, visited research establishments in South Africa, Rhodesia, Europe, and the U.S.A. concerned with desalination of water, fuel technology, and nuclear energy, and university departments working in the fields of fluid mechanics, process dynamics, and the application of computing techniques.

Dr. A. L. G. Rees, Chief, Division of Chemical Physics, visited the U.K., the U.S.A., the U.S.S.R., and Japan in examining recent developments in the application of physical phenomena to the resolution of chemical problems and to study the trends of scientific instrument development. He also attended the International Union of Pure and Applied Chemistry, XXI Conference, Montreal, Canada; the Gordon Conference on Instrumentation, New Hampshire, U.S.A.; and the International Conference on Magnetism and Crystallography, Kyoto, Japan.

Dr. W. J. Scott, Assistant Chief, Division of Food Preservation, attended the Symposium on Low Temperature Microbiology, Camden, U.S.A.

Dr. A. Walsh, Assistant Chief, Division of Chemical Physics, visited the U.K., Europe, and the U.S.A. for consultations with firms licensed to operate various C.S.I.R.O. patents in the fields of optics and spectroscopy. In addition he attended four international conferences on spectroscopy and analytical chemistry.

Dr. D. F. Waterhouse, Chief, Division of Entomology, attended, as Australian delegate, the 10th Pacific Science Congress in Hawaii and also visited research institutions in the U.S.A.

Mr. J. P. Wild, Chief Research Officer, Division of Radiophysics, attended the General Assembly of the International Astronomical Union, Berkeley, California. He also attended a Symposium on The Earth Storm and Cosmic Rays at Kyoto, Japan.

A number of officers undertook assignments in overseas countries on behalf of agencies of the United Nations at the invitation of overseas Governments and overseas research establishments.

Overseas Visitors

A number of scientists from overseas establishments visited C.S.I.R.O. laboratories during the year, and many of these collaborated with the Organization's officers in undertaking specific investigations. These visitors included:

Dr. H. E. Adler, School of Veterinary Medicine, University of California, undertook a comparative study of *Mycoplasma mycoides* with strains of avian origin at the Parkville Laboratory of the Division of Animal Health, under a Fellowship granted by the U.S. National Institutes of Health.

Professor H. Bevers, of Purdue University, is spending 12 months as a Fulbright Fellow with the Plant Physiology Unit of the Division of Food Preservation.

Professor V. F. Chervinsky, of the Department of Agricultural Economics at the University of Moscow, visited several C.S.I.R.O. laboratories in connexion with a study of Australian irrigation techniques.

Emeritus Professor L. R. Cleveland, of Harvard University, is spending 12 months working with the Division of Entomology on host-parasite relationships.

Dr. F. Aragon de la Cruz, of the University of Madrid, holder of the Selby Fellowship of the Australian Academy of Science, spent a further year in the Division of Chemical Physics, working on methods of structure analysis using electron diffraction.

Dr. Marvin Druger, of the Department of Zoology, Columbia University, New York, worked at the Division of Animal Genetics, under a Fellowship Award of the U.S. Public Health Service on the genetic control of invariable characters.

Professor P. P. Ewald, President of the International Union of Crystallography, visited the Division of Tribophysics.

Dr. F. H. Fisher, of the University of California, visited the Division of Physical Chemistry and studied the influence of high pressures on the ionization of some salts that occur in sea-water.

Dr. H. Fraenkel-Conrat, of the Virus Laboratory, University of California, visited the Division of Protein Chemistry to give a series of lectures on the structure and function of proteins and nucleic acids.

Dr. J. A. Gibb, an officer of D.S.I.R., New Zealand, visited the Wildlife Survey Section to discuss work on rabbit ecology.

Dr. Harold T. Gordon, of the California Agricultural Experiment Station, Berkeley, is spending 6 months at the Division of Entomology to study the biochemistry of the green shield bug (*Nezara viridula*).

Dr. J. H. Hofmeyr, of the Division of Animal Husbandry and Dairying, Department of Agricultural Technical Services, South Africa, studied sheep breeding research and general livestock improvement, at the Animal Breeding Section, Division of Animal Genetics.

Dr. V. Kovda, of the Soil Institute, Academy of Sciences, U.S.S.R., now Director of Department of Natural Sciences, and Dr. M. Batisse, Arid Zone Program Specialist, UNESCO, Paris, visited a number of C.S.I.R.O. laboratories and spent a week with the Division of Soils.

Professor Richard L. Lewontin, Department of Biology, University of Rochester, New York, worked with the Division of Animal Genetics and the Department of Zoology, University of Sydney, under a Fulbright Award, on the development of techniques for analysing problems in population genetics.

Dr. L. Leyton, of the Forestry Research Institute, Oxford, spent 3 months in Australia in connexion with the Pine Research Program of the Division of Soils. He travelled extensively in Western Australia, South Australia, and Victoria.

Dr. Coby Lorenzen, Professor of Agricultural Engineering, University of California, visited the Irrigation Research Station, Griffith, to discuss harvest problems of fruit and vegetables.

Dr. W. H. Marshall, Professor of Economic Zoology, University of Minnesota, visited the Wildlife Survey Section to discuss techniques in wildlife research.

Dr. Vincent J. Schaefer, Research Consultant and Adviser to the Atmospheric Science Centre of the University of New York, who was involved (with Dr. Irving Langmuir) in the first modern successful cloud-seeding experiment, spent 4 weeks at the Division of Radiophysics, at the conclusion of the International Conference on Cloud Physics, in September 1961.

Dr. R. E. Shope, of the Rockefeller Institute, New York, visited C.S.I.R.O. laboratories during the course of a visit to Australia at the invitation of the New South Wales Department of Agriculture, the Victorian Department of Lands, and C.S.I.R.O., to report on the use of fibroma virus in commercial rabbiteries.

Dr. G. A. Siwabessy, Director-General of the Indonesian Institute of Atomic Energy, and Mrs. G. A. Siwabessy, Deputy Head of the Institute's Raw Materials Division, visited C.S.I.R.O. laboratories during the course of a visit to Australia arranged by the Department of External Affairs.

Dr. Lloyd M. Smith, of the University of California, visited the Dairy Research Section to study the techniques used in the fields of fat oxidation and flavour chemistry.

Professor F. J. Stevenson, of the University of Illinois, spent 10 months as a Fulbright Scholar in the Microbiology Laboratory of the Division of Soils.

Mr. A. R. Stobbs and Mr. D. M. Lang, of the British Soil Survey (Overseas), spent 6 months working with the Division of Soils.

Dr. R. H. Stoughton, formerly Professor of Horticulture, University of Reading, and now Principal of the University College of Ghana, visited a number of C.S.I.R.O. laboratories to discuss the problems of graduate training in horticulture.

Dr. James H. Turner of the Beltsville Parasitological Laboratory, U.S. Department of Agriculture, studied at the McMaster Laboratory, Division of Animal Health, as a Fulbright Fellow.

Professor E. L. Yates, of the University College of Rhodesia and Nyasaland, is working with the Division of Tribophysics for 4 months during his sabbatical leave.

Conferences

A Symposium on Geochronology and Land Surfaces in Relation to Soils in Australasia sponsored by the Australian Academy of Science and the Reserve Bank of Australia was held in the Laboratory of the Division of Soils, Adelaide, from December 5 to 8, 1961. The conference was attended by Professor F. E. Zeuner, Head of the Institute of Environmental Tropeology, University of London, and Professor J. Tricart, Head of the Institute of Geography, University of Strassbourg.

An International Conference on Cloud Physics was held from September 11 to 20, 1961, under the joint sponsorship of the Australian Academy of Science and C.S.I.R.O., and was attended by 141 delegates from 17 countries. The conference was divided into two Sessions. The first, held at Canberra, was a scientific one devoted to the presentation and discussion of scientific papers concerned with the physical processes which enter into the formation and behaviour of cloud, and precipitation in its various forms, both natural and artificially induced. The second session, held at Sydney, took the form of a series of informal seminars which provided opportunities for critical discussion on the methods, instruments, and techniques used in cloud physics research. It also included flight and laboratory demonstrations of the techniques used in cloud physics and cloud-seeding investigations in Australia.

A Food Science Conference, held from September 19 to 22, 1961, and organized by the Division of Food Preservation to inaugurate its new headquarters and laboratories at North Ryde, N.S.W., attracted 300 delegates of whom 31 were from other Australian States and 11 from overseas. Overseas delegates included as guest speakers, Dr. E. C. Bate-Smith, Director, Low Temperature Research Station, Cambridge, England; and Professor J. B. Biale, Professor of Plant Physiology, and Dr. C. O. Chichester, Associate Professor of Food Science and Technology, both of the University of California, U.S.A.

The Third Australian Conference in Soil Science, convened by C.S.I.R.O. at the invitation of the Standing Committee on Agriculture, was held at the School of General Studies of the Australian National University, Canberra, from February 15 to 21, 1962. Following the official opening by His Excellency the Governor-General, Viscount de L'Isle, the conference followed the general theme of The Interpretation of Soil Characteristics in Relation to Plant Production. Over 200 local and interstate delegates took part in the discussions as well as representatives from New Zealand, the U.S.A., and Dutch New Guinea. Several tours to inspect local soil and agronomic features were arranged, including a week-end visit to the Snowy Mountains and a post-conference excursion to the Wagga–Griffith area.

The Eighth Meeting between C.S.I.R.O. and Representatives of Woolgrower Organizations was held in November 1961. At these meetings important research findings of significance to woolgrowers are presented, and the nature and scope of the C.S.I.R.O. wool research program are discussed.

The Division of Building Research, on behalf of the Building Research Committee, which consists of representatives of all the Commonwealth agencies concerned with building research, organized the First Australian Building Research Congress. This was held at Monash University on August 16 and 17, and problems of the building industry were discussed. Among the 40 authors who presented technical papers at the Congress were Dr. T. L. Webb, Director of the National Building Research Institute in South Africa; Dr. P. C. Kreijger, from the Institute for Building Materials and Building Structures, Delft, Holland; and Dr. L. Bastings, Director of the Building Research Bureau in New Zealand. The Congress was attended by 500 delegates from Australia and overseas.

Liaison Activities

Agricultural Research Liaison Section

The Section has continued to produce liaison publications, including *Rural Research in C.S.I.R.O.*, which keeps extension officers informed of the wide range of C.S.I.R.O. research results which bear on Australia's rural industries.

Much of the information in *Rural Research in C.S.I.R.O.* has been used by State authorities in their extension programs among primary producers; more than 30,000 reprints of the article on "Bushfire Sense" have been distributed among firefighters by bushfire control authorities.

A liaison tour was organized for senior officers of the New South Wales Department of Agriculture, who visited C.S.I.R.O. laboratories at Canberra and the Department's Agricultural Research Institute at Wagga.

The Southern Tablelands Regional Research and Extension Study, a cooperative project with the N.S.W. Department of Agriculture, has now completed five years of work. An evaluation of this project by the Section has recently been published.

Industrial Research Liaison Section

The 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.

A pamphlet, "C.S.I.R.O. and the Food Industry", giving a broad outline of the Organization's work in this field, has been prepared for use by management in the industry. This is the first of a series of publications about C.S.I.R.O.'s work for industry.

An important part of the work of the Section relates to patents and patent licences. Many 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.

Two important agreements entered into during the year are concerned with the commercial development of a sliver converter invented by the Division of Textile Industry and a cyclone elutriator devised by the Chemical Engineering Section. The sliver converter is the main component in a new system of processing wool that is being developed in C.S.I.R.O. to replace the traditional carding and combing stages. Arrangements have been completed for the Warner & Swasey Company of U.S.A. to carry out the development of a laboratory-scale prototype. The cyclone elutriator, an instrument for rapid determination of size distribution of mixed powder, is expected to have important applications in the mining industry. Commercial production of the elutriator is in the hands of an Australian company, Warmans International Pty. Ltd., and this firm proposes to manufacture the instrument in Australia for the local and the export market.

Collaboration with Industry

During the last decade the primary industries, because of their relative cohesion, have made substantial contributions towards the cost of both long and short term research programs. These contributions, raised by means of a levy on a suitable unit of production, have in many instances been paid into a central trust fund established by Commonwealth statute. The Commonwealth Government has made matching contributions to these funds. Grants have been made from funds on the recommendation of special committees representing their contributing industry, the Commonwealth Government, and the organizations carrying out the research and advisory work for the particular industries.

The first industry to establish a scheme to finance research in this way was the wool industry. This was followed by the establishment of tobacco, wheat, and dairy research funds and, more recently, by the Beef Industry Research Fund. The recommendations of the Cattle and Beef Research Committee which were recently approved provided for an expenditure by C.S.I.R.O. of some £100,000 during the first year (1962–63) in which funds will be available from this source. This grant will allow expansion of C.S.I.R.O. research concerning cattle tick, development of more productive crops and pastures in the northern cattle areas, diseases of cattle, genetic factors related to the adaptation of cattle to tropical conditions, and cattle nutrition and reproduction.

In association with other interested bodies, C.S.I.R.O. has explored the possibility of establishing similar funds for research into problems associated with the secondary industries. However, the pattern of the major secondary industries in Australia does not lend itself to development of this nature. In some overseas countries research institutes or associations have provided a means of conducting research for particular industries. Development in Australia of similar establishments has been limited to the Bread Research Institute, the Wine Research Institute, and the Australian Coal Association (Research) Ltd. Each of these receive support from the industries concerned and also from the Commonwealth Government through C.S.I.R.O.

While it is not a general policy of the Organization to utilize its resources to assist individual companies to solve their specific problems, it may do so if other help is not available. Industry provides support for a number of research projects in the Organization, and new cooperative projects include:

Research concerning soil mechanics and land use in urban areas by the Soil Mechanics Section, supported by the South Australian Housing Trust; a nitrogen grazing experiment in the Division of Tropical Pastures with the support of Imperial Chemical Industries of Australia and New Zealand Ltd.; a study by the Division of Plant Industry, with financial support from the Sulphur Institute, Washington, of the differential changes in plant development upon the removal of nutritional stresses as a means of diagnosing nutrient element deficiencies with special reference to the element sulphur; research by the Division of Coal Research into combustion characteristics of Leigh Creek coal on behalf of the Electricity Trust; the study of the effects of fly ash on fish and marine life by the Division of Fisheries and Oceanography, supported by the Electricity Commission of New South Wales; investiga-

tions by the Soil Mechanics Section in cooperation with the Country Roads Board on the foundation problems associated with a proposed crossing of the Yarra River near Spotswood, Victoria; research by the Division of Building Research on fungicides as paint additives to reduce the problem of mould growth in houses, sponsored by the Victorian Housing Commission, the Victorian Railways, and the State Electricity Commission of Victoria.

The Organization has continued to be associated with the National Association of Testing Authorities and the Australian Standards Association.

Collaboration with the Universities

Many C.S.I.R.O. Divisions and Sections continue to work in close collaboration with Australian universities on particular research programs. Officers of the Organization have continued to assist in university lecturing, demonstrating, and supervising in specialized fields.

In addition grants have been made to support a number of university research programs of particular interest to C.S.I.R.O. These include grants for the following purposes:

University of Melbourne:
- Mathematical computing
- Research on hardening of metals
- Brown coal pollen research

University of Queensland:
- Research Fellowship in Parasitology
- Research Fellowship in Veterinary Anatomy

University of Adelaide:
- Readership in Animal Ecology

University of Western Australia:
- Research on marsupials
- Research on atomic absorption spectroscopy

University of Sydney:
- Research on fruit fly
- Research on dairy and beef production
- Colloid science research
- Readership in Dairy Husbandry
- Research on nitrogen metabolism

Australian National University:
- Research on casein

University of Tasmania:
- Research on biophysics

Grants were also made to the University of Melbourne in connexion with the purchase of a spectrometer; to the University of Queensland for studies on the efficiency of rain gauges and the development of solvent-in-pulp extraction processes;

to the University of Sydney for research on mineral deficient chloroplasts and the establishment of single cell cultures; to the University of New England for research in cloud physics; and to the University of New South Wales for work on chemical and botanical analyses and wool measurements.

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 it 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.

Foreign Aid

C.S.I.R.O. has continued to make facilities available for the training of scientists from other countries who visit Australia under the auspices of the Colombo Plan or the international agencies. In addition, a number of C.S.I.R.O. officers have been made available to carry out assignments overseas in connexion with Colombo Plan aid or developmental projects being undertaken by agencies of the United Nations. Arrangements have also been made to provide closer liaison with Commonwealth departments and instrumentalities concerned with the administration of foreign aid programs. This has resulted in the Organization being more closely associated with a number of developmental projects in south-east Asian countries.

Overseas Research Contracts

For a number of years C.S.I.R.O. has received grants from overseas establishments for specific research projects of interest both to them and to Australia. The majority of these awards have been made by agencies of the United Nations or the United States of America. Where necessary, special arrangements have been made to ensure that results of this work were not lost to Australia. Major grants received during the year include:

$172,000 from the U.S. National Aeronautics and Space Administration, in support of research on the Division of Radiophysics radio telescope at Parkes, N.S.W.

$550,000 from the Ford Foundation, for the development and construction of a radio heliograph for the Division of Radiophysics. The telescope involves a new and technically difficult principle and represents a highly original approach to the problem of producing high resolution radio pictures of areas in the sky.

$29,000 from the U.S. Air Force Office of Scientific Research, to supplement research in the Division of Physics for a period of two years, on measurements of the thermal expansion of solids at low temperatures.

$4000 from the Sulphur Foundation of Washington, U.S.A., for additional research on trace nutrients for plants, in the Division of Plant Industry.

$5650 from the International Atomic Energy Agency, to supplement research in the Division of Plant Industry on the measurement of the rate of radiation-induced mutations in plants.

$3000 from the World Health Organization, to assist research on resistance to insecticides being undertaken by the Division of Entomology.

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 U.K., Europe, and the U.S.A.

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

As part of its policy of encouraging post-graduate research training in Australia, the Executive made additional funds available for the award of C.S.I.R.O. post-graduate studentships. A record number of applications was received, and it was possible to grant a greater number of studentships than in previous years, at the same time maintaining the high standard required for success.

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 a main subject. There were 134 applications; 42 studentships were awarded (seven were subsequently declined), and candidates who accepted them are listed below with their universities:

E. E. Best (Sydney)
A. J. Blake (Adelaide)
R. A. Bryce (Qld.)
R. G. Burns (Qld.)
J. P. Byrne (Sydney)
B. S. Chandler (Adelaide)
J. C. Connelly (Miss) (Adelaide)
P. J. Dallimore (W.A.)
P. G. Dodds (New England)
G. K. Eagleson (Sydney)
J. A. Elix (Adelaide)
E. M. Fowler (Miss) (W.A.)
G. I. Gaudry (Qld.)
R. E. Hartwig (Adelaide)
A. J. Hosking (Adelaide)
P. J. Jennings (W.A.)
M. J. K. Kesteven (Sydney)
M. P. C. Legg (Tas.)
P. M. McCulloch (Tas.)
A. G. R. McIntosh (New England)
T. E. Martin (Adelaide)
K. W. Mills (Adelaide)
N. M. Morrissy (Adelaide)
L. R. Newsome (Qld.)
R. G. Nicholls (Tas.)
G. L. Nyberg (W.A.)
M. L. G. Oldfield (Sydney)
D. B. Paul (Adelaide)
H. F. Paull (Miss) (Sydney)
M. S. Polya (Miss) (Tas.)
R. W. Retallack (W.A.)
B. W. Ricketts (Sydney)
I. D. Robb (Sydney)
V. P. St. John (W.A.)
B. Window (Qld.)

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 165 applications were received; 49 awards were made (eight were subsequently declined), and candidates who accepted them are listed below:

P. L. Airey (Qld.)
M. L. Arthur (Adelaide)
M. Batley (Sydney)
P. J. Black (W.A.)
R. G. Body (Sydney)
G. S. Chandler (Adelaide)
C. W. C. Davis (Miss) (Sydney)
L. R. Dodd (Adelaide)
R. J. Drewer (Adelaide)
C. H. Ellen (Sydney)
G. D. Finn (Qld.)
G. Fischer (Melbourne)
N. D. Fowkes (Qld.)
W. J. Franklin (N.S.W.)
C. A. Hendrick (W.A.)
I. R. Kennedy (W.A.)
D. F. Kerr (Qld.)
K. Vijeyasehari (Adelaide)
K. G. McIntyre (Melbourne)
B. H. J. McKellar (Sydney)
K. G. McKenzie (W.A.)
P. M. Martin (Sydney)
C. S. Nilsson (Adelaide)
T. C. Parks (W.A.)
R. J. Potter (Adelaide)
D. W. Puckridge (Adelaide)
M. Rasmussen (Sydney)
J. A. Robertson (Sydney)
T. W. Sag (Adelaide)
G. B. Segal (Sydney)
J. S. Shapiro (Sydney)
J. C. Swann (Adelaide)
J. Tendys (Qld.)
D. Tennant (W.A.)
J. A. Thomas (Miss) (Adelaide)
M. L. Thornett (W.A.)
R. T. Waechter (Adelaide)
J. R. Williams (W.A.)
L. R. Williams (Adelaide)
G. Wilson (Sydney)
F. E. Yeomans (Adelaide)

Overseas Studentships

These are awarded to research workers in science and allied fields who have obtained, or who are about to obtain, the degree of Ph.D., 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, 44 applications were received, and 11 candidates were selected, one of whom declined in favour of another award:

B. G. Briggs (Miss) (Sydney)
G. B. Deacon (Adelaide)
R. S. Dickson (Adelaide)
R. Dingle (W.A.)
D. R. Liljegren (Adelaide)
A. D. McEwan (Melbourne)
P. B. Nicholls (Adelaide)
R. H. Prager (Sydney)
K. G. Skene (Melbourne)
D. E. Smiles (Sydney)

Awards 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. The Wool Research Committee also made available one Fellowship, and the Organization was asked to assist in selecting a candidate.

Science and Industry Endowment Fund

The Executive, as Trustees of the Science and Industry Endowment Fund, made grants to assist the following research workers: Mr. R. Burn to complete his project on the New South Wales Opisthobranchia; Mrs. Thelma Daniell to complete studies of fungi; Mr. N. W. Schleiger to carry out a geological survey of the Seymour district, Victoria; Mr. D. L. Cook for financial assistance in obtaining a radiocarbon analysis in connexion with cave deposits; Mr. N. V. Dobrotworsky to continue studies of the systematics and ecology of the Victorian mosquitoes; Mr. D. Stenhouse to study the behaviour and general biology of the magpie lark; Dr. I. Vigeland to enable him to continue his study on collections of Polyzoa at the National Museum of Victoria. The Trustees also agreed to the purchase of a stereoscopic binocular microscope for issue on loan to Mr. A. C. Collins for his studies on Pliocene and Pleistocene Foraminifera for the National Museum of Victoria and for a continuing study of the recent shallow-water Foraminifera of south-eastern Australia.

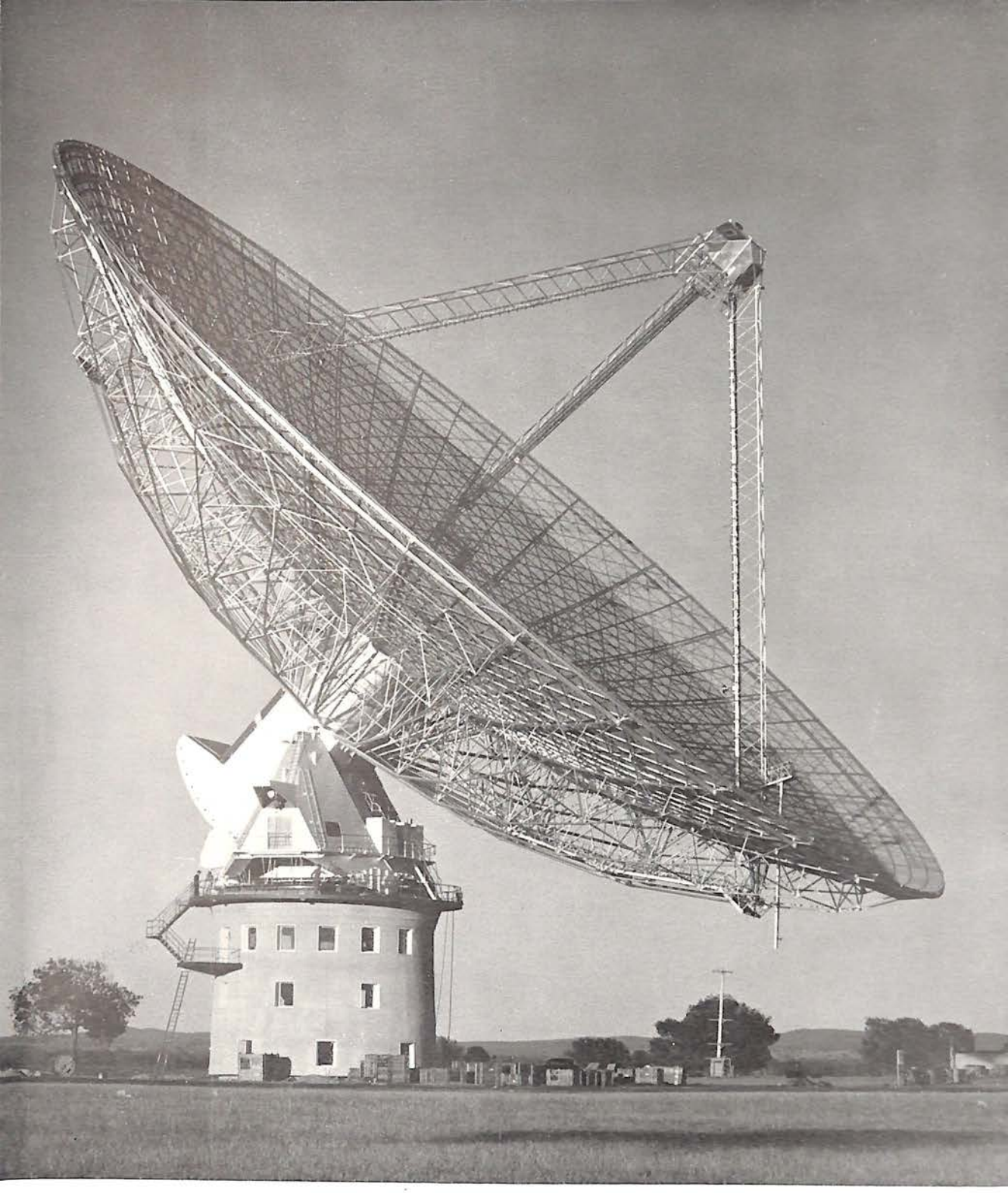
Grants were made towards travelling expenses of the following research workers: Mr. G. Caughley for a research project on the red and grey kangaroo; Dr. R. C. Carolin to visit England and Europe to study important type material housed in various European institutes which were not available on loan.

Grants were also made to: the supplementing of Australian Awards of 1851 Scholarships; the Science Teachers' Association of New South Wales for annual school science awards; the Science Teachers' Association of Victoria for the Eleventh Annual Science Talent Search; the Astronomical Society of New South Wales towards an expedition to Lae to observe the solar eclipse in February 1962; students of the Universities of Queensland, Adelaide, Western Australia, and Tasmania, and the University College of Townsville, to enable them to attend the School of Marine Biology held at the Division of Fisheries and Oceanography, Cronulla, N.S.W.

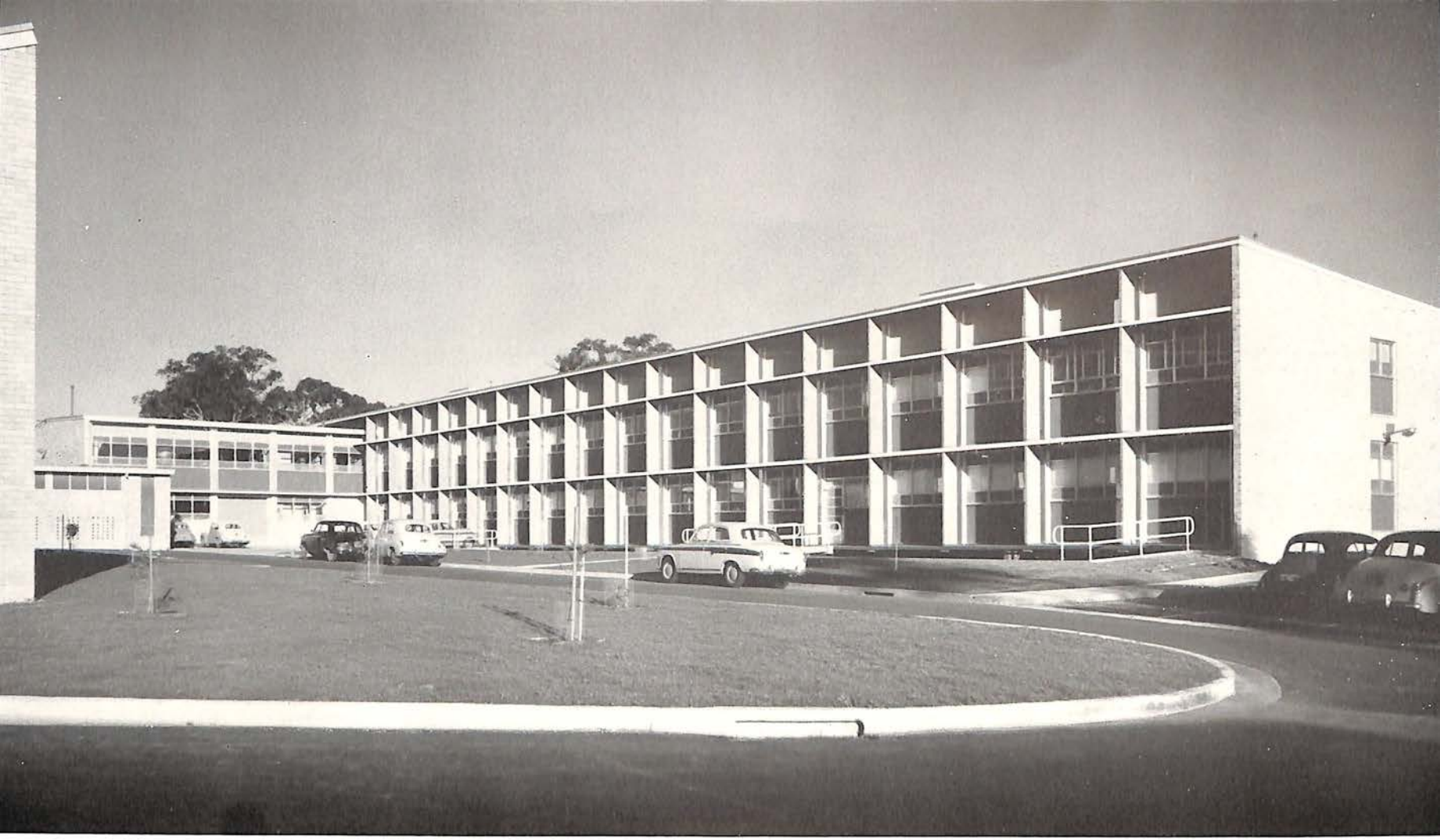
Australian National Radio Astronomy Observatory

The 210 ft radio telescope for the Division of Radiophysics was officially commissioned on October 31, 1961, by the Governor-General of the Commonwealth of Australia, His Excellency Viscount De L'Isle, at an impressive ceremony held on the telescope site at Parkes, N.S.W. His Excellency also named the installation at Parkes as the Australian National Radio Astronomy Observatory. Some 500 guests inspected the structure and a special display of photographs dealing with radio astronomy, prior to the ceremony.

The Executive wishes to record its gratitude to the Rockefeller Foundation and the Carnegie Corporation of New York and to private donors and the Commonwealth Government for providing substantial funds needed to realize this project. It also acknowledges the valuable assistance given by the Radio Astronomy Trust in administering these funds.



View of the Australian National Radio Astronomy Observatory at Parkes, N.S.W.



The Division of Food Preservation's new laboratories at North Ryde. The illustration shows the Food Science Building, Cold Room Block, and Engine Room.

The design of the instrument was undertaken by Freeman, Fox and Partners, London, in consultation with officers of the Division of Radiophysics, Dr. Barnes Wallis, and other noted scientists and engineers. The construction was undertaken by Maschinenfabrik Augsburg-Nürnberg A.G. (M.A.N.), in collaboration with Associated Electrical Industries, Manchester, with Askania-Werke, Berlin, and with Concrete Constructions Ltd., Australia.

The telescope, after being put through a final series of performance trials, has been accepted from the contractors. The accuracy of the reflector surface and of the drive and control systems has more than come up to expectations and the instrument is already proving itself an outstanding new tool for the study of the universe by the new radio techniques.

Division of Food Preservation

A new headquarters laboratory for the Division of Food Preservation was opened by Dr. the Hon. D. A. Cameron on September 18, 1961. It is located at North Ryde, N.S.W. Its construction was undertaken on behalf of the Organization by the Commonwealth Department of Works at an overall cost of £637,000.

The opening marked the completion of the Organization's largest post-war building project and the first rehousing of a major C.S.I.R.O. Division.

The Division has since 1938 had the use of facilities at the Homebush abattoir of the Metropolitan Meat Industry Board. For a number of years because of the limitation of this accommodation it was not possible to provide adequate laboratory space for the Division's extensive program of research into problems associated with the handling, preservation, processing, storage, and transport of meat, fish, eggs, fruits, and vegetables. The new laboratory will allow expansion in some aspects of this work and will enable new investigations on poultry and cured pig meats to be undertaken.

Northern Australia

In the post-war period C.S.I.R.O. has been able to provide increased resources for research into problems associated with the development of northern Australia. Land use problems, diseases and pests of cattle, investigations into tobacco culture, insect pests, the beneficiation of minerals, and the development of improved pastures for tropical areas are amongst the projects being undertaken.

The completion of laboratories recently opened by Senator J. G. Gorton at the C.S.I.R.O. Coastal Plains Research Station, near Darwin, will allow expansion of research into problems associated with the establishment of agriculture on the coastal plains of the Northern Territory. Work in collaboration with the Northern Territory Administration is initially being concentrated on tropical rice and associated crops.

The decision of the Government to support the development of a C.S.I.R.O. research centre at Townsville, Qld., will enable the work of the Division of Tropical Pastures, in association with other groups in the Organization, to be extended into

the more northern areas of Queensland. Plans for the building of a laboratory in Townsville on a site made available by the Townsville Council are well advanced. A property near Townsville has been selected for development as a field station to be associated with the new laboratory and arrangements have been made for its acquisition.

Australian National Insect Collection

An important step was taken to ensure the preservation and emphasize the significance to Australian science of the collection of insects held by the Division of Entomology by gazetting it as the Australian National Insect Collection.

The collection consists principally of specimens collected by officers of the Division but also contains numerous private donations and bequests.

Scientific Computer Network

A survey of computing requirements in Australian scientific establishments has shown a serious shortage of readily available modern computing equipment.

Following a decision by the Commonwealth Government, arrangements are now being made for the establishment, under the auspices of C.S.I.R.O., of an electronic computer network for use by Commonwealth scientific establishments, and universities. The network will consist of a central unit to be located at Canberra and a number of satellite computers located at other sites to be integrated with the central unit. The first satellite computers in C.S.I.R.O. will be installed at Sydney, Melbourne, Canberra, and Adelaide. Additional satellite units will be installed by other principal users as the network develops.

Besides providing an urgently needed service facility for Australian scientific research, the computer network will enable Australia to play a bigger part in research into computer theory.

Buildings and Accommodation

In the last Annual Report reference was made to the problems facing the Executive in providing adequate laboratory buildings and other accommodation. The sum of approximately £1,000,000 was made available from Treasury funds for the capital works program during the year under review. A large part of this was needed for the two major items mentioned in the previous report, the radio telescope and the Controlled Environment Research Laboratory (Phytotron), but nevertheless two major laboratories were completed during the year: a biochemical laboratory for the Division of Plant Industry in Canberra; and a second laboratory for the Division of Soils at Glen Osmond, S. Aust. This has enabled the Division of Soils to complete the move from the accommodation provided by the Waite Agricultural Research Institute that it had occupied since its formation in 1930. A number of other buildings were completed and others commenced. At present, there is no major building financed from Treasury funds under construction.

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In the last Annual Report reference was made to the problems facing the Executive in providing adequate laboratory buildings and other accommodation. The sum of approximately £1,000,000 was made available from Treasury funds for the capital works program during the year under review. A large part of this was needed for the two major items mentioned in the previous report, the radio telescope and the Controlled Environment Research Laboratory (Phytotron), but nevertheless two major laboratories were completed during the year: a biochemical laboratory for the Division of Plant Industry in Canberra; and a second laboratory for the Division of Soils at Glen Osmond, S. Aust. This has enabled the Division of Soils to complete the move from the accommodation provided by the Waite Agricultural Research Institute that it had occupied since its formation in 1930. A number of other buildings were completed and others commenced. At present, there is no major building financed from Treasury funds under construction.

During the year £463,000 was provided by the Wool Research Committee for buildings and associated services. The construction of two major wool research laboratories, one at Belmont, Vic., for the Division of Textile Industry, and one at Parkville, Vic., for the Division of Protein Chemistry, has been commenced; both are being financed from these funds.

The Organization is, however, still faced with the situation that half of its Divisions and Sections are housed in wholly inadequate and unsuitable quarters and that, on its present budget, there can be little improvement. In recent months considerable effort has been put into reviewing the situation and planning a program which, with adequate Government support, will enable the Organization's present staff to be properly accommodated within a reasonable number of years. This comprehensive building program will be presented to the Government in the next few months. Steps have been taken to strengthen the staff within C.S.I.R.O. to handle such a program.

C.S.I.R.O.'s laboratories and field stations are dispersed throughout the Commonwealth, and each year it is necessary to erect a number of minor buildings and works, such as fencing and dams which, in the aggregate, account for quite a large sum. The amount of money available for building major laboratories is, therefore, not as great as it might appear at first sight.

The following buildings and works were completed:

New South Wales:	
Parkes	Radio telescope
Albury	Laboratory for phasmatid investigations, Division of Entomology
Victoria:	
East Melbourne	Building alterations, Head Office
Clayton	Caretaker's cottage, Chemical Research Laboratories
Parkville	Conversion of sheep pens to cattle stalls, Division of Animal Health
Queensland:	
St. Lucia	Conversion of garage accommodation to radioisotope laboratory, Division of Tropical Pastures
South Australia:	
Glen Osmond	Second major laboratory, Division of Soils
Australian Capital Territory:	
Canberra	Biochemistry Laboratory, Division of Plant Industry

Research Services

Films

The following films were produced by the Film Unit:

"Building on Research"

16 *mm*, *Colour*, *Sound*, *Screening Time* 28 *min*

This film shows how research in Australia has contributed to the better use of the traditional building materials, masonry, timber, and plaster, and to the development of some new materials.

These materials, used in conjunction with a study of the science of soil mechanics, have influenced the erection of many of our modern structures. Fire-resistant materials, ventilation, and lighting are also covered. The film was produced for the Building Research and Development Advisory Committee in collaboration with the Building Research Liaison Service, Department of Works, and Commonwealth Government research laboratories.

"THE RAINMAKERS"

16 *mm, Colour, Sound, Screening Time* 25 *min*

The story is portrayed of current research on rainmaking carried out in Australia by the Division of Radiophysics using "dry ice" and silver iodide.

"GREEN PEA HARVEST PREDICTION"

16 *mm, Colour, Sound, Screening Time* 10 *min*

A method, developed by the Division of Food Preservation, is shown for the accurate prediction of the optimal date for harvesting in commercial pea production and its application in the industry.

"FIGHTING THE CATTLE TICK"

16 *mm, Colour, Sound, Screening Time* 16 *min*

A study of the life history and survival times of cattle tick larvae by the Division of Entomology leads to two methods of control—pasture spelling and strategic dipping. The film outlines the research on which the methods are based, and the conditions under which they are most likely to be successful.

"SAMPLING BALED WOOL—A FAST CORING TOOL"

16 *mm, Black and White, Sound, Screening Time* 6½ *min*

This film demonstrates the use of an improved, hand-operated, wool-coring tool, developed by the Division of Textile Physics. All the normal requirements of baled-wool sampling are met without the need for a power source or severe manual effort. Prints have been distributed through the International Wool Secretariat, London and Tokyo; the Wool Industries Research Association, Leeds, U.K.; the Wool Bureau Incorporated, New York; and the Department of Agriculture, Wellington, New Zealand.

"CLUNIES ROSS—A MAN OF SCIENCE"

16 *mm, Black and White, Sound, Screening Time* 12 *min*

This has been produced from archival film material for the Clunies Ross Memorial Foundation in May 1962 for the opening of an appeal for the establishment of a National Science Centre.

Two, short, silent, 16 mm films, "The Sliver Converter" and "The Continuous Shrinkproofing of Tops", were produced for the Division of Textile Industry for limited screening by members of the Division in association with discussions with other scientists and technicians in the textile industry, and for screening at the eighth meeting of the Executive and Advisory Council of C.S.I.R.O. with representatives of the sheep and wool industry in November 1961.

During the year, television stations made further use of excerpts from our film productions in both specialist and general release programs. In addition, several short television news films were distributed throughout Australia, and, through the News and Information Bureau, to television authorities in Great Britain, America, and other overseas countries. The subjects covered included the giant radio telescope at Parkes, the proposed radio heliograph, and rainmaking.

Portions of the film "The Mallee Fowl" were used by the American Institute of Biological Sciences in their film series on Birds and Mammals, and portions of this film have also been made available to the Australian Broadcasting Commission for inclusion in a series of natural history films for television to be shown in Australia and overseas.

A total of 71 prints of C.S.I.R.O. film productions, valued at £3866, were distributed during the year. Of these, 40 prints were sold for a total of £1964. The remaining 31, with a total value of £1902, were distributed to the Commonwealth National Library in Canberra, the Australian Scientific Liaison Offices in London and Washington, the Australian Wool Bureau, and the Rockefeller Foundation, New York.

Libraries

Although the C.S.I.R.O. library system primarily provides ancillary service for the Organization's research staff, the resources available enable limited assistance to be given to readers outside the Organization. The Head Office library handled approximately 30,000 requests for assistance; additional enquiries were received at main libraries in Canberra and Sydney and at libraries of Divisions and Sections. A comprehensive index of specialists in many fields enables enquiries on subjects outside the Organization's interests to be referred to an appropriate authority.

On a cooperative basis the library has undertaken Australian abstracting for Commonwealth Agricultural Bureaux journals. Australian coverage is provided for Horticultural, Field Crop, and Herbage Abstracts and partial coverage for Dairy Science Abstracts.

During the year a revised edition of the Directory of Scientific and Technical Research Centres in Australia was issued. Since the original Directory was issued in 1953 the demand for copies has continued to be received, particularly from centres outside Australia. It was with the intention of making known, particularly in other countries, the various research groups working in scientific and technical fields, that the Directory was published. All centres, other than those at universities, were included.

The coverage of both the C.S.I.R.O. Abstracts and the Australian Science Index has been increased and their format improved. A new method of reproduction has been used to enable a steadily increasing demand for both publications to be met.

As there is no national translation centre in Australia, information for research workers about translations completed or about to be undertaken has been published as part of C.S.I.R.O. Abstracts.

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 *C.S.I.R.O. Wildlife Research*, 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 publishing and 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), Professor J. S. Turner, Professor W. P. Rogers, Professor N. S. Bayliss, Dr. J. L. Pawsey, and Dr. N. S. Noble (Editor). 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 and the Physical Society (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*.

Contributions are published 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 have been published.

Following representations from the Australian Society of Soil Science and after consultation with the Australian Academy of Science, it has been decided to establish a journal for the publication of scientific papers arising from research in soil science and related disciplines. It is intended that the journal, to be known as the *Australian Journal of Soil Research*, should be open for contributions advancing the knowledge of soil or soil phenomena and so cover pure and applied studies of soil as a material or of soil phenomena by the methods applicable to the natural sciences. Descriptive and interpretative studies on soils, including their origin, distribution, and classification, and studies arising from related disciplines, provided these advance the knowledge of soils or their use, will also be included.

It is intended that these related disciplines should include soil mechanics, hydrology, meteorology, microbiology, soil fertility, geomorphology, statistics, ecology, and climatology.

Translation

The Translation Section, with officers stationed at Melbourne, Sydney, and Canberra, 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 Organization's expenditure of £12,089,389 incurred during 1961–62 are set out in Chapter 5. Of this sum £10,967,035 was spent on investigations. The amount of £174,814 was made available to outside bodies such as the Commonwealth Agricultural Bureaux. Expenditure on capital works amounted to £1,122,354. Funds for this overall expenditure were derived from the Commonwealth Treasury, the Wool Research Trust Fund, and similar research funds. A number of direct contributions to the Organization were also received from industry. These are set out in detail in Chapter 5. The following table summarizes the sources of the Organization's funds and the activities on which they were spent.

SOURCE OF FUNDS	*Investigations*	*Capital Works*	*Total*
	£	£	£
Treasury Appropriation	8,582,436	609,083	9,191,519
C.S.I.R.O. Revenue	89,314		89,314
Total Treasury Funds	8,671,750	609,083	9,280,833
Wool Research Trust Fund	1,670,447	420,316	2,090,763
Contributions (other than Wool)	624,838	92,955	717,793
	10,967,035	1,122,354	**12,089,389**

Organization

C.S.I.R.O. has a number of Divisions and Sections and four major group laboratories. The four group Laboratories are the Animal Research Laboratories grouping three Divisions, the Chemical Research Laboratories grouping four Divisions and two Sections, the National Standards Laboratory grouping two Divisions, and the Wool Research Laboratories grouping three Divisions. There are also 15 independent Divisions in other research fields and an additional 15 independent Sections.

Since the investigations are Commonwealth-wide and many—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

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

Animal Physiology, with headquarters and main laboratories at Prospect, N.S.W., a laboratory in Brisbane, and a laboratory with field station at Armidale, N.S.W.

Chemical Research Laboratories, consisting of the following four Divisions:
Chemical Physics, Melbourne;
Mineral Chemistry, Melbourne;
Physical Chemistry, Melbourne;
Organic Chemistry, Melbourne;

the following two Sections:

Cement and Refractories, Melbourne;
Chemical Engineering, Melbourne;

and

Sugar Research Unit, Melbourne.

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

National Standards Laboratory, consisting of the following two Divisions:
Applied Physics, Sydney;
Physics, Sydney.

Wool Research Laboratories, consisting of the following three Divisions:
Protein Chemistry, Melbourne;
Textile Physics, Ryde, N.S.W.;
Textile Industry, Geelong, Vic.

Other Divisions are:

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

Building Research, Melbourne;
Coal Research, Sydney.

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

Fisheries and Oceanography, with headquarters and main laboratories in Cronulla, N.S.W., laboratories in Perth and Melbourne, and a field station at Hobart.

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

Forest Products, 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.

Mathematical Statistics, Adelaide, with officers stationed at a number of Divisions and Sections, as well as at the University of Melbourne.

Meteorological Physics, Melbourne.

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.

Radiophysics, with headquarters and laboratories in Sydney, the Radio Astronomy Observatory at Parkes, N.S.W., and field stations at Bulli, Dapto, Pott's Hill, Richmond, St. Mary's, Wallacia, and Wollongong, N.S.W.

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

Tribophysics, Melbourne.

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

INDEPENDENT SECTIONS

Agricultural Research Liaison, Melbourne.
Commonwealth Research Station, Merbein, Vic. (Murray Irrigation Areas).
Dairy Research, Melbourne.
Editorial and Publications, Melbourne.
Engineering, Melbourne.
Fodder Conservation, Melbourne.
Industrial Research Liaison, Melbourne.
Irrigation Research Station, Griffith, N.S.W. (Murrumbidgee Irrigation Areas).
Mineragraphic Investigations, Melbourne.
Ore Dressing Investigations, Melbourne, and Kalgoorlie, W.A.
Physical Metallurgy, Melbourne.
Soil Mechanics, Melbourne.
Upper Atmosphere, Camden, N.S.W.
Wheat Research Unit, Sydney.
Wildlife Survey, with headquarters in Canberra and field stations at Perth.

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.

2

Progress in Research

This chapter consists of a brief survey of some of the more important and interesting developments in the research being carried out by C.S.I.R.O. For many of the individual projects details may be found in the scientific papers and in the letters patent that are listed in Chapter 3.

Detailed information about the Organization's research program is available from individual reports issued by each Division and Section. These may be obtained by direct application to the Chief or Officer-in-Charge of the Division or Section concerned. The addresses of the headquarters of each establishment are given in Chapter 4.

Tropical Pasture Plants

The key to increasing animal production from pasture in northern Australia is the provision of more productive pasture plants to supplement and replace the low-quality native species. Legumes, because of their nitrogen fixing ability, are of particular importance. Some new legumes and grasses of value to the grazing industry have become available as the result of recent work and are now coming into practical use.

Lotononis bainesii is a species new to Australia which was introduced from Africa and extensively used in pasture experiments at Beerwah (south Queensland). It is now being grown on a number of light soils in coastal and subcoastal regions of Queensland and northern New South Wales.

"Siratro", the product of breeding work with a new plant to adapt it to the environments of the Australian tropics, is a legume bred from two strains of *Phaseolus atropurpureus* introduced from Mexico. It is being increasingly used in a wide range of situations in north-eastern Australia on a variety of soils and in rainfalls of 25–30 in. or better; further breeding work to produce varieties adapted to lower rainfalls has been commenced.

"Nunbank" buffel grass, released this season, is a new variety of a species already of proven commercial value, selected after comprehensively testing a range of varieties over several seasons. It proved superior to existing commercial types in seeding ability, ease of establishment, and production on heavy fertile clay soils in the brigalow region.

These examples illustrate the different ways in which new pasture species and varieties become available for practical use. Many other new species and varieties are now under test, and some of these will become available for commercial use over the next few years.—*Division of Tropical Pastures.*

Provision of Cobalt to Grazing Ruminants

The heavy pellets ("cobalt bullets") designed to remain in the rumen and continuously provide the modicum of cobalt necessary to ensure optimum production of vitamin B_{12} have revolutionized cobalt therapy in husbandry practice. The original type of pellet has, in usage, manifested two disabilities—some are lost through regurgitation, and under certain conditions the surface of some of those retained tends in the course of time to become masked, usually by concretory deposits of calcium phosphate. A new type of pellet was evolved three years ago to lessen these hazards. Incorporation of iron filings instead of china clay as a binding matrix for the active constituent, cobaltic oxide, increased the specific gravity sufficiently to ensure retention in the rumen, and, in order to renew the active surface by abrasion, introduction of a steel grinder (an engineer's grub-screw) along with the pellet was recommended. Long-term experimental trials have proved the effectiveness of the grub-screws. Single pellets in some animals cease to function after about two years. Introduction of grinders restore the effectiveness, and all sheep treated in this way have remained healthy five years after the pellets were introduced during grazing on deficient pastures where the untreated members of the flock all died within a year. The prevention of phalaris staggers, which can only be effected by a continual, ample supply of cobalt to the rumen contents, is a stringent criterion. Grazing conditions on *Phalaris tuberosa* at Glenroy in 1961 induced a more than 90% incidence of staggers in the untreated group, and 40% in the group to which cobalt pellets had been administered in 1959. Prevention was 100% effective in the group which from the beginning had been provided with pellets and grinders. Occasionally, under certain grazing conditions, not yet under experimental observation, both pellets and grinders have been observed to become coated with calcium phosphate. In such areas periodic renewal of the pellets is necessary.—*Division of Biochemistry and General Nutrition.*

Mutations in Plant Breeding

Most of the important characters of agricultural plants such as yield, quality, and flowering time, are determined, not by single genetic factors, but by the combined action of large numbers of genes, each of which has only a small effect. To find out whether these characters can be improved by inducing changes or "mutations" in the genes, plant cells have been exposed to radiation.

By irradiating seeds of Tallarook subterranean clover with X-rays and neutrons, plant geneticists were able to produce new "mutants" having an appreciable variation in flowering time. A second cycle of radiation and selection was then applied to early and to later flowering mutants that had resulted from the first cycle of treatment. Further variations were induced in this way, but the additional progress that could be achieved by selection was only one-fifth as great as that achieved in the first cycle.

This suggests that successive cycles of radiation may not be as efficient as a single radiation treatment followed by crossing and selecting as in conventional plant breeding techniques; this would utilize more effectively the genetic variation generated by mutation.—*Division of Plant Industry.*

Phosphate Fertilizer Requirements for Wheat

A method of soil analysis has been developed to provide a direct assessment of the phosphate fertilizer requirements of wheat for optimal economic return. The method has been checked in the field by means of experiments carried out in the southern wheat belt of New South Wales and it is to this region that the results are applicable. It is not yet possible to apply them more widely to other soils and conditions.

Because of differences in the soil and land use history of individual paddocks, fertilizer requirements vary widely from site to site and the results of field experiments can only indicate average regional conditions in an average climatic cycle. There is thus a real need for a routine analytical service for farmers. This has not been possible in the past because soil analyses could not be satisfactorily interpreted in relation to field crop requirements.

Extraction of the soil with sodium bicarbonate provides values which correlate highly with superphosphate requirements for the 26 localities tested. From such analyses the results of field trials can be extended to embrace other soils of widely different phosphorus content. The analyses can thus serve as the basis for fertilizer recommendations to farmers. These recommendations would ensure, for the average season for that locality, a net increase in the return from the crop.

Results from the field experiments indicate that the average rate of application of superphosphate for wheat growing in the region could well be increased to yield economic returns of as much as £2–3 per acre cropped.—*Division of Soils.*

Regional Survey in the Northern Territory

A broad-scale field survey of the land resources of the Tipperary region, about 8000 sq. miles of country near the Daly and Katherine Rivers in the Northern Territory, was completed during the year. The survey was made in cooperation with the Northern Territory Administration to identify and broadly map the lands that may be suitable for development with improved pastures and crops which have been under test at Katherine by C.S.I.R.O. and the Northern Territory Administration. This experimental work has shown that sorghum, peanuts, fodder crops including bulrush millet and cowpeas, and improved pastures of Townsville lucerne–birdwood grass can be grown on loamy red and yellow earths, while cotton, fodder crops, and Townsville lucerne–birdwood grass pastures do well on sandy red earth soils. However, the economics of production of these crops is yet to be proved. The Northern Territory Administration is now considering the establishment of a number of pilot farms for pasture improvement–cattle fattening in the Katherine district on loamy soils.

The survey has shown that there are at least 200 sq. miles of loamy red and yellow earths suitable for arable crops or improved pastures, 400 sq. miles of sandy red earth soils suitable for arable crops and improved pastures, and over 3000 sq. miles of country suitable for pasture improvement but not for arable crops. The remainder is probably only suitable for rough grazing.

When the economics of production have been clarified on the pilot farms, more detailed land surveys will be necessary before development of these lands can take place.—*Division of Land Research and Regional Survey.*

Successful Plant Introductions

There is usually a considerable interval between recognition of a valuable strain and its widespread acceptance by the farming community. The following are some C.S.I.R.O. introductions of recent years which have been successful in various regions of Australia.

Two introductions of cocksfoot (*Dactylis glomerata*) have been named and are becoming important pasture grasses in Western Australia. "Currie" originated in Algeria and "Neptune" in Portugal. Other strains still only known by numbers may turn out to be still more valuable. In this state also several clovers (*Trifolium cherleri*, *T. clypeatum*, *T. hirtum*, and *T. spumosum*) show considerable promise in areas too dry for subterranean clover, and some vetches are becoming prominent grain legumes, especially an early strain of *Vicia sativa*.

Grasses making a useful contribution in temperate eastern Australia include "Brignoles" cocksfoot from France; "Demeter" fescue (a variety of *Festuca arundinacea*); *Bromus inermis*, a useful species in a genus containing some troublesome weeds; and Ronpha grass, a hybrid (introduced from South Africa) between *Phalaris tuberosa* and *P. arundinacea*. In some areas, recently introduced strains of lucerne, particularly "Du Puits" and "African", are superior to Hunter River, the standard strain developed in Australia from French seed imported at a very early stage of Australian settlement.

Sorghum almum, a tall perennial grass from Argentina, is now planted in one million acres in north-west New South Wales and inland southern Queensland. It has greatly increased the carrying capacity in summer rainfall areas. "Katambora" Rhodes grass, a strain of *Chloris gayana* from Northern Rhodesia, is also prominent in this region, being superior in dry conditions to types introduced earlier. Buffel grass (*Cenchrus ciliaris*) is now an important pasture grass grown over much of Queensland; two of the important strains, "Biloela" and "Gayndah", are derived from C.S.I.R.O. introductions originating in East Africa. Legumes whose value in building up soil fertility has been demonstrated in subtropical Queensland include: *Desmodium uncinatum*, *Glycine javanica*, *Indigofera spicata*, *Leucaena glauca*, *Lotononis bainesii*, *Phaseolus lathyroides*, and *P. atropurpureus*. Selection and breeding work are continuing to provide non-toxic strains of *Indigofera spicata* and *Leucaena glauca*. *Glycine javanica* shows great promise in inland southern Queensland, and it is hoped

that numerous accessions received in the present year will increase its effective area in Australia.

Following its collection in Kenya in 1951 a variety of *Dolichos lablab* C.P.I. 16883 was selected as promising in nursery trials in Brisbane and supplied to the New South Wales Department of Agriculture at Grafton for trial. Following numerous trials and recommendations by that Department the seed has now become commercially available.—*Division of Plant Industry.*

Inoculation for Establishment of Pasture Legumes

One of the major factors affecting the establishment of pasture legumes on soils of low fertility is the death of seedlings from nitrogen stress when nodules are not produced on the roots. This may be caused by failure to inoculate the seed in areas from which appropriate nodule bacteria are absent, by premature death of the applied inoculum, or by dry conditions delaying germination of the seed until the inoculum has been reduced to an ineffectual level. Considerable progress has been made in two aspects of this problem.

It has been found that inoculation of pelleted seed with exceedingly high numbers of nodule bacteria by a multi-step process can produce up to 100% nodulation of subterranean and crimson clovers sown on skeletal hill soils where standard commercial inoculation is without effect. The improved establishment followed both machine and aerial sowing of the specially treated seed.

Successful nodulation has been obtained with seed sown into dry soils 3–4½ weeks before germinating rains fell. This was accomplished by incorporating a commercial peat inoculant within a lime pellet. This method shows promise for the dry sowing of legume seed for pasture improvement in semi-arid areas.—*Division of Plant Industry.*

Mineral Deficiencies in Plants

A serious obstacle to increasing agricultural and pastoral production is the difficulty of determining which nutrient elements are deficient for the crop or pasture. A new and very promising approach to this problem has arisen from recent research aimed at achieving more rapid responses of plants than are normally obtained in field experiments. The method is rapid and it is based on the actual response of a plant that has grown under the existing nutritional and other environmental conditions in the field. This method involves the transfer of sample plants from the field to a series of culture solutions in a glass-house. One of these contains all the required nutrients but each of the others is deficient in a different element.

Plants which have been grown in soil deficient in a particular element grow more slowly in the culture solution which is also deficient in that element than they do in the other solutions. Plants which are not deficient continue to grow normally for a few days after transfer to the deficient solutions. By recording changes in leaf area it is possible to distinguish between deficient and non-deficient plants only three days after transfer.—*Division of Plant Industry.*

Silicification of the Oat Plant

It has been recognized for a long time that some plants, particularly the monocotyledons, absorb large amounts of silicon which is deposited as silica in epidermal cells. A technique has now been developed by which it is possible to separate composite particles of silica from a plant without damaging the structure or altering the composition of the particles. Detailed studies of silica from the vegetative and reproductive parts of the mature oat have revealed that the walls of all types of epidermal cells except cork cells are impregnated with silica. Walls of cells in the hypodermal layer, vessels, and fibres are also impregnated as are those of tracheids in the roots. The impregnating silica is invariably opal and some fine details of the structures suggest that the silica is deposited in intimate association with the cell wall. These observations raise several issues, such as the mechanism of the deposition of the silica and the effect which it may have on the metabolism of the plant and of animals fed on oaten hay and grain.—*Division of Plant Industry.*

Cobalt Status of Australian Pastures

Untoward effects from cobalt deficiency prevail over much more widely dispersed terrain than was first realized. Extensive tracts have now been positively identified where, seasonally, a shortage of cobalt in the pastures limits productivity of flocks and herds sufficiently to incur serious economic losses, without revealing clinical symptoms. Delineation of these incipiently deficient areas is imperative as simple means are available to provide cobalt to sheep and cattle. Methods evolved for assessing unequivocally the effective cobalt (i.e. the vitamin B_{12}) status of grazing sheep have been developed to a stage that an Australia-wide survey of the seasonal variations of cobalt intake of sheep and cattle may be undertaken without an undue superstructure of observational study. This study is in progress. Valuable collaboration from the State Departments of Agriculture has been assured, and the investigations have been extended to the study of cattle depastured in the Northern Territory and in Queensland at localities typical of widespread grazing conditions.—*Division of Biochemistry and General Nutrition.*

Fungal Stimulation of Pine Tree Growth

Under some soil conditions, certain fungi are capable of stimulating significant increases in the establishment and growth of many tree species. These fungi infect the roots, envelop the short laterals (causing "mycorrhizas"), and act as nutrient absorbers for the plant. The absorption characteristics of the root can be changed considerably by the fungi.

Several of these mycorrhizal fungi have been cultured from the roots and are being tested for their ability to stimulate growth of *Pinus radiata* in South Australian, Western Australian, and Victorian soils of potential forestry importance. Studies with radioactive phosphorus have shown not only that the infected roots take up

larger quantities of nutrients but also that there are marked differences in the stimulating effect of different mycorrhizal types. Mycorrhizas of one type absorbed phosphate at twice the rate of uninfected roots, but another type absorbed it at eight times the rate. This suggests that particularly efficient fungi can be selected for inoculation of forestry nurseries.

Differences of absorption between mycorrhiza types were related to the extent of fungal growth around the roots, to the size of infected roots, and to differences at the cellular level, such as the number of phosphate-absorbing sites. Soil moisture level in an agricultural sand profoundly affected the rates of uptake of nutrients. Attempts are being made to relate plant growth to these criteria and to other physiological factors such as movement of nutrients from the fungi to the tree. This information will help in defining a fungus selection program.—*Division of Soils.*

Chlorophyll in Marine Plants

Plants which grow near the surface of the sea are mostly of microscopic size and are known as phytoplankton. Sea plants, like land plants, contain the green colouring matter chlorophyll, which is essential for the utilization of light energy in the synthesis of organic matter. But all the chlorophyll in sea plants is not identical with the chlorophyll in land plants. Some of it is in a form known as chlorophyll *c*, not found elsewhere in nature.

Marine biologists measure the chlorophyll content of sea-water as a means of assessing the content of phytoplankton. If this assessment is to be accurate, the properties of all of the forms of chlorophyll must be known. Success has been achieved in isolating, for the first time, pure crystalline chlorophyll *c*. This is of significance in making accurate estimations of the plant life in the sea and in the basic study of how plants use light energy.—*Division of Fisheries and Oceanography.*

Flower Initiation in the Sultana

In some seasons vines form insufficient flowers, and as a consequence, insufficient grape bunches for a full crop to be realized. Recent work has shown that buds are less likely to form flowers if the amount of light they receive at the time of flower initiation in late spring is reduced by shading the buds alone.

Progressive shading reduced flower initiation and when light was completely excluded, the proportion of buds forming flower initials was reduced by about half. It could not be shown that this reduction in flower formation, and hence fruitfulness, depended in any way on the spectral quality of the light.

The results of some earlier experiments, which showed that leaves can be removed from the sultana vine without affecting flower initiation in the neighbouring buds, provide supporting evidence for the important role of the bud itself in this process. Generally, it is assumed that the stimulus leading to flower initiation in plants origi-

nates in the leaves, and is transported to receptive buds which are then transformed from the vegetative to the reproductive stage.

This is believed to be the first report that flower initiation can be affected by a treatment applied directly to the buds.—*Commonwealth Research Station, Merbein.*

Rhythm in Cropping and Fruit Cell Numbers

The rhythm of alternating heavy and light crops in deciduous fruits is a well-known horticultural problem. It has now been established that the cropping rhythm is accompanied by a rhythm in the cell numbers in the fruits. A plot of Jonathan apple trees has been under observation since 1952. For the period 1952–55 the crops were steady and there was no rhythm in cell numbers. In 1956 there was an exceptionally heavy crop and this initiated a rhythm of light crops in the subsequent odd years. The 30% fewer fruits borne in the light-crop years had 20% fewer cells per fruit. The stress of a very heavy crop either retards the development of the fruiting buds for the next season or results in inadequate nutrient reserves being carried over for the development of the fruit in the cell division stage.—*Division of Plant Industry.*

Studies on the Ripening of Fruit

The ripening of many fruits is associated with a marked increase in respiration and the storage life of fruit is determined by the time of onset of this increase. The rate of respiration of plant tissues is frequently controlled by processes involving phosphorylation. The compound adenosine triphosphate (ATP) produced in the tissue by phosphorylation plays an important role but so far evidence of the control of respiration via ATP has not been conclusive.

When slices of root and other storage vegetables are washed in water the increase of respiration is similar to that found in maturing fruit. This increase can be inhibited by treating the tissue with L-methionine, a naturally occurring amino acid, and the experimental evidence suggests that methionine exerts its effect by blocking the metabolism of ATP. The reduced rate of respiration of tissue treated with methionine can be restored to approximately its normal rate by compounds (e.g. dinitrophenol) which are known to uncouple the processes of respiration and ATP production.

In attempts that have been made to determine whether products of methionine are responsible for its observed inhibition of respiration the methionine was rendered radioactive by incorporating radioactive carbon (^{14}C) in it and then tracing the movement of the "labelled" group into other compounds present. It has been found that the cellular organelles (mitochondria) associated with ATP production become heavily labelled by the methyl group of methionine. Most of this labelled group is in the lipid fraction and, in particular, plant sterols and ubiquinone (coenzyme Q_{10}) have now been isolated and found to be radioactive. These compounds are known to influence the processes of oxidative phosphorylation (which produces ATP) and it seems likely that methionine exerts its control over oxidative phosphorylation by the methylation of compounds present at the site of ATP synthesis in the mitochondrial membranes of fruit tissue.—*Division of Food Preservation.*

Blue Mould in Tobacco

For many years research has been carried out on blue mould, a disease which menaces Australian tobacco crops. One approach to the control of this disease is to produce resistant plants, and attempts to achieve this have been made by two methods. One involves the crossing of wild, resistant plants with commercial varieties. The other is an attempt to induce changes or "mutations" in the genes of the tobacco plant, in the hope that some of the mutants may show resistance to the disease. Some degree of success has been achieved recently with each of these methods.

Another approach to the control of blue mould has been recently developed from observations made 30 years ago. It was noticed at that time that if a plant were mildly infected in its stem, the whole plant would then develop a resistance to further infection. It has now been discovered that the plants, when first infected, produce antifungal substances, which circulate through the plant. Two of these antifungal substances have been isolated from plant material. When very small amounts of them are sprayed on to tobacco plants, they protect the plants from blue mould. Efforts are now being made to discover the chemical identity of the antifungal substances.—*Division of Plant Industry.*

Mode of Action of Some Antifungal Agents

The porphyrins, a class of compounds of vital biological significance, are notable for their ability to enter into complex combination with metals. The two metals of greatest importance in these complexes are magnesium (chlorophylls) and iron (haem compounds). Haem compounds are essential for the life of animal, plant, and bacterial cells, and studies are being made of the way in which various chemical systems, natural and synthetic, promote haem formation by catalysing the reaction of porphyrins with metals.

A large number of other chemical compounds (chelating agents) are capable of combining with metals to form complexes, and it is known that a very small proportion of such complexes of iron or copper have antifungal or antibacterial activity; these particular chelating agents include 8-hydroxyquinoline and diethyldithiocarbamate. At Canberra, chemical studies of the reaction of metals with porphyrins have recently shown that just these metal chelates which are antifungal or antibacterial, *and only these*, have the power of giving up their bound metal ions to porphyrins; in such a system the porphyrin-metal complex is formed thousands of times faster than in a simple mixture lacking the chelating agent. The mechanism of action of the antifungal metal chelates is obscure, and these findings suggest that they may act by catalysing the entry of the wrong metal (copper) into a porphyrin, or by catalysing the entry of the right metal (iron) into a porphyrin at the wrong stage in its synthesis in the cell.

To investigate these possibilities, the natural, enzymic formation of iron-porphyrin complexes (haems) is being studied. A soluble preparation of the enzyme (ferrochelatase) has been obtained from pig liver, and it has been found that this enzyme catalyses the insertion of iron into porphyrins provided that the iron is present in

the ferrous state and air is absent. There are indications that in different types of tissues, for example some bacteria, there are other ferrochelatases, each associated with the formation of a particular type of haem. Chelators such as 8-hydroxyquinoline not complexed with metals have been found, as expected, to block the ferrochelatase reaction by competing with it for the iron present. On the other hand, the antifungal chelator-metal complexes do not interfere with the action of the soluble, cell-free ferrochelatase, but in current studies it has been found that they do interfere with chlorophyll synthesis in certain intact microorganisms. The situation is a complex one, and more work will be required to unravel it. Much insight is being gained into the chemical and the biological mechanisms of the reaction of porphyrins with metal ions, and time should show whether the antimicrobial activity of the metal chelates is due to their interference with the formation of porphyrin-metal complexes.—*Division of Plant Industry.*

Pisatin, an Antifungal Compound from Peas

In the course of fundamental studies into the physiology of disease resistance in plants, a new kind of antifungal compound named "pisatin" was isolated from infected peas. Its structure has now been established as 3-hydroxypterocarpin, a compound of the isoflavonoid class.

Pisatin is a relatively weak antibiotic which is effective against a wide range of fungi. Its biological significance lies in the fact that pathogenic fungi of peas are able to tolerate much higher concentrations of pisatin than other pea fungi, although its formation is induced by both types of fungi. This property is unique and provides evidence for the claim that pisatin plays a primary role in the protection of peas from fungal diseases. In its present form pisatin is not suitable for use as a fungicide for application on foliage. However, natural or synthetic analogues of pisatin, or similar compounds from other plants, may provide a new source of biologically active compounds, a few of which may find a role in plant or animal chemotherapy.—*Division of Plant Industry.*

Small-scale Baking Tests

Wheatgrowers are continually needing new varieties of wheat, since nearly all varieties eventually become susceptible to disease. Plant breeders in all States produce and test thousands of new crosses each year. Most of these are rejected for one reason or another and only a very few are ever released as varieties for commercial use.

Most wheat is used for bread making and one of the important attributes of a new variety is that it should produce flour of good baking quality. Unfortunately the baking quality of a new cross cannot be reliably predicted from a knowledge of its parent stocks and each promising cross must be milled and the flour used to bake test loaves. To do this it is necessary to raise enough plants to give several pounds of wheat. This means that a breeder would have to propagate and grow about 100 plants of a new variety to produce enough wheat for a single test.

A micro-baking test has been devised, in which loaves weighing less than 2 oz are used; this requires grain from only a few wheat plants. As a result, wheat breeders can be saved a great deal of work, since they need to grow a much smaller number of plants for testing purposes. The new technique has been introduced as a routine method in our biochemical quality research program.—*Wheat Research Unit.*

Salt Meter for Testing Stock Water

An instrument which provides a quick and accurate estimate of the salt concentration in water samples has been developed. It has been designed for use by farmers who depend on bore water for watering stock and who are concerned lest the salinity of the water should reach dangerous levels.

The instrument measures the electrical conductivity of the water sample, which varies according to the amount of the salts dissolved in the water and is thus a measure of the salinity. It is small, rugged, and simple to operate, and, complete with battery, weighs less than 1 lb. It is now being made commercially.—*Division of Chemical Physics and Chemical Engineering Section.*

Purification and Identification of Proteins

Proteins form a vital part of all living things and are an important constituent of foods. However, proteins are of many different kinds, are very large molecules, and are difficult to separate from one another completely. This difficulty has hampered research in many fields of biology. In the course of research on the protein hormones that control wool growth, a method used for the separation of proteins has been developed to provide an accurate means of identifying them. This procedure, zone electrophoresis on starch gel, will detect contaminating proteins present in very small concentrations—as little as 0·01%; few if any proteins have yet been prepared to this degree of purity. The method has also been used to study genetic differences in the blood and other tissue proteins of individual sheep. Ultimately it may be possible, in this way, to assess the genetic merit of sheep for a large number of characteristics.—*Division of Animal Physiology.*

Tissue Culture

For some years, physiologists have been able to remove small pieces of living tissue from an animal and maintain them, away from the body, in a "living" state. The pieces do not undergo the degenerative changes associated with death but continue to utilize oxygen and manifest all the other properties of living tissue. This technique is called "tissue culture" and has become a powerful laboratory aid in experimental physiology.

Techniques for the tissue culture of cells from insects have now been successfully established. Four strains of cells originating from the ovarian sheath of the emperor

gum moth have been maintained in culture flasks for over 12 months. It has been possible to "deep freeze" these cultures and successfully regenerate them later. To be able in this way to keep strains for long periods will permit the study of many problems in the mechanism of multiplication of viruses, in cell physiology, in radiation biology, and in other fields.—*Division of Entomology.*

Infertility in Sheep Grazing Clovers

Research in Western Australia, about 20 years ago, revealed a severe reduction in the fertility of ewes grazing on subterranean clover. This clover has now been sown over about 30 million acres, so the problem is potentially a serious one. The disease is due to the presence in pasture plants of oestrogenic hormones which upset the reproductive cycles of the ewes.

Similar trouble has now been recorded in other States, and red clover has also been incriminated. Furthermore, changes similar to those produced in the reproductive organs of ewes grazing subterranean clover have been detected in some areas where there is no improved pasture. A definite reduction in fertility of ewes may occur even when the disease is so mild that there are no outward signs.

Methods have now been developed for measuring the oestrogenic potency of pastures as grazed. The most accurate measure requires spayed ewes, but a simple practical test can be made with wethers and requires only 2 weeks grazing. There is a distinct possibility too that the fertility of rams grazing these pastures may be reduced, but experimental work on this point is not yet complete.—*Division of Animal Physiology.*

Function of Cobalt in Animal Tissues

Long-term experimental investigations have revealed the way in which cobalt functions in the metabolism of animals. Cobalt effects a physiological role in animal tissues only when it is an integral part of vitamin B_{12}, a complex molecule produced in nature solely by certain microorganisms. The fodder usually provides the minute amount of cobalt necessary to ensure adequate production of this vitamin by the sheep's rumen flora. Deficient pastures, however, cannot maintain the concentration of 1 part of cobalt in 25 million parts of rumen contents essential to support an adequate rate of synthesis. Below this level, production of the vitamin declines precipitately to amounts which cannot provide the animal's requirements; the tissues become depleted to a stage at which the animal cannot deal effectively with a full feed; thence, as depletion proceeds, appetite fails progressively and, if additional vitamin B_{12} is not provided, the animal declines and dies of inanition. The metabolic defect supervening on cobalt (i.e. vitamin B_{12}) deficiency in the sheep is manifested by a failure of the animal's ability to cope with propionic acid, a major constituent of the rumen-fermentation products from which ruminant animals derive their energy. The breakdown of metabolic efficiency incurred by vitamin B_{12} deficiency has now been located in the channel of chemical transformations through which propionic acid is

launched into the energy-producing cycle—precisely, the site of the metabolic lesion is in the isomeric conversion of the intermediate methylmalonic acid to succinic acid. The coenzyme responsible has been shown to be a simple nucleoside of vitamin B_{12}. Thus the discovery that cobalt is an essential micronutrient element for ruminants, which stimulated a general appreciation of the limitations imposed in agriculture by trace element deficiencies within the soils of particular areas has, by continued study, opened up a new vista to the understanding of the intermediary metabolic processes of all animals.—*Division of Biochemistry and General Nutrition.*

Effects of Stress on Sheep

Recent research has shown that common stresses, though producing no outward manifestations, may have profound effects on sheep. The stress involved in yarding, handling, or trucking sheep has been found to disrupt the reproductive cycle of ewes. Even the mild stresses involved in handling ewes may decrease the rate of sperm transport after mating and hence affect fertility. Deterioration in the quality of ram semen occurs as a result of heat stress, which is common under Australian conditions.

Some forms of stress lead to responses which are designed by nature to help the animal withstand the stress, but which on occasion go too far and produce harmful effects. In the pregnant ewe, undernutrition and various stresses lead to excessive production of a hormone (cortisol) by the adrenal gland, and this in turn leads to interference with the normal chemical changes in the body, which can precipitate a fatal attack of pregnancy toxaemia.

An excess of this adrenal hormone also leads to reduction or cessation of wool growth, producing "tenderness" or "break" in the fleece. An understanding of these effects can be expected to lead to improved sheep husbandry and greater efficiency of production.—*Division of Animal Physiology.*

Liver-damaging Alkaloids

Most of the pyrrolizidine alkaloids that occur in plants are known to cause either chronic or acute liver damage when eaten by animals. A study of these alkaloids has shown that those that are biologically active in this way have certain similarities in the structural make-up of their molecules and that their reported effects on the cell nuclei resemble the effects of the so-called biological alkylating agents. These are chemical substances which, when administered to animals, cause the insertion of an alkyl (organic) radical into essential cell constituents resulting in changes in the genetic material in the cells.

That these alkaloids might undergo chemical changes within the animal resulting in the production of substances having this alkylating function was indicated by a study of the by-products of metabolism of animals feeding on them. It has now been found in laboratory studies that these alkaloids can undergo this change and thus indirectly act as alkylating agents.

These observations lead to the hypothesis that alkylation of some essential cell constituents is the primary cause of chronic pyrrolizidine liver damage and it is now being tested directly in an attempt to clarify the precise nature of the fundamental biochemical changes involved. An important practical outcome of this work is the ability to predict whether plants not at present regarded as poisonous are in fact potentially dangerous to stock. One such example is the well-known plant *Echium plantagineum* (Paterson's curse or salvation Jane) which has now been shown to contain quantities of these liver-damaging alkaloids. This finding strengthens the earlier suggestion that this widely distributed plant has caused chronic liver disease in sheep and emphasizes the risks involved in allowing grazing stock access to it.—*Division of Animal Health and Division of Organic Chemistry.*

Fertilization in Ewes

About 60 million ewes are mated in Australia each year, and about 20 million fail to produce or rear a lamb. Perhaps half of this loss is due to mortality of lambs, but the remainder can be ascribed to infertility. This major practical problem has stimulated research on many aspects of reproduction in sheep. During recent experiments on the physiology of fertilization after mating, it has been observed that when ewes are mated under favourable, undisturbed conditions, contractions of the uterus are primarily responsible for transport of sperms from the vagina to the fallopian tubes where fertilization takes place. The swimming motion of the sperms seems to play little or no part as the transport takes only a few minutes. A substance in ram's semen, called prostaglandin, has been found to increase the activity of the ewe's uterus in transporting sperms after mating. When ewes were disturbed by handling or by an unfamiliar environment at the time of mating, sperm transport was delayed by several hours. This delay would be sufficient to reduce the chances of conception when mating occurs near the end of the heat period.—*Division of Animal Physiology.*

Effect of Heat on Cattle

Some cattle are better than others at coping with hot conditions. The reasons for this are being investigated as part of a program for assessing the heat tolerance of dairy cattle. In controlled temperature rooms at Badgery's Creek, N.S.W., the behaviour of a small number of Jersey, Zebu, and Jersey–Zebu cross cattle has been studied. In the experiments, the cattle in the hot room were subjected to temperatures rising from 70 to 105°F. Sweating rates, respiration rates, skin temperatures, and body temperatures were measured. The Jersey cattle soon increased their sweating rate but the Zebus did not do so until the air temperature reached 85°F and their skin temperature 95°F.

At constant mild temperatures the body temperatures of the Zebus were higher than those of the Jerseys, and their sweating rates were lower. But when the conditions were maintained at a high heat level, the body temperatures of the Jerseys rose until they were higher than those of the Zebus; the sweating rate of the Zebus rose until

it was higher than that of the Jerseys; the Jerseys lost their appetites whereas the Zebus continued to eat normally.

These experiments reveal some of the differences between Zebus and Jerseys and are being continued as part of a program for breeding cattle for the north.—*Division of Animal Genetics.*

Flight Behaviour of Locusts

Several localities in central western and west New South Wales are especially favourable for the survival and multiplication of the Australian plague locust. When the locust populations in these "outbreak areas" reach a high level of population density, flying swarms develop which may emigrate into extensive areas of New South Wales and Victoria. The swarms are able to persist in the invaded areas and produce further swarms.

A study of the flight behaviour of the Australian plague locust early in 1962 has shown that, even when conditions in the "outbreak areas" are most favourable for a rapid build-up of locust populations, the occurrence of numerous flying swarms in these areas is not necessarily a prelude to a widespread outbreak. Adult locusts have a low air speed and, if wind speed is low, they are able to maintain their course through the air by reference to landmarks, e.g. as provided by gross differences in pasture cover along depressions. Thus when flying in a cross-wind the locusts are able to navigate by correcting for drift.

However, when wind speed is high, creating turbulence close to the ground, with wind gusts equal to or greater than the locusts' air speed, the swarms make little progress and may even break up. For example, in conditions of high wind speed and turbulence, especially when the pasture cover is fairly uniform, the locusts attempt to fly upwind, but the majority are blown downwind and land at random. In this way the original swarm becomes widely scattered.

Further investigations on flight behaviour and examination of the history of locust outbreaks in relation to wind conditions may help to explain the development of previous outbreaks and the unexpected termination of incipient ones. The investigations may also aid in the prediction of future outbreaks.—*Division of Entomology.*

Resistance to Myxomatosis

The Australian wild rabbit population has acquired some resistance to myxomatosis and attempts are being made to find out how this resistance is developed.

Changes similar to those occurring in cancer occur in the tissue cells of all infected rabbits. The nature and extent of these changes vary with the strain of myxoma virus used. In resistant rabbits, survival seems to be due to a rapid immunological response in the body of the rabbit. The tissues of the resistant animal undergo pathological changes typical of myxomatosis, but the rabbit nevertheless recovers. It has been found that the Glenfield strain of myxomatosis is effective against resistant rabbits bred in the laboratory, and there is some field evidence that this strain is effective in wild rabbits.

The laboratory production of more effective virus strains requires a detailed background knowledge of the mechanism of the disease. A study of the effect of cortisone and nucleic acid preparations has given useful leads in what is, as yet, an early stage of a program. If this program is successful, it will be not only of great value to the pastoral industry, through the production of strains of myxomatosis capable of killing resistant rabbits, but also for our understanding of many disease processes.—*Division of Animal Genetics.*

Animal Sounds and Communication

People have always been interested in animal sounds but the complexity of these sounds has been a serious obstacle to scientific study. Recent developments in the recording and analysis of sound, which have been made possible by the use of the tape recorder, the cathode-ray oscilloscope, and the sound spectrograph, have overcome many of the difficulties. As a result considerable advances have been made in understanding the calls of birds, mammals, insects, frogs, and even fish. In other countries, the alarm and distress calls of birds have been replayed through amplifiers and loud speakers to disperse them from roosts or feeding grounds. It is possible that such methods may be used to drive birds from valuable agricultural crops, from city buildings, or from airfields, where they are a menace to the safety of high-speed jet aircraft.

This work has produced some rather puzzling and inconsistent results but it is promising enough to warrant further research into the origin and meaning of sounds made by birds and other animals. A laboratory has been established at Canberra where the alarm and distress calls of several species have been recorded and prepared for analysis. Aggressive, territorial, food finding, mating, and other calls of birds are being studied in relation to their behaviour and their social organization. This work is a prerequisite to the development of any new techniques of acoustic scaring, whether they are based on work carried out in Australia or elsewhere.—*Wildlife Survey Section.*

Surveying the Oceans

The abundance of fish in the oceans surrounding Australia is affected by the amounts of nutritive elements in the water.

The very great amount of information that C.S.I.R.O. oceanographers have been able to gather during numerous cruises of the frigates H.M.A.S. *Diamantina* and *Gascoyne* has indicated the location of areas of the ocean which are rich in these elements compared with other areas.

Two of these richer areas have been found in the Indian Ocean between north-western Australia and Java. In these places, the meeting of several ocean currents has caused enrichment of the surface waters by more fertile deep water.

Discoveries such as these, apart from providing short cuts in the search for new fisheries, reveal valuable test areas for the investigation of factors controlling the growth of life in the sea.—*Division of Fisheries and Oceanography.*

Tuna

Tuna are caught in large numbers off the New South Wales south coast in the spring. The season is a short one, covering only about 3 months, and fishermen can catch as many fish as the canneries can handle. Therefore the fishing season must be extended if the catch is to be increased. Efforts are being made to find out how this can be done, and whether the overall stocks of tuna are big enough to allow a larger seasonal catch to be taken.

It is known that the tuna are most likely to be found in water which lies within certain ranges of temperature and salt content. In a cooperative survey in which the fishermen themselves take part, C.S.I.R.O.'s fisheries research vessels *Derwent Hunter* and *Marelda* operate in the commercial fishing grounds, taking measurements of the temperature and salt content of the water, while the fishermen record temperature readings and details of their catch. All this information is radioed to the C.S.I.R.O. shore station, and plotted on maps. These maps are made available to fishermen every day so that they can take advantage of really up-to-date information in planning their next day's fishing.

A similar scheme has been organized for the summer tuna fishing season in South Australia. The shore station there is operated by the fishermen's cooperative cannery at Port Lincoln.—*Division of Fisheries and Oceanography.*

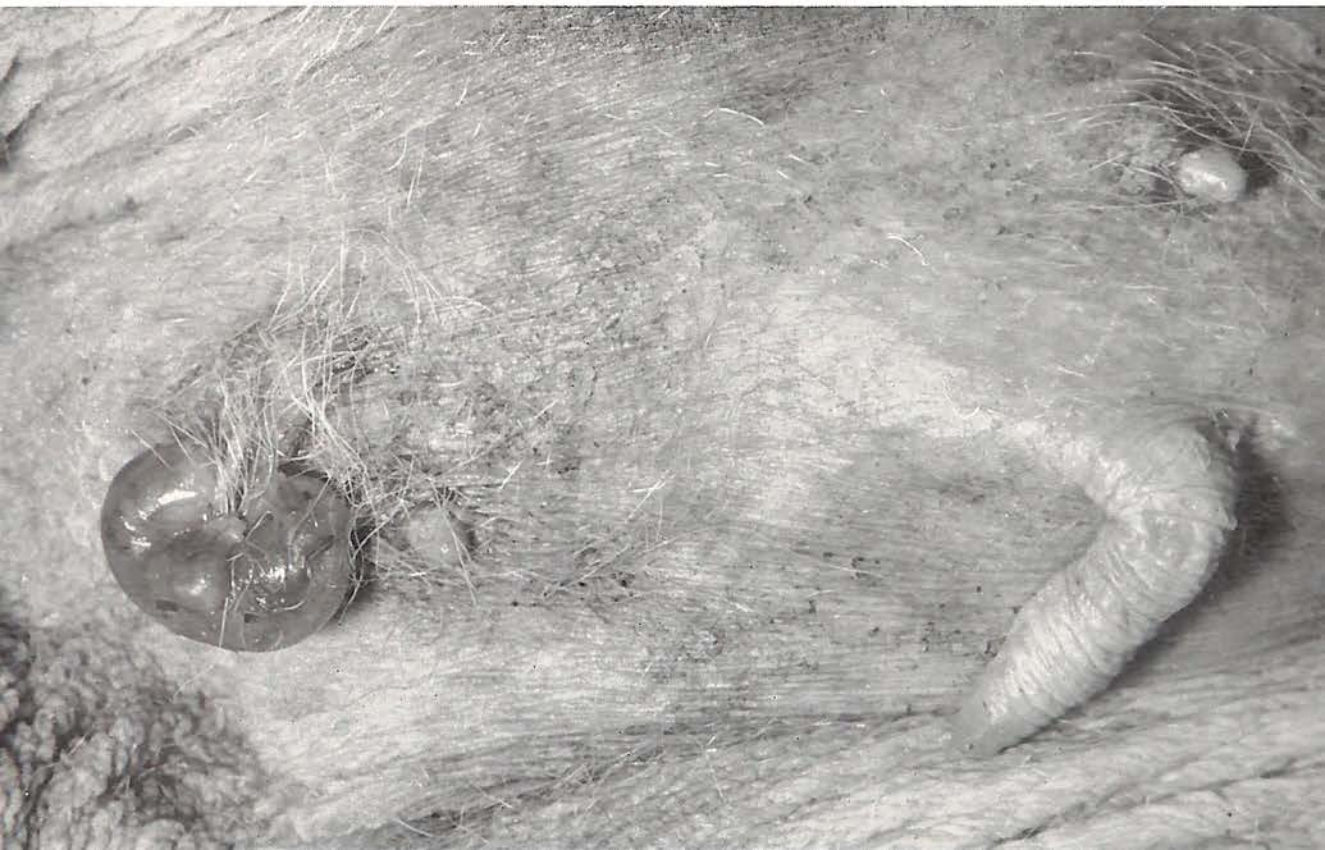
Lactation in the Kangaroo

An important adjunct to field studies of various fauna is the parallel study, using captive animals, of breeding habits, growth rates, water metabolism, and other biological processes. A field study of the plains kangaroo in western New South Wales showed, amongst other things, that a large proportion of the adult females were accompanied by a young out of the pouch (the weaner), and had a second, much smaller, young in the pouch. The lower photograph (on the opposite page) was taken looking inside the opened pouch of one of the plains kangaroos in the kangaroo enclosures at Gungahlin, Canberra. This kangaroo has a one-day-old young, about $\frac{3}{4}$ in. long, attached to the upper teat on the left side of the picture. The lower teat on the right side is greatly enlarged and is being used to suckle a weaner, 222 days old, which has just left the pouch (upper photograph). The two teats not being used can be seen—one on the left near the day-old young and one on the right above the large teat.

In kangaroos, as in other mammals, the composition of the milk changes as the young mature. During the early stages of pouch life the young kangaroo is fed on a clear milk which contains a low proportion of fat and solids but this changes during growth of the young to a milk of typical appearance, which contains a higher proportion of fat and solids. Since the kangaroo pictured here, and many other kangaroos, have overlapping periods of lactation from different mammary glands, the inference is that the mother kangaroo can simultaneously produce two kinds of milk of different composition.—*Wildlife Survey Section.*

Above: *Plains kangaroo, shown with 222-day old weaner.*

Below: *View inside pouch, showing one-day-old attached to teat.*



Above: *Pedestrian crossing with conventional lighting.*

Below: *Effect of floodlighting the pedestrians from the directions of the approaching traffic streams.*

Solar Distillation of Water

Research on solar distillation for the desalination of water has been mainly concerned with the development of the simple single-effect solar still.

An improved design with a plastic base has been built and is now undergoing tests. The experimental still which covers an area of 100 sq. ft. produces about 10 gal of distilled water on a clear summer day. A prototype intended for use in isolated areas is being built and will be tested to determine its suitability for supplying water for both human and stock consumption from sources which would otherwise be too saline.

Since the operating cost of this equipment is almost entirely interest and depreciation on capital outlay, the cost of the water depends on the amount spent on the initial installation. On the assumption that salt water is available free, the cost of fresh water produced from a solar still is at present estimated to be £1 per thousand gallons.

Another approach to the use of solar energy for the desalination of water is the use of a multiple-effect diffusion still. This is much more efficient than the simple single-effect unit, but it is also much more expensive. Work is proceeding on the many problems which remain to be solved before such a unit would be economically and technically feasible.—*Engineering Section.*

Illumination of Pedestrian Crossings

People using pedestrian crossings at night are often hard to see. Even if the general illumination of streets were to be greatly improved, special lighting of pedestrian crossings would still often be required. The "silhouette" type of lighting generally used on streets has its limitations. It is often unsatisfactory in wet weather, and it is not good enough for pedestrian crossings near curves or near crests, or for pedestrians near the curb.

It has been suggested by the Division of Physics that special lighting of crossings can best be effected by floodlighting the pedestrians from the directions of the approaching traffic streams. The pedestrians are then strongly illuminated on the sides visible to approaching motorists, so that they can be seen directly, rather than in silhouette. An assessment has been made of the amount of illumination required to make pedestrians easily visible, whatever the brightness of the background. Lenses are needed to concentrate the light on the crossing, with a special shield on the floodlight to eliminate glare, but these have been found to be quite practicable.

This method of lighting pedestrian crossings has been tested successfully with an experimental installation on a crossing at the Sydney suburb of Wahroonga, in cooperation with the New South Wales Pedestrian Crossings Committee. A second successful experimental installation has been made at Newcastle, with the cooperation of the Shortland County Council. The Pedestrian Crossings Committee is now attempting to interest the lighting industry in the development of special floodlights

for this purpose, and it is hoped that a number of permanent floodlighting installations will then be installed.—*Division of Physics.*

Extraction of Proteins from Wool

Many important properties of wool depend on the characteristics of the individual proteins that make up the wool fibre. Thus when wool is dyed the dye molecules attach themselves to the wool proteins, and when wool is shrinkproofed the proteins are chemically altered. Some of these proteins contain less sulphur than wool itself (low-sulphur proteins) and some more (high-sulphur proteins).

Electron microscopic and X-ray diffraction studies have shown that low-sulphur proteins of wool probably lie in the well-ordered filaments or microfibrils and that high-sulphur proteins occur in the relatively amorphous matrix. It is very difficult to study the chemistry of these two groups of proteins in the intact wool fibre, but they can be extracted, separated, and purified, and it is then possible to determine their size and shape, the conformation of the chains of amino acids within the fibre, the properties of the individual amino acids, and the sequence in which these are linked together in the chains.

Four protein preparations have now been extracted from the fibre; two have a low and two a high content of sulphur. The latter have much smaller molecules than the former, as might be expected of structural units which comprise the amorphous filling material in the fibre, like concrete in reinforced concrete. The low-sulphur proteins make up the microfibrils which correspond to the steel reinforcing rods. Analysis of the low- and high-sulphur proteins shows that the former are acidic in nature and the latter basic in the original fibre. These acid and basic properties provide a mutual affinity which would tend to link these proteins together in wool through electrostatic forces. These forces would be expected to supplement the strengthening effect of the bonds between the sulphur atoms which are believed to make a major contribution to the holding together of the individual amino acid chains or helices in the fibre.—*Division of Protein Chemistry.*

The Surface of Wool Fibres

The surface of a wool fibre is covered with scales which all point towards the tip of the fibre. It is mainly this scale structure which is responsible for fibres moving more readily in tip to root direction during washing, thus causing felting shrinkage of woollen goods. Most shrinkproofing treatments are designed to modify the fibre surface to reduce the preferential movement towards the root end. Exact information on the changes which take place at the surface is of considerable importance.

Some changes can be seen by ordinary light microscopes, but the higher magnification of the electron microscope is needed to get fine detail. Methods have been found for making casts of the fibre surface, and these have been examined under the

electron microscope. It has been confirmed that the C.S.I.R.O. permanganate-salt shrinkproofing process makes very little change in the surface, but that interesting changes take place progressively as the woollen goods are washed.

The scale tips that have been modified by the shrinkproofing treatment are gradually broken away during washing to leave fresh scale edges. These new scale edges appear to be sufficient to reduce the effectiveness of the shrinkproofing treatment if washing is too prolonged. In practice some types of garments are washed much more than others. With better information on surface changes, it should eventually be possible to specify more exactly the shrinkproofing treatment appropriate for various cloths.—*Division of Textile Physics.*

Important Role of Cystine in Wool

Among the amino acid units of which the proteins of the wool fibre are composed, the sulphur-containing amino acid cystine occupies a position of central importance. It provides the important sulphur cross-links associated with the elasticity and other important physical properties of the fibre. When these linkages are split by treatment with certain chemicals the fibre loses its elasticity and some of its other important properties. In fact the sulphur contributed by cystine to wool occupies a role similar to that of the sulphur incorporated in rubber during vulcanization.

When proteins are to be extracted from wool, chemicals are normally used which split the disulphide bonds by reduction or oxidation; both methods have been in use in wool chemistry for many years. A new method developed in Melbourne and now accepted by protein chemists throughout the world as the "Swan Method" after its discoverer, Dr. J. M. Swan, is also now available and may be used when it is desired to extract the proteins in neutral solution to avoid possible damage to them by acid or alkaline conditions.

In wool technology, peroxide bleaching and treatments designed to promote resistance to shrinkage, such as chlorination and the permanganate-salt process, attack the disulphide bonds of cystine causing complete splitting of some bonds and the addition of oxygen to others forming sulphur oxyacids. The Si-ro-set permanent pleating process on the other hand splits the disulphide bonds by reduction.

It has been found that the ultraviolet radiation in sunlight also splits the disulphide bonds of cystine, and from chemical studies of pure cystine it seems that in the presence of air it is mainly the bond between the carbon and sulphur atoms that is split in neutral or alkaline solutions, but it is the bond between two sulphur atoms that is split if the irradiation is conducted in acid solutions. The chemical products obtained after irradiation in alkaline solution thus differ from those formed under acid conditions. Rapid identification of these products has been made possible by the application of the techniques of paper chromatography and paper electrophoresis on a micro scale. These studies have taken us a stage further in an understanding of how wool is modified by textile finishing processes, and of the damage caused by long exposure to sunlight and possible means by which this might be avoided.—*Division of Protein Chemistry.*

Pressing Wool under Vacuum

A new method has been devised for packing wool into bales by using the type of vacuum pump which is used in a milking machine instead of the usual mechanical press. An air-tight plastic bag is filled with wool and the neck of the bag is connected to the vacuum pump. When the air is withdrawn the pressure of the atmosphere outside the bag compresses the wool more tightly than if it had been compacted in a conventional press. The plastic bag is then placed inside a bale.

If, as seems likely, the process can be applied in industry it may be superior to present methods because it would avoid jute contamination of the wool, it would eliminate the arduous physical labour in wool pressing, and handling practices in the woolshed could be streamlined. In addition, a vacuum pump in the woolshed could easily be made to work a simple hoist for handling bales.

Several patent applications have now been filed and C.S.I.R.O. has sought the cooperation of industrial organizations in developing the idea. However, it may be some time before the invention reaches the stage of practical application.—*Division of Protein Chemistry.*

Pasteurization of Carcass Meat

British people much prefer chilled to frozen beef. Successful storage of chilled beef during the long period of shipment from Australia has been made possible by using gas storage in refrigerated cargo spaces and by paying strict attention to hygiene when beef is prepared for shipment.

It has been shown in the past that hides and hooves of cattle are an important source of microbial infection of carcasses. Since it is impracticable to sterilize the hides of live cattle, a very simple hygienic technique has been developed for pasteurizing the dressed carcasses before they are chilled. A mild treatment with hot water, which has no permanent effect on carcass appearance, was found to destroy 90–99% of the microorganisms capable of growing at low temperature. The treatment is selective in so far as it kills the faster-growing microorganisms, leaving only the slower-growing ones.—*Division of Food Preservation.*

Powdered Butter

A new dairy product called powdered butter has been developed that has the same fat content as butter (80%) and contains in addition 15% of milk protein and some mineral salts. It is produced by spray drying an emulsion of butter fat in a solution of sodium caseinate and non-fat milk solids.

Because of the ease with which it mixes with other ingredients, powdered butter is more convenient than normal butter for use in cakes (both for commercial mixes

and in the home), white sauce, frying batter, and ice cream. It does not melt in hot weather, which should make it popular in tropical climates, and it contains a wholesome inexpensive protein (butter contains virtually no protein). Powdered butter cannot be turned into normal butter by adding water. This can be an advantage where surplus butter fat may have to be disposed of at reduced prices—the market for butter as a spread is not affected. Costs of production are about the same as for butter. Whether or not it becomes an important food will depend on economic factors and effective promotion.—*Dairy Research Section.*

Flavour Chemistry

Flavours in foods nearly always arise from constituents that are present in minute quantities, and the techniques of flavour chemistry require highly specialized methods for isolating and identifying these compounds. Sensitive as the methods are, the sense of taste can sometimes reach beyond them. A compound responsible for a most unpleasant metallic flavour in oxidized fats was recently identified after several years study. It has a flavour threshold of 1 part in 10 thousand million and its occurrence in such minute quantities made its identification very difficult. The compound is vinyl n-amyl ketone; vinyl compounds have not previously been isolated from oxidized fats and oils.—*Dairy Research Section.*

Wheat Storage

It is well known that the moisture content of wheat has an important effect on its deterioration in bulk storage. However, recent work has shown that temperature is a vital factor and should be allowed for. A long-term study is in progress relating the physical factors important in bulk wheat storage, particularly heat and moisture transfers within the bulk. The results of this study will enable the behaviour of storages to be predicted and the merits of different treatments and storage methods assessed.

The rates of moisture movement under moisture and temperature gradients have been measured in laboratory experiments. In the latter case, movement of moisture in a horizontal bed of wheat 8 in. thick was detected by an electrical method. Particular care was taken to minimize moisture transfer by air movement.

Wheat in six Victorian country silos was kept under observation during 1961. Determinations of temperature, moisture content, and insect infestation were made to depths of 35 ft, with equipment specially developed for the purpose. It has been possible to show that there is a relationship between the temperature and moisture content of the grain in the bulk and the rate of deterioration of the surface wheat. High temperature and high moisture content give rise to rapid deterioration; reduction of either reduces the rate. Since much of our wheat enters bulk storages at a high temperature it is important to cool it as soon as possible after acceptance. It appears that cooling of the wheat by aeration is a very practical way of reducing storage losses, and equipment to study the resistance of wheat to low rates of air flow is at present under construction.—*Engineering Section.*

Theory of Heat and Mass Transfer

The known methods for calculating rates of heat transfer by convection are much less reliable than those which apply to the less complex processes of conduction or radiation. Work in progress is aimed at developing better methods.

In convection, not only can heat transfer occur between a fluid stream and the solid surface over which it flows, but some of the fluid may itself be transferred, as happens for example during evaporation or condensation. This is known technically as mass transfer. Most of the resistance to heat or mass transfer occurs in the boundary layer, which is that part of the fluid immediately adjacent to the surface. The mathematical equations which govern the behaviour of the fluid in the boundary layer are well known but could not be readily solved before rapid computers became available.

Current work involves computing accurate solutions to these equations covering as wide a range as possible in the following three variables: (1) the type of fluid, whether a gas or a liquid, (2) the pressure gradient in the fluid, and (3) the rate of inward or outward mass transfer. From these solutions, tables and charts are being drawn up which will enable engineers to calculate rates of heat or mass transfer for a wide variety of practical problems.—*Division of Food Preservation.*

Improved Instrument for Measuring Relative Humidity

Because conventional instruments for measuring relative humidity are often not satisfactory for cold storage investigations, a new humidity-sensitive element which possesses important advantages for a wide range of industrial and scientific applications has been developed. It consists essentially of a thin layer of selenium dioxide whose electrical resistance responds to changes in the humidity of the surrounding atmosphere.

The element, which can be produced in batches with uniform characteristics, is small enough for use in very confined spaces such as between packed fruit in cool storage and, contrary to the behaviour of many other instruments, the amount of moisture exchanged between the element and the surrounding atmosphere is too small to affect the conditions being measured. The element has a rapid response and high sensitivity. It gives good accuracy even above 90% relative humidity and near the freezing point, which is generally difficult to achieve. The measurements, being electrical, are easy to make and record.

The instrument at present requires frequent calibration but studies are in progress to improve its long-term stability.—*Division of Physics.*

Water Desalination

One important limitation to the economic production of fresh water from saline water by evaporation is the formation of scale on the heated surfaces. This presents a barrier to heat and the efficiency drops rapidly as the thickness of the scale increases. Research on this problem has centred on a novel type of evaporator in which the

saline water is entrained as a spray in steam and the heat is supplied through the wall of a tube into the spray.

Two methods have been proposed for minimizing the detrimental effects of scale. One involves interrupting the flow of saline water periodically for a few seconds, thus causing the scale to come away from the surfaces which can, in this way, be kept effectively clean over long periods.

The second method involves pre-treatment of the heated surfaces with relatively small quantities of certain chemical reagents which decrease the rate of formation of scale. Applications have been made for patents protecting these procedures.—*Chemical Engineering Section.*

Atomic Time

The most stable timekeepers available at present are the so-called "atomic clocks" which are oscillators based on atomic properties. These are used to provide an extremely uniform time scale for physical measurements. For standards laboratories which do not possess an atomic clock, some means must be found to refer their standards—usually quartz crystal oscillators—to an atomic standard.

It has been found possible to do this over long distances by utilizing the stable propagation characteristics of very low frequency radio waves. A number of special radio stations in England and North America have their carrier frequencies controlled by atomic standards. Special equipment has been developed to receive two of these stations, G.B.R. from Rugby, England, and N.B.A. from Balboa, Canal Zone. The equipment records continuously the difference in time between the local clock and the atomic clock, represented by the radio transmission. Most of the variations in the propagation time of the transmission are eliminated by averaging over 24 hr and an accuracy of intercomparison of about 10 millionths of a second per day is obtained. A special digital gear-box has been developed to enable known corrections to be applied to the local standard to adjust it to atomic time.—*Division of Applied Physics.*

Ozone

Ozone, a gas which is found in the lower and middle stratosphere, plays an important part in controlling the heat balance of the Earth and in screening us from ultraviolet radiation. The ozone content of the stratosphere varies at different latitudes and from season to season, and the nature of these variations is of major geophysical interest. A mass of air in the stratosphere changes its ozone content very slowly, so ozone can serve as a "tracer" for air movements in the upper atmosphere. The quantity of ozone over any part of the Earth can be measured from the ground with a spectrophotometer.

The first survey of the distribution of ozone in the southern hemisphere has now been completed, with data from Melbourne, Brisbane, Macquarie Island, Wellington, and the Antarctic. Measurements are now also being made at Salisbury, South Australia. This study has shown that the ozone distribution in the southern

hemisphere differs significantly from the distribution in the northern hemisphere. In particular, the discovery of a sharp maximum at the latitude of Macquarie Island has important implications and calls for the intensification of observations there.

A study of the distribution of ozone at different heights above sea-level is to be commenced, initially in Melbourne. High altitude balloons will be used to carry chemical samplers into the stratosphere.—*Division of Meteorological Physics.*

Doubly Ionized Molecules

The observation of doubly ionized diatomic molecules such as N_2^{2+} in mass spectroscopic investigations poses interesting problems in the basic theory of molecular structure and the energy states of molecules. These molecules are unique in that their energy is considerably above that of their dissociation products, the separated atomic ions. Nevertheless, many of these molecules are completely stable when isolated from collisions as in a high vacuum.

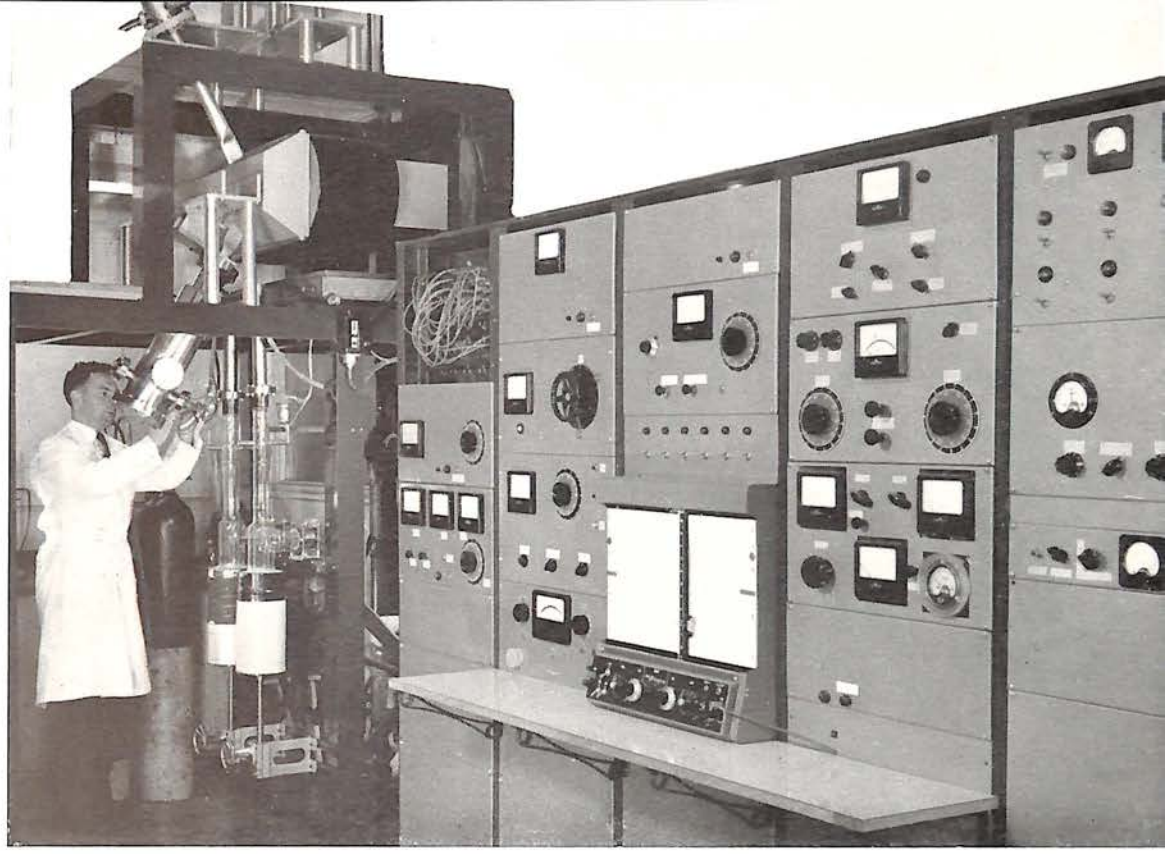
A theory has been developed which relates the properties of a doubly ionized molecule to the properties of a neutral molecule which contains the same number of electrons. For example, corresponding to N_2^{2+} there is the neutral molecule C_2. Since many properties of the neutral molecules are accurately known experimentally, mainly through the analysis of their band spectra, the new theory may be used to calculate many properties of the doubly ionized molecules.

This theory has been successful both qualitatively and quantitatively. It provides a simple explanation of the marked stability which the doubly ionized molecules exhibit despite their negative dissociation energies, and it leads to molecular energy levels which agree well with those observed in the mass spectrometer.

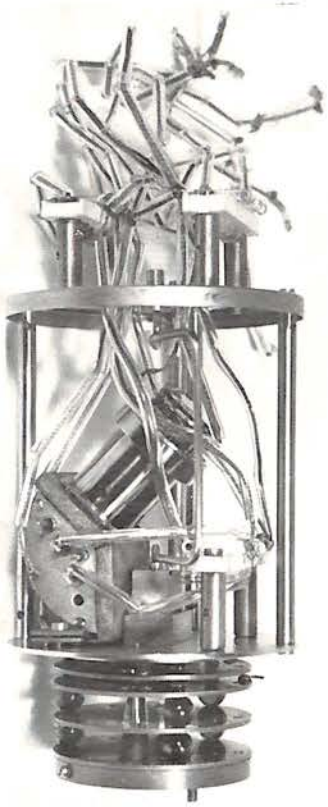
The theory has also helped to explain a new band in the optical spectrum of nitrogen gas. This band has been assigned to a transition between two states of the doubly ionized molecule N_2^{2+}. Such an assignment leads to precise values not only of the energy difference between the two states but also of the length and vibration frequency of the molecule in each state. These are all in good agreement with the theory and the values of these quantities have been predicted for a number of transitions in the ions N_2^{2+}, NO^{2+}, and O_2^{2+}. These species are of especial interest since they may occur in certain regions of the Earth's atmosphere.—*Division of Chemical Physics.*

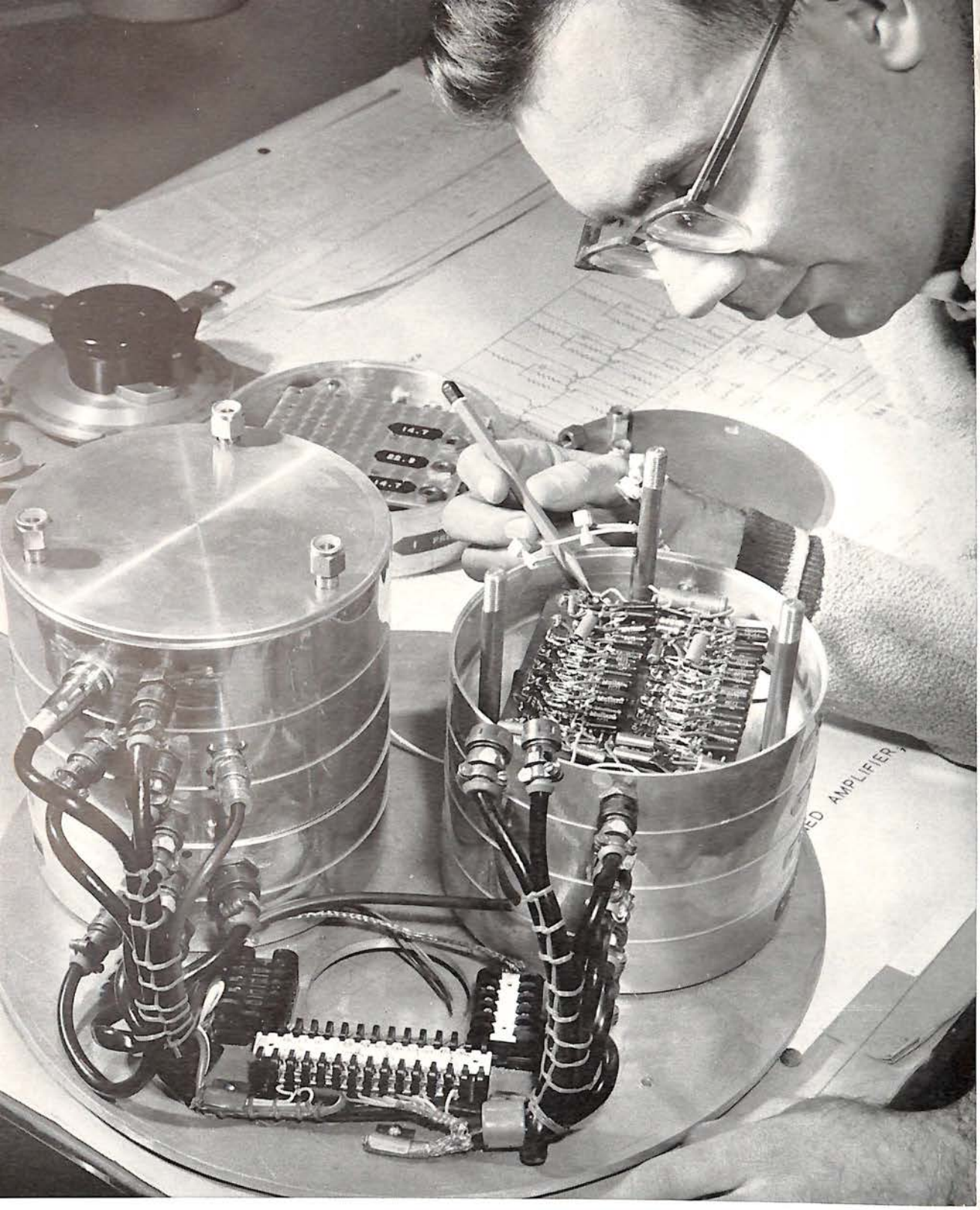
Identification of Traces of Chemical Substances

Over the last few years a very considerable advance has been made in the identification of minute quantities of organic materials by combining the techniques of gas-phase chromatography and mass spectrometry. By means of the gas chromatograph a sample can readily be obtained which has the extreme purity required for unequivocal identification in the mass spectrometer; the mass spectrometer is almost the only instrument that can provide information about such a small sample. This combined technique has been particularly fruitful in the fields of natural product chemistry (where samples are frequently very small) and of "taints" and "smells" where the



SIGNIFICANT advances in science often depend on the development of instruments of novel design and improved performance. The Division of Chemical Physics, in common with other parts of C.S.I.R.O., has developed a number of instruments with this in mind. The high-resolution mass spectrometer illustrated above and one of its parts, the ion source illustrated at the right, depend for their performance on the precision with which the various components are located with respect to one another. In the ion source, for example, this has been achieved by the use of accurately dimensioned ruby and sapphire balls for precise location of slits and electrodes and for their electrical isolation. This method of construction, which has been used extensively in the Division's instrument work over the last five or six years, allows complex devices to be taken apart for cleaning or modification and reassembled reproducibly. The improved performance achieved in these instruments has led to the unambiguous identification of traces of organic chemicals and to the better understanding of the way in which the atoms are bound together in molecules.





Assembling electronic recording equipment, to be placed in high-altitude rocket, for the study of radio noise from the upper atmosphere.

human nose reacts strongly to quantities well below the detectable limits of most instruments. A mass spectrometer of high sensitivity is required, and an instrument constructed in the Division of Chemical Physics can be readily adapted for this purpose. In this adaptation there is some loss of resolution (ability to distinguish between substances having very similar properties) in obtaining high sensitivity (for the accurate determination of their actual amounts), but the instrument can fairly easily be switched from high resolution to high sensitivity and the two approaches are complementary in identifying unknown compounds.

Several joint projects of this nature have been undertaken in cooperation with other groups in C.S.I.R.O. In one project concerned with taints in milk and butter-fat, an elusive taint whose identity has been a mystery for several years has now been positively identified. In another a series of gas chromatographic fractions of the derivatives of "suint" acids from wool wax has been examined. This work confirmed the structures previously postulated for these fractions and in one case identified an acid whose presence was quite unexpected.—*Division of Chemical Physics.*

Radio Noise from the Upper Atmosphere

During the last two or three years studies have been made of a very low frequency radio noise which is of uncertain origin. There are two likely sources of this noise. It may originate in the ionosphere, a layer of electrically charged particles extending from 60 miles above the Earth's surface up to 500 miles. It is also possible that the noise may originate in the exosphere, tens of thousands of miles above the Earth's surface. It is doubtful whether ground-based experiments alone could ever determine just where this radio noise is coming from.

Current American developments in rocketry and the use of satellites have provided an opportunity to take this work a stage further. Observations from a satellite could be invaluable in pin-pointing the sources of the radio noise. The U.S. National Aeronautics and Space Administration, as part of its program of international cooperation, has given permission to C.S.I.R.O. to place recording equipment (see illustration on opposite page) in one of its high altitude rockets, as a preliminary test for a satellite experiment. It is expected that the first rocket test will be made towards the end of 1962.

It is expected that the experimental program will establish the origins of the radio noise, and promote the understanding of how it is produced.—*Upper Atmosphere Section.*

Optimum Use of Experimental Data in Ionization Studies

When molecules are bombarded by beams of electrons or photons in a mass spectrometer, reactions of ionization and dissociation may occur. The study of these processes provides information on molecular energies. This is of considerable theoretical and practical importance.

For these measurements to be accurate, the beams of particles used to produce the ionization must be monoenergetic, i.e. all the particles must have the same energy. So far, it has been impossible to obtain such monoenergetic beams. All practical sources produce beams with a spread in energy, and this causes a corresponding "blurring out" of the measured energy states. Many attempts have been made, both in the laboratories of C.S.I.R.O. and elsewhere, to reduce this energy spread. All of these attempts involve taking a narrow "slice" out of the initial distribution, and using it in the ionization experiments. The narrower the slice however, the less the intensity of the beam and the lower the accuracy of the ultimate results.

A radically new approach has now been made to this problem. By taking advantage of certain redundancies which are present in the measured data, it has proved possible to devise mathematical methods for removing the effect of the spread in energy and simultaneously greatly reducing the random scatter which is present in all experimental observations. The calculations are lengthy, and require the use of a computer. The results obtained, both on artificial examples and on some experimental data, are extremely promising, the effective energy spread being reduced fivefold. The method would appear to be applicable in any field where the resolving power of an instrument has to be increased.—*Division of Chemical Physics.*

Damage to Metal Surfaces by Particle Bombardment

The materials from which nuclear reactors are built are subject to damage caused by irradiation. The mechanical properties of the materials are altered by the irradiation, and it is important to understand how this occurs.

Experiments have been performed to find out what happens when a metal is hit by particles of low energy. When gold is bombarded with ions of inert gases, such as helium, neon, argon, and xenon, the resulting damage can be seen with the aid of an electron microscope. Particles will cause damage only if their energy exceeds a certain value. This value has been determined for particles of each of the inert gases.

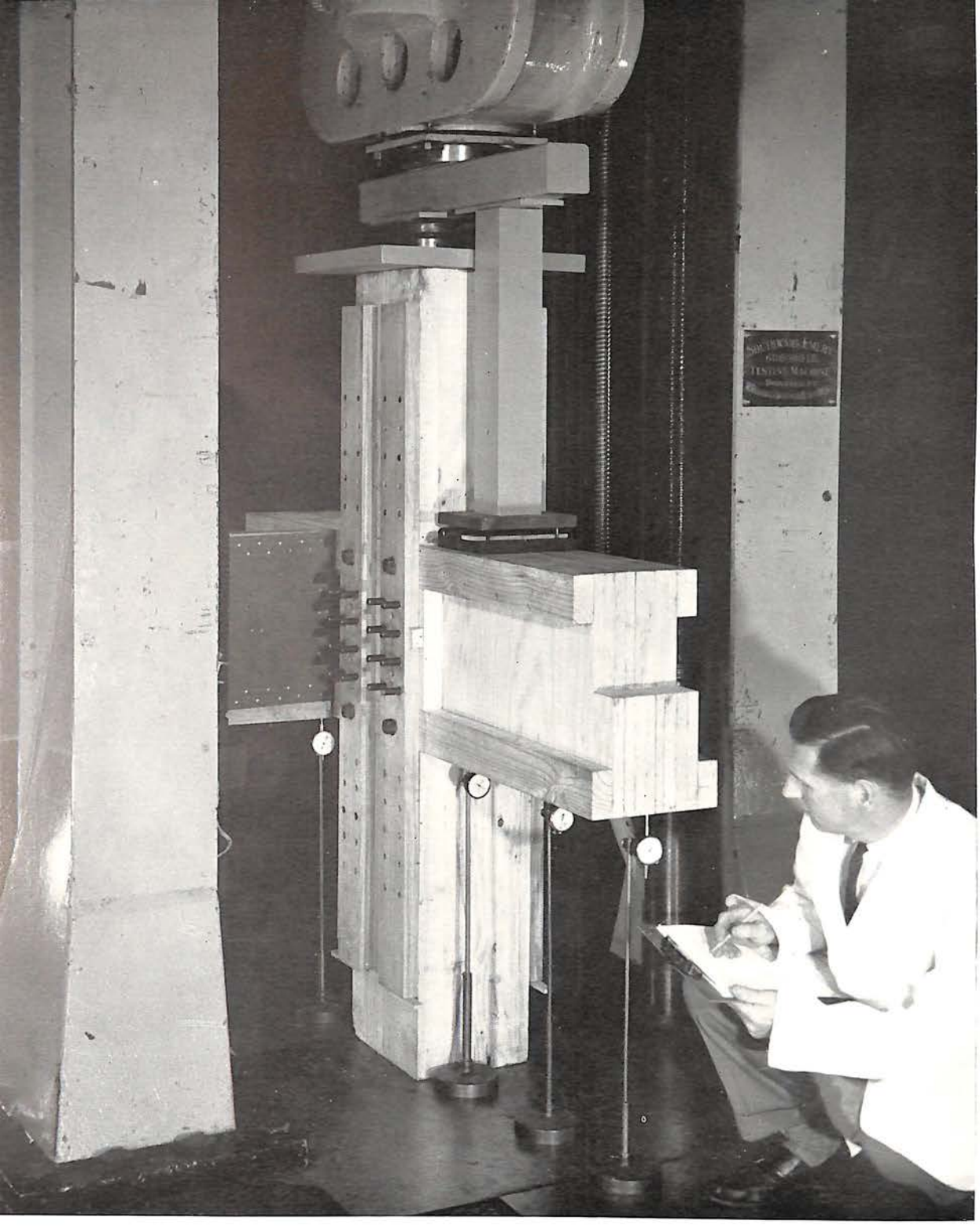
When the particles have an energy greater than this value, they create point defects near the surface of the metal, which accumulate to produce damage such as the dislocation lines which can be seen in the illustration on the opposite page. These dislocation lines produce changes in the mechanical properties of the materials.—*Division of Tribophysics.*

Fibrous Plaster

Fibrous plaster, which is the most widely used internal wall lining material in Australia, is flush jointed by trowelling plaster into the joints between the sheets. This operation produces a plaster at the joint different from the plaster in the sheets themselves. It is much denser, because of the mechanical compaction during trowelling, and it absorbs less water than the cast plaster of the sheets.

This difference often produces a defect in decoration, since the plaster joints appear to show through the paint film, and attempts have been made to overcome this problem by modifying the water absorption of the plaster sheet to make it similar to that of

Electron micrograph showing dislocation lines on the surface of a metal, caused by particle bombardment.



Test of a novel timber column and beam assembly for low cost, high performance buildings.

the joint. This has been achieved by the addition of water-soluble silicones to the plaster during the manufacture of the plaster sheets. This procedure has been found to have the additional advantage of facilitating the operation of jointing and the application of water-based paints.

An application has been made for a patent covering this process, which is now being used commercially by members of the Fibrous Plaster Federation of Australia and New Zealand.—*Division of Building Research.*

Timber as a Structural Material

Although timber is not generally considered a basic structural material for multi-storey buildings, recent studies have indicated that it may have substantial advantages in performance and cost, especially where foundation conditions are poor.

As a result of experimental work, a design has been developed for a laboratory building which could be of two or more storeys. In this design the primary wooden beams are 18 in. deep, spanning 22 ft, and continuous through the solid timber columns over a length of 32 ft. It is proposed to use radiata pine plywood webs glued to solid radiata pine flanges to form double I- or box-beams. The proposed secondary floor beams are 18 in. deep, span 24 ft, and are spaced 2 ft apart. These consist of green hardwood flanges nailed to a discontinuous web of $\frac{3}{16}$ in. thick standard hardboard. For strength, dependence is placed on nailing the elements together; however, the possibility of enhancing the stiffness by gluing the hardboard to the green timber is being investigated.

In a multi-storey building the joints between beams and columns must transmit high bending moments as well as shear forces. Although such joints are generally difficult to make in timber, a novel but simple design has been developed. Each joint is designed to transfer most of the moment by non-uniform bearing between column and beam, a residue amounting to about 30% of the total being transferred by timber side plates pinned to the beam and column with short steel dowels.

The practicability of a beam and column assembly of this type has been determined by laboratory testing.—*Division of Forest Products.*

Air Seasoning of Timber

Sawn timber may be seasoned either by air drying, by kiln drying, or by partial air drying followed by kiln drying. Whichever method is used, it is essential that the timber be stacked so that air can circulate freely between the boards. Recent surveys by the Division of Forest Products, however, have shown that inadequate drying practices are responsible for a considerable material and economic loss to industry. This is partly because industry is reluctant to accept recommendations until they have been substantiated on an economic basis, and partly because there is still lack of complete knowledge of some technical aspects of air drying. Some causes of wasteful or uneconomic air drying are obvious, but others are not so readily discernible. To study the latter, two interdependent investigations have been undertaken.

One involves field studies on stack variables, such as the covering of stacks, a practice not common in Australia. Work completed has demonstrated that in areas of moderate-to-high rainfall, coverings result in great economic benefits, including major savings in plant establishment costs, working capital, operating costs, and ultimately kiln drying costs, all of which are dependent on the efficiency with which air drying is carried out.

The other investigation complementary to this concerns the basic principles of the design of air-seasoning yards, particularly the influence of factors affecting yard efficiency. Laboratory model experiments have been commenced with wind tunnel and water channel techniques. Analyses of flow, pressure, and velocity patterns through and around experimental model units are being used to identify and predict the best field conditions. This work has already demonstrated the importance of stack orientation in relation to wind direction.—*Division of Forest Products.*

Electrodes for Aluminium Manufacture

The consumption of imported materials required in the manufacture of electrodes for use in aluminium production is likely to increase considerably in view of the great expansion being planned for the Australian aluminium industry.

In aluminium manufacture, a current is passed through an electrolytic cell containing a mixture of aluminium oxide and cryolite. Aluminium is produced at one electrode and oxygen at the other electrode, which is consumed during the electrolysis. This electrode is normally made of a mixture of pitch and a form of carbon known as petroleum coke. Both are imported, and two-thirds of a ton of electrode material is used for every ton of aluminium produced.

A method has now been discovered for making a suitable binding pitch from gas works tar; material from the carburetted water gas plant of the Australian Gas Light Company would be suitable. If this process can be made to work satisfactorily on an industrial scale, there will be a very considerable saving in imports.—*Division of Coal Research.*

Extraction of Gold

For more than 70 years gold has been extracted from its ores by treatment with cyanide but the plant operator still encounters difficulties which can result in high consumption of cyanide and low yields of gold. In this process air is bubbled through the mixture of ore and cyanide and for some time it has been suspected that the rate of aeration might be partly responsible for variations in the efficiency of extraction. A study of the effect of dissolved oxygen on plant solutions, sponsored by the Chamber of Mines of Western Australia, has now been made.

It has been found that, although some dissolved oxygen is essential for the solution of the metal, at certain levels of oxygen and cyanide concentration the gold is rendered "passive" and dissolves more slowly than would be expected. The results of the laboratory investigations have been successfully applied to the recovery of gold from mill products.

The application of this information to practice has required a knowledge of the oxygen concentration in the mill solution. The plant method of estimating oxygen is not very sensitive and it calls for a high degree of skill on the part of the operator. To overcome this, a new method was developed by which low concentrations of oxygen can be measured and registered automatically with good accuracy and reasonable speed.

Further work has shown that the "passivity" of gold can be controlled by the addition of trace amounts of certain chemicals to the cyanide solutions. This promises to improve the rate of gold recovery and also lead to savings in the consumption of reagents.—*Division of Mineral Chemistry.*

Climate of the Sun

The climate of the Sun is at least as varied as that of the Earth. Just as a comprehensive study of the Earth's climate requires the cooperation of meteorological stations in different parts of the world, so does the study of the Sun require the cooperation of observatories at different longitudes around the world.

For some years studies have been made of the chromosphere, a region which lies just above the Sun's surface. Photographs of the Sun, taken through a suitable telescope, show the waxing and waning of "structures" in this region. Some of these chromospheric structures show violent and rapid change, and can be followed from a single observatory; some develop and change slowly and cannot be observed fully from any one observatory.

Through the offices of the International Astronomical Union, the Chief of the Division of Physics was able to organize in May a two-week international cooperative observing program. Observatories in Australia, the U.S.A., Japan, Italy, France, Germany, and U.S.S.R. participated. The Sun is always visible from one or other of these countries, and pictures of its surface were taken at approximately three-hourly intervals throughout the fortnight. The results of this work will help to resolve some of the scientific controversy about the physical nature of the chromospheric structures.—*Division of Physics.*

Retention of Strength of Paper Pulp after Drying

In the conversion of wood into paper it is often necessary, for purposes of transport or storage, to dry the wood pulp at some intermediate stage of manufacture, later rewetting and making it into paper. Pulp which has been dried in this way gives paper of lower strength than paper made from pulp which has not been dried. This loss of strength is much more pronounced if the pulp has been beaten before drying.

The strength of paper depends largely on the formation of bonds between the individual cellulose fibres, and the deleterious effects of drying are considered to be the result of molecular changes within the fibres which reduce their capacity to bond together. The nature of these molecular changes has been studied, and the results have suggested practical methods of reducing or eliminating the loss of potential paper strength.

In order to overcome this deterioration of the fibre as a papermaking material, it is necessary before drying to introduce materials which will associate with the cellulose fibres in such a way that, after drying and rewetting, the bonding capacity of the fibres is preserved. Materials such as sugar, which consist of relatively small molecules and are of such a chemical nature that they can form the type of bond required, have been found to be effective, but at rather high concentrations. Other materials consisting of much larger molecules, such as starch, are also suitable under some conditions.—*Division of Forest Products.*

Structural Lightweight Concrete

Two ways of reducing the structural costs of a building are the simplification of form and the reduction of the dead weight of the structure by the use of lightweight materials. The latter may be achieved by the use of expanded shale aggregate to produce concrete about one-third lighter than ordinary concrete but of the same strength. The contribution made by the Division of Building Research to the successful establishment of the shale aggregate industry in Australia was described in the last Annual Report.

This year, experiments have been conducted using this lightweight aggregate in flat plate structures, for which only simple formwork is needed. Beams can be eliminated and floor slabs of uniform thickness are connected directly to the columns. Three such experimental flat plates have been constructed for studies of their behaviour under various short-term and long-term loads. The photographs on the opposite page show one plate undergoing a test to destruction. In this test pressure was applied pneumatically to the whole surface via the plastic bag visible in the upper photograph, which shows the distortion of the plate at a load of over four times the design load of 40 lb per sq. ft. Failure eventually occurred at a pressure of 300 lb per sq. ft., by shearing at the supporting columns (lower photograph). The information that has been obtained is being applied to the theory of design of this type of construction, which is becoming of increasing importance in the Australian building industry.—*Division of Building Research.*

Shaping Metals with Explosives

A study is being made of two types of high-speed deformation of metals, a field of research that has become important in relation to the rapidly changing techniques used in industry.

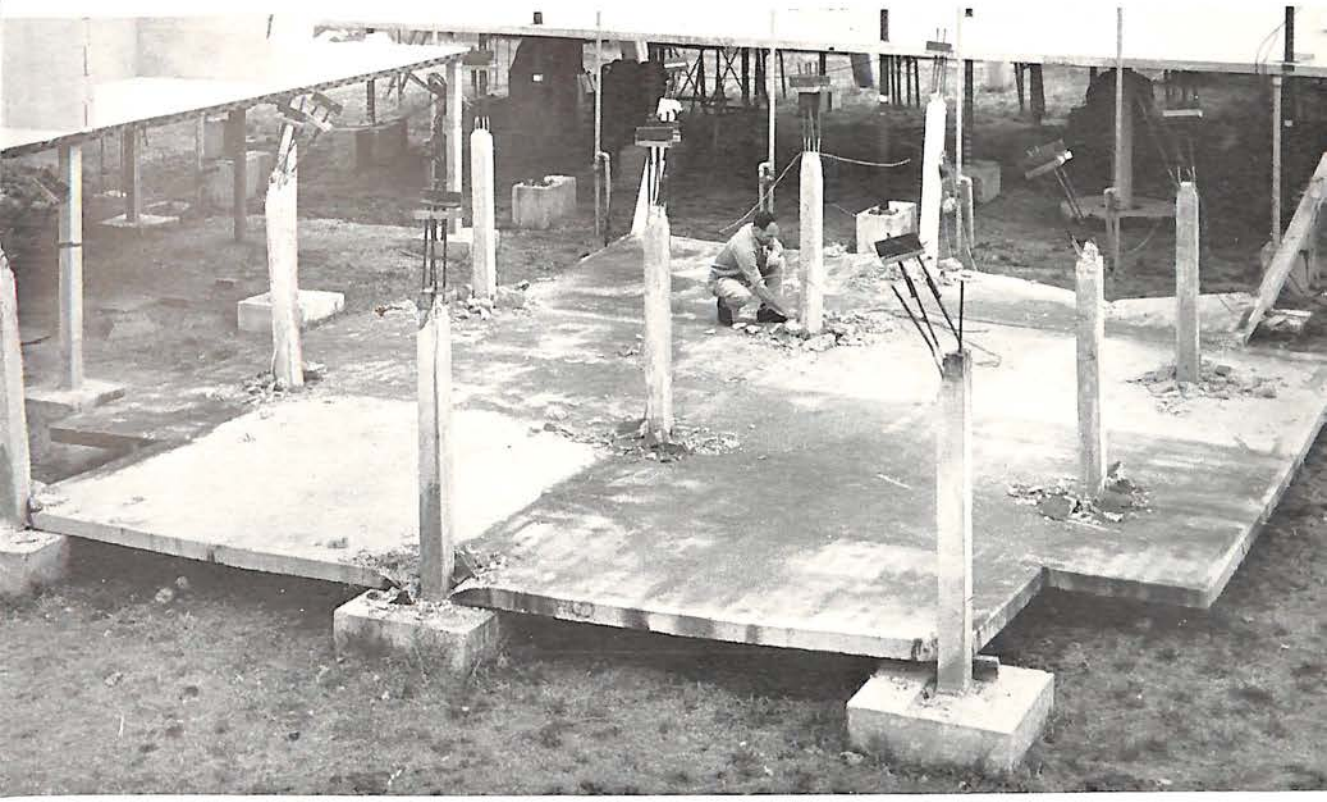
In the first of these the interest lies in the forming of metals into useful shapes with the aid of explosives. The advantages of this method are the ease of forming some complex shapes and the avoidance of the cost of large metal-working equipment. Research has shown that the mechanism of deformation involved in explosive forming may be different from that in conventional forming methods. This research may allow one to predict which metals are suitable for explosive forming.

The second field of interest is in the use of "powder-powered" fasteners driven into metal plates. Although such fasteners have been used for some time, the factors

Lightweight concrete structure being tested.

Above: *Experimental flat plate made from lightweight aggregate concrete showing distortion under four times the design load.*

Below: *Shearing at the supporting columns eventually leads to failure.*



The cracking of glass in the curtain wall of an office building in Melbourne. The bright spots are painted hardwood panels temporarily replacing panes of toughened glass that have broken because of inclusions of nickel sulphide. Inset photograph shows a full size curtain wall frame used during laboratory studies to determine the cause of failure.

influencing the penetration of the fastener and its subsequent adhesion to the plate are not fully understood. In this case not only is high speed deformation of the plate involved, but also high speed friction between the fastener and the plate. Research has shown that this friction may cause melting of the surface of the fastener. The presence of a liquid film reduces the friction and aids further penetration. As the fastener comes to rest, welding takes place and produces a strong fastening. By altering the surface structure of the fastener the area and strength of the welded junction can be increased, so that the load to remove the fastener may be increased by as much as three times.—*Physical Metallurgy Section.*

Cracking of Glass

Coloured glass has been extensively used in many modern city buildings. In some of these, where annealed glass has been used, panes have cracked because of uneven heating between the centre and the shaded edges. Because of this the use of toughened glass is considered desirable. Unfortunately, in an office building in Melbourne, even toughened glass has cracked.

This failure was investigated and was found to be due to a most unusual circumstance—the presence in the original glass of spherical impurities, or "stones", of nickel sulphide less than one hundredth of an inch in diameter. Where the cracked glass remained in place, one of these stones was found at the point where each failure had started. The stones are barely visible to the naked eye and their origin is still not known.

The part played by them in causing the cracking of the glass is due to a change in the crystal structure of the nickel sulphide. This has two crystalline forms, one stable at high temperatures, the other at low temperatures. Because of the rapidity of cooling during the toughening process the high temperature form still persists in the glass when it is installed in the building, and it changes only slowly to the low temperature form. This change is accompanied by an expansion of the stone which produces a stress of about 12 tons to the square inch. This is sufficient to crack the glass and bring about the complete shattering of a pane. However, this is an isolated instance of failure and toughened glass free from "active" stones should give satisfactory service.—*Division of Building Research.*

Origin of Ice Nuclei

One of the outstanding problems in rain physics is the source of nuclei which cause ice to form in supercooled clouds. One theory is that they are merely ground dusts swept up from the continents. If this were true, then the particles should be more numerous over a dusty continent than in Antarctic regions, since clouds and rain are efficient in removing small particles from the air.

With the help of the National Science Foundation, measurements were made at McMurdo Sound (latitude 78°S.), over a period of 2 months. The surprising result was that on the average, for any given temperature, there were 2 to 10 times as many

ice nuclei active at McMurdo Sound as at any rural site in Australia. Yet the concentrations of particles visible under a high-powered microscope were lower by a factor of 1000 or more.

This result gives some support to the contentious hypothesis that extraterrestrial material may form ice nuclei and hence affect the weather.—*Division of Radiophysics.*

Seeing through the Atmosphere

The principal obstacle to high-resolution astronomical observation is the Earth's atmosphere, which refracts light waves passing through it. Variations in the air temperature cause the refractive index of the atmosphere to fluctuate, and as a result images in a telescope are distorted. Some of the trouble occurs high in the atmosphere, some very close to the ground, and some even inside the telescope itself.

Atmospheric distortion can spoil measurements of the total light from a star, measurements of its position, and its image. An instrument has been invented that measures simultaneously these three kinds of distortion. This instrument, called a "seeing monitor", will be used for testing the suitability of various solar observatory sites and for deciding on the designs of telescopes and their domes so as to minimize man-made disturbances.

The "seeing monitor" will, of course, have other applications. It could be a useful aid to the design of equipment for rocket tracking and, indeed, for any long-range optical observations.—*Division of Physics.*

Radio Astronomical Observations

The resolution obtainable with the 210 ft radio telescope at Parkes, N.S.W., is so much greater than that of previous instruments that many of the findings being made are completely novel. Exploratory investigations began in January 1962 with receivers on wavelengths of 75, 20, and 10 cm, and also a hydrogen-line receiver at 21 cm wavelength. The experimental possibilities being opened up by the availability of such a large steerable aerial and receivers of high sensitivity are many and varied. A wide range of astronomical studies is already in progress.

The structure of our Milky Way Galaxy is being traced out in greater detail than ever before, and a survey of the nearest external galaxies to us, the Magellanic Clouds, is revealing the existence of many new features. Large numbers of "radio stars" have been observed, and there is little doubt that one may soon expect a substantial increase in the number of these radio sources that can be identified with optically observed objects.

One of the first research projects has been a detailed study of radiation from one of the strongest sources of radio noise in the heavens, Centaurus A, a galaxy some 12 million light-years away in the region of the Southern Cross. It has been known for some time that Centaurus A contains not one, but a number of separate sources of radio noise. The radio astronomical observations have shown that the radio

waves exhibit a high degree of polarization. The nature of this polarization indicates to radio astronomers that the radio waves are originating from a mass of electrons spinning spirally around a magnetic field. Radio astronomers had already suggested on theoretical grounds that this might be the cause of radio emission in galaxies. The observations made from Parkes strongly support this theory, and indicate that a magnetic field in a galaxy must be aligned in the same direction through a very large volume of space. This project has demonstrated the great scientific value of the Parkes radio telescope—no other instrument in the world could have been used so successfully for these observations.—*Division of Radiophysics.*

Intensity Measurement in Electron Diffraction

Methods developed in the Division of Chemical Physics for analysing the crystal structures of submicroscopic particles require that the intensities of very weak electron beams should be measured with considerable accuracy. Even greater accuracy is called for in tests of the applicability of the various theories of electron diffraction on which much of this work is based. In the past the best method of intensity measurement has been photographic, but even with extreme care the accuracy obtained was no better than 5–10%. Equipment has now been built up embodying a novel approach to the measurement of the intensities of electron beams by direct, electronic methods. In the initial stage it has been shown that for measurement in one dimension, across the diameter of diffraction rings, ring intensities can be compared with an accuracy approaching 1%. An extension of the method is being made to measurement in two dimensions so that the more complicated patterns from single-crystal specimens can be studied.—*Division of Chemical Physics.*

I.S.A.A.C. — a Computer for Structure Analysis

In the processes of crystal structure analysis based on the intensities of X-ray, electron, or neutron diffraction patterns it is in general not possible to deduce the relative positions of atoms directly from the measured data. What can be deduced from intensity measurements is a map showing the interatomic vectors and known as a Patterson map. The problem then remains of interpreting the Patterson map in terms of atomic positions.

One of the best methods for doing this is the process known as "image-seeking", a process which is extremely tedious when done by hand computation, and which is lengthy and expensive on even the most powerful digital computers. Several years ago members of the Division of Chemical Physics devised an analogue computer capable of carrying out this process accurately and quickly. For example, with molecules containing tens of atoms it will enable the initial stages of analysis to be accomplished by several orders of magnitude faster than existing digital computers. This computer, the Image-Seeking Automatic Analogue Computer, I.S.A.A.C., is now undergoing preliminary tests and, when in full operation, will represent the only facility of this kind in the world. It will provide structure analysts in Australia with a service of unequalled capabilities.—*Division of Chemical Physics.*

3

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The following papers have been published during the year. Letters Patent granted to C.S.I.R.O. during the year are also included.

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4

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CHEMICAL ENGINEERING SECTION

See Chemical Research Laboratories

DIVISION OF CHEMICAL PHYSICS

See Chemical Research Laboratories

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At Tasmanian Regional Laboratory, Hobart:

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Plant Introduction

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See Chemical Research Laboratories

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See Wool Research Laboratories

DIVISION OF TEXTILE PHYSICS

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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, M.Sc.
Experimental Officer—J. K. Raison, B.Sc.(Hons.) (*on leave*)
Experimental Officer—C. W. Wrigley, M.Sc.

WILDLIFE SURVEY SECTION

Headquarters: Barton Highway, Canberra

Administration

Officer-in-Charge—H. J. Frith, B.Sc.Agr.
Divisional Administrative Officer—P. Magi, B.A.
Scientific Librarian—Mrs. E. M. Wylie, B.Sc.

Marsupial Biology

Principal Research Officer—G. B. Sharman, D.Sc.
Senior Research Officer—J. H. Calaby, Dip.App. Chem.
Research Officer—S. Barker, B.Sc.(Hons.), Ph.D.
Research Officer—R. Mykytowycz, D.V.M.
Research Officer—W. E. Poole, B.Sc.(Hons.)

Rabbit Biology

Principal Research Officer—K. Myers, B.Sc. (Hons.)
Senior Research Officer—A. L. Dyce, B.Sc.Agr. (Hons.)
Research Officer—R. L. Hughes, B.Sc.(Hons.)
Experimental Officer—Miss E. M. Kingsmill, B.Sc.(Hons.)

Rabbit Control

Senior Research Officer—B. V. Fennessy, B.Agr. Sc.

Field Ecology

Officer-in-Charge—H. J. Frith, B.Sc.Agr.
Principal Research Officer—D. L. Serventy, B.Sc. (Hons.), Ph.D. (*at Perth*)
Senior Research Officer—M. G. Ridpath, B.Sc. (Hons.) (*at Hobart*)
Research Officer—I. C. R. Rowley, B.Agr.Sc.
Senior Experimental Officer—F. N. Robinson, B.A.
Experimental Officer—S. J. J. Davies, B.A.(Hons.) (*on overseas studentship*)

Bird Population Studies

Senior Principal Research Officer—R. Carrick, B.Sc.(Hons.), Ph.D.
Experimental Officer—Miss S. E. Ingham, B.A. (Hons.)

Animal Physiology

Principal Research Officer—M. E. Griffiths, D.Sc.

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—R. D. B. Fraser, Ph.D., D.Sc.
Senior Principal Research Officer—H. Lindley, B.A., Ph.D.
Principal Research Officer—W. F. Forbes, B.Sc., Ph.D.
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. (*abroad*)
Senior Research Officer—B. S. Harrap, Ph.D., M.Sc.
Senior Research Officer—A. S. Inglis, M.Sc.
Senior Research Officer—J. A. Maclaren, Ph.D., M.Sc.
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., M.Sc.
Senior Research Officer—P. H. Springell, M.A., Ph.D. (*abroad*)
Research Officer—R. A. De Deurwaerder, Ph.D.
Research Officer—B. Milligan, Ph.D.(Adel. and Cantab.), B.Sc.
Research Officer—C. M. Roxburgh, Ph.D., B.Sc.
Research Officer—G. W. Stevenson, B.A., M.Sc., Ph.D.
Research Officer—J. R. Yates, Ph.D., M.A.
Senior Experimental Officer—J. P. E. Human, Ph.D., M.Sc.
Experimental Officer—A. K. Allen, B.Sc.
Experimental Officer—J. B. Caldwell, B.Sc.
Experimental Officer—N. F. Cheetham, B.Sc.
Experimental Officer—L. M. Dowling, B.Sc.
Experimental Officer—Miss J. E. Eager, B.Sc.
Experimental Officer—B. K. Filshie, B.Sc.

Experimental Officer—G. F. Flanagan, F.R.M.T.C.
Experimental Officer—Mrs. J. L. Hill, M.Sc.
Experimental Officer—I. H. Leaver, B.Sc.
Experimental Officer—A. B. McQuade, B.Sc.
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.
Librarian—Miss M. M. Clippingdale, M.A.

DIVISION OF TEXTILE INDUSTRY

Headquarters: Princes Highway, Belmont, 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. (*seconded to Australian Wool Bureau*)
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. Delmenico, B.Sc., Ph.D.
Senior Research Officer—J. R. McPhee, B.Sc., Ph.D. (*overseas*)
Senior Research Officer—D. S. Taylor, B.A., B.Sc., Ph.D.
Senior Research Officer—W. V. Morgan, B.Sc.
Senior Research Liaison Officer—J. M. Preston, D.Sc.
Research Officer—E. A. Cookson, B.A., Ph.D.
Research Officer—D. E. Henshaw, B.Sc.
Research Officer—R. Pearcy, M.Sc.
Research Officer—V. A. Williams, B.Sc., Ph.D.
Experimental Officer—I. B. Angliss, A.G.Inst. Tech.
Experimental Officer—B. B. Beard, A.G.Inst. Tech.
Experimental Officer—B. C. Ellis, A.M.C.T.
Experimental Officer—H. J. Katz, B.Sc., Ph.D.
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—I. J. Poulter, B.Sc.
Experimental Officer—D. C. Shaw, B.Sc. (*overseas*)
Experimental Officer—G. C. West, A.G.Inst.Tech.
Experimental Officer—J. L. Woo, M.Sc.

DIVISION OF TEXTILE PHYSICS

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

Chief—V. D. Burgmann, B.Sc., B.E.
Divisional Administrative Officer—J. I. Platt, B.Sc.(Econ.)
Senior Principal Research Officer—J. G. Downes, B.Sc.
Senior Principal Research Officer—M. Feughelman, B.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. G. David, B.Sc.
Senior Research Officer—A. R. Haly, M.Sc.
Senior Research Officer—H. W. Holdaway, B.Sc., B.E.
Senior Research Officer (Fellow)—P. Mason, M.Sc., Ph.D.
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—J. F. P. James, M.Sc.
Research Officer—D. T. Liddy, B.Sc.
Research Officer—B. M. Mackay, B.Sc., A.S.T.C.
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.
Senior Experimental Officer—H. W. Lunney, B.Sc., B.E.
Experimental Officer—J. E. Algie, B.E., A.S.T.C., M.Sc. (*overseas*)
Experimental Officer—N. W. Bainbridge, B.Sc.
Experimental Officer—P. G. Burton, B.Sc.
Experimental Officer—Miss J. C. Griffith, M.Sc., A.S.T.C.
Experimental Officer—Miss P. H. Hetherington, B.Sc.
Experimental Officer—G. B. McMahon, B.Sc.
Experimental Officer—T. W. Mitchell, A.S.T.C.
Experimental Officer—R. Postle, B.Sc.
Experimental Officer—R. M. Rabbidge, 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.

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—P. R. Strutt, B.Sc. (*on leave*)
Experimental Officer—J. A. Thompson, B.Sc. (*on leave*)

5

Finance

A summary of the Organization's receipts and expenditure from July 1, 1961 to June 30, 1962 has been given on page 27. Details are given below:

Expenditure

	£	£	£
Salaries and Contingencies*			**426,646**
Investigations			
Animal Research Laboratories		1,190,120	
LESS contributions from—			
Wool Research Trust Fund	567,818		
Dairy Produce Research Trust Account	11,200		
United Graziers' Association of Queensland	10		
Ian McMaster Bequest	1,857		
Alexander Fraser Memorial Fund	313		
U.S. Public Health Service	188		
Burdekin Bequest (Drought feeding)	2,252		
The Population Council Inc.	3,238		
Merck, Sharp & Dohme (Aust.) Pty. Ltd.	2,640		
Special Revenue Funds—"Belmont" Field Station	17,632	607,148	582,972
Plant Research			
Plant Industry		994,727	
LESS contributions from—			
Wheat Research Trust Account	8,644		
Brown Rot Trust Account	2,206		
Dairy Produce Research Trust Account	4,997		
International Atomic Energy Agency	2,425		
Wool Research Trust Fund	227,186		
Coresta	1,235		
River Murray Commission	1,875		
Fisons Pest Control and J. R. Geigy	9,916		
General Donations	50	258,534	736,193

* 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		209,658	
LESS contributions from—			
Dairy Produce Research Trust Account ..	1,704		
Imperial Chemical Industries A.N.Z. Ltd. ..	2,849		
Special Revenue Fund—Samford Farm ..	1,692	6,245	203,413
Suspense (Overseas transactions)			1,191
			940,797
Entomology		434,183	
LESS contributions from—			
Department of Health	500		
General Donations	272		
Wheat Research Trust Account	2,988		
U.S. Public Health Service	2,296		
Wool Research Trust Fund	8,712		
Dairy Produce Research Trust Account ..	3,774		
World Health Organization	3,907		
River Murray Commission and Snowy Mountains Hydro-Electric Authority	3,997		
Special Revenue Fund—Ingham	2,191	28,637	405,546
Soils and Irrigation—			
Soils		360,048	
LESS contributions from—			
Wool Research Trust Fund	6,969		
Australian Mineral Industries Research Association	3,257		
S. Aust. Woods and Forests Department, W.A. Forests Department, and Australian Paper Manufacturers Ltd.	5,078		
Ruminant Fertilizers Fund	1,673		
Wheat Research Trust Account	5,738		
Dairy Produce Research Trust Account ..	1,043		
Australian Petroleum Exploration Association Ltd.	2,081		
Commonwealth Fertilisers & Chemicals Ltd., Australian Fertilizers Ltd., Cuming Smith and Mt. Lyell Farmers Fertilisers Ltd.	609	26,448	333,600
Soil Mechanics		91,477	
LESS contributions from—			
Department of the Army	19,599		
Various Contributors—Subgrade Moisture Investigations	1,899		
Launceston City Council	288 Cr.		
Broken Hill Pty. Ltd.	1,736		
S. Aust. Housing Trust	431		
Lime Manufacturers' Association of Australia ..	467		
Country Roads Board, Victoria	4,603		
Various Contributors—Research on Building Foundations	1,756		
Tasmanian Department of Health	1		
U.K. Colonial Office	100	30,304	61,173

	£	£	£
Commonwealth Research Station, Merbein ..		97,672	
LESS contributions from—			
Dried Fruits Control Board	1,095		
Nyah-Woorinen Dried Fruits Committee ..	507		
Packing Companies and Co-operative Dried Fruit Sales Pty. Ltd.	541	2,143	95,529
Irrigation Research Station, Griffith		116,551	
LESS contributions from—			
N.S.W. Water Conservation and Irrigation Commission	9,251		
Wright & Rain Ltd.	623		
Special Revenue Fund—Griffith Research Station ..	3,139	13,013	103,538
Suspense (Overseas transactions)			758
			594,598
Food Preservation		390,294	
LESS contributions from—			
N.S.W. Department of Agriculture	2,274		
Metropolitan Meat Industry Board	513		
Queensland Meat Industry Board and Australian Meat Board	1,731		
Australian Egg Board	706		
Department of Primary Industry	4,271		
Various Contributors	6,713		
Egg Producers' Council	1,767		
Australian Dried Fruits Association	399		
Broken Hill Pty. Ltd.	4,060		
Australian Apple and Pear Board	1,057		
Australian Apple and Pear Board, Australian Apple and Pear Shippers' Association, Fibre Board Development Council	592		
Australian Meat Board	105	24,188	366,106
Forest Products		426,306	
LESS contributions from—			
Australian Paper Manufacturers Ltd. Associated Pulp and Paper Mills Ltd. Australian Newsprint Mills New Zealand Forest Products Ltd. ..	7,437		
Department of Territories	3,496		
General Donations	1,161		
Australian Plywood Board	11,302		
Department of Forestry, Fiji	2,339	25,735	400,571

	£	£	£
Mining and Metallurgy		61,849	
LESS contributions from—			
Australasian Institute of Mining and Metallurgy ..	583		
Consolidated Zinc Pty. Ltd., Northwest Tantalum, N.L.	1,639		
General Donations	1,413	3,635	58,214
Radio Research—			
Upper Atmosphere Section		31,947	
Radio Research Board Activities	38,362		
LESS contributions from—			
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission	20,862	17,500	49,447
Research Services		495,189	
LESS contributions from—			
Wool Research Trust Fund	19,151		
Wheat Research Trust Account	12,348		
Department of Works and Department of Labour and National Service	142	31,641	463,548
Chemical Research Laboratories		981,747	
LESS contributions from—			
Cement and Concrete Association of Australia ..	7,706		
State Electricity Commission of Victoria, Gas and Fuel Corporation of Victoria, and Australian Paper Manufacturers Ltd.	1,131		
Commonwealth Aluminium Corporation ..	2,525		
Smith, Kline, and French Laboratories (U.S.A.) ..	20,043		
Reserve Bank of Australia	880		
The Population Council Inc.	999		
Consolidated Zinc Pty. Ltd.	688		
Wool Research Trust Fund	39,696		
Union Carbide Aust. Ltd.	9,626		
Colonial Sugar Refining Co. Ltd.	3,751	87,045	894,702
Fisheries and Oceanography		257,412	
LESS contributions from—			
Department of the Navy	4,523		
N.S.W. State Fisheries Department	466		
South Pacific Commission	43		
Electricity Commission of N.S.W.	202	5,234	252,178
Mathematical Statistics		105,087	
LESS contribution from—			
University of Western Australia	200	200	104,887

	£	£	£
National Standards Laboratory		836,017	
LESS contributions from—			
Department of Supply	3,118		
General Donations	40	3,158	832,859
Tribophysics		125,988	
LESS contributions from—			
H. C. Sleigh Ltd.	1,148		
Union Carbide Aust. Ltd.	2,970		
General Donations	50	4,168	121,820
Building Research		208,046	
LESS contributions from—			
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries Ltd., and Colonial Sugar Refining Co. Ltd.	3,781		
Housing Commission of Victoria, State Electricity Commission of Victoria, Victorian Railways Department	230		
Cement and Concrete Association of Australia ..	466		
Australian Paint Manufacturers Association ..	140		
Jaywoth Besser Ltd.	35	4,652	203,394
Biochemistry and General Nutrition		170,664	
LESS contribution from—			
Wool Research Trust Fund	65,367	65,367	105,297
Fodder Conservation		39,937	
LESS contribution from—			
Dairy Produce Research Trust Account ..		2,896	37,041
Radiophysics		492,664	
LESS contributions from—			
General Donations	200		
U.S. National Aeronautics and Space Administration	2,244	2,444	490,220
Metallurgical Research			16,604
Tobacco Research		64,560	
LESS contributions from—			
Tobacco Research Trust	63,782		
Tobacco Growers' Association in Burdekin Valley	778	64,560	NIL
Meteorological Physics		129,444	
LESS contributions from—			
Tobacco Research Trust	559		
Middleton & Co.	53	652	128,792

	£	£	£
Dairy Research		165,698	
LESS contributions from—			
Dairy Produce Research Trust Account	75,411		
General Donations	121	75,532	90,166
Wool Research		711,331	
LESS contributions from—			
Wool Research Trust Fund	682,428		
Wool Buying and Selling Account	14,971		
Worsted Processing Research–Various Donations	1,263		
Associated Woollen Worsted Textile Manufacturers of Australia	11	698,673	12,658
Fuel Research		299,203	
LESS contributions from—			
Department of External Affairs	2,146		
State Electricity Commission of Victoria	15,579		
Colonial Sugar Refining Co. Ltd.	196	17,921	281,282
Wildlife Survey		187,254	
LESS contributions from—			
Wool Research Trust Fund	51,572		
Altona Survey Group	28	51,600	135,654
Land Research and Regional Survey		364,929	
LESS contributions from—			
Department of National Development	7,992		
Department of Territories	89,498	97,490	267,439
Miscellaneous—			
Patent Fees		5,414	
Extra-mural Investigations		38,258	
Furlough and Compensation		30,050	
Unattached Officers		5,681	
Wheat Research		23,081	
Grants to Scientific Workers		2,126	
Geological Microbiology		4,816	
Various		12,245	
		121,671	
LESS contributions from—			
Science and Industry Endowment Fund	2,126		
Wheat Research Trust Account	22,810		
Mining Research Association	4,816		
W. McIlrath Fund	2,250	32,002	89,669
TOTAL INVESTIGATIONS			**7,926,461**

	£	£	£
Other Services			
Research Associations—Grants			
Bread Research Institute	15,359		
Wine Research Institute	5,000		
Tobacco Research Trust	10,500		
Coal Association (Research) Ltd.	20,000	50,859	
Overseas Research Studentships	96,129		
LESS contributions from—			
Wool Research Trust Fund	1,547		
Science and Industry Endowment Fund ..	1,612	92,970	
Other Grants—			
Commonwealth Agricultural Bureaux	53,525		
Standards Association of Australia	87,000		
National Association of Testing Authorities ..	17,300		
Australian and New Zealand Association for the Advancement of Science	1,000		
National Institute of Oceanography	6,268		
Minor International Associations	9,721	174,814	
TOTAL OTHER SERVICES			**318,643**
TOTAL SALARIES AND CONTINGENCIES, INVESTIGATIONS, AND OTHER SERVICES			**8,671,750**
LESS receipts from sales of equipment, publications, etc., and revenue earned by Divisions and Sections, details of which are shown on page 152 ..			89,314
			8,582,436

Contributions

This Section shows receipts and disbursements during the year 1961–62 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 150–2. Of the total expenditure of £2,808,566 recorded in this Fund, £2,295,285 refers to normal research activities and £513,281 to capital works. The following table summarizes the sources of these funds and the activities on which they were expended.

SOURCE OF FUNDS	ACTIVITY		TOTAL
	Investigations	*Capital Works*	
	£	£	£
Wool Research Trust Fund	1,670,447	420,316	2,090,763
Contributions (in addition to Wool)	624,838	92,965*	717,803
	2,295,285	513,281	2,808,566

* Includes £10 in respect of 1960–61 expenditure.

The details are as follows:

	Receipts 1961–62 & *Balances brought forward* 1960–61	*Expenditure* 1961–62
	£	£
Wool Research Trust Fund (*details are shown on pages* 150–2)	2,141,000	2,090,763
W. McIlrath Research Fellowship Fund—*Dairy Beef Production*	2,250	2,250
General Donations (Animal Genetics)	1,481	NIL
Dairy Produce Research Trust Account—*Infertility in Dairy Cattle*	4,677	4,654
Alexander Fraser Memorial Fund—*Fluke Investigations*	345	313
Dairy Produce Research Trust Account—*Virus Diseases of Dairy Cattle*	3,277	3,263
Estate of the late Captain Ian McMaster—*Scholarship*	2,054	1,857
Dairy Produce Research Trust Account—*Endoparasites of Dairy Cattle*	3,317	3,283
Burdekin Bequest—*Drought Feeding Investigations*	3,535	2,252
Merck, Sharp & Dohme (Aust.) Pty. Ltd.—*Anthelmintics Research*	6,236	2,640
Special Revenue Fund—"*Belmont*" *Field Station, Rockhampton, Qld.*	26,052	17,632
U.S. Public Health Service—*Visit of Dr. Adler*	221	5
Beef Cattle Nutrition Account (Animal Physiology)	89	NIL
U.S. Public Health Service—*Visit of Dr. Druger*	221	183
General Donations (Animal Health)	3	NIL
Special Revenue Fund—*Burdekin Bequest*	3,005	NIL
United Graziers' Association of Queensland—*Tick Fever Studies*	10	10
The Population Council Inc.—*Studies on Induced Infertility*	7,226	4,237
Dairy Produce Research Trust Account—*Nutrition in Dairy Pastures*	5,000	4,997
Trust Fund Brown Rot Investigations—*Brown Rot Survey*	1,143	2,206*
River Murray Commission—*Alpine Ecology*	1,875	1,875
General Donations (Plant Industry)	50	50
North Queensland Tobacco Growers' Coop. Association Ltd.—*Investigations in Burdekin Valley*	1,517	778
Western Australian Golf Association—*Research on Grasses*	50	NIL
Australian Tobacco Research Trust—*Tobacco Investigations*	88,635	64,381
International Atomic Energy Agency—*Movement of Strontium 90*	1,895	1,742
International Atomic Energy Agency—*Measurement of Mutation Rates in Plants*	1,000	684
Coresta—*Contribution to Overseas Visit of A. V. Hill*	1,122	1,236*
Sulphur Institute of America—*Plant Nutrient Element Deficiencies*	1,771	NIL
Fisons Pest Control and J. R. Geigy—*Chemical and Plant Antifungal Investigations*	26,797	9,916
Estate of J. O. Holston—*Alpine Ecology*	650	NIL
Special Revenue Fund—*Grazing Trials, Samford Farm*	1,692	1,692
Various Contributors—*Soybean Harvester*	221	NIL
Imperial Chemical Industries of Australia and New Zealand Ltd.—*Nitrogen Grazing Experiments*	4,000	2,849

* Expenditure on this work in excess of receipts will be recovered in 1962–63.

	Receipts 1961–62 & *Balances brought forward* 1960–61 £	*Expenditure* 1961–62 £
Dairy Produce Research Trust Account—*Pastures of Coastal Plains, Southern Queensland*	2,000	1,704
Special Revenue Fund—*Cattle Tick Investigations, Ingham*	2,191	2,191
General Donations (Entomology)	273	272
U.S. Public Health Service—*Multiplication of Insect Polyhedron Virus*	3,083	2,028
U.S. Public Health Service—*Visit of Dr. Cleveland*	—	268*
Australian Dairy Produce Board—*Black Beetle Investigations*	103	103
Snowy Mountains Hydro-Electric Authority and River Murray Commission—*Phasmatid Investigations*	4,093	3,997
World Health Organization—*Insecticide Resistance in Cattle Tick*	2,678	2,678
World Health Organization—*Insecticide Resistance in House Flies*	1,339	1,228
Department of Health—*Sirex Wasp Investigations*	1,100	500
Dairy Produce Research Trust Account—*Nematode Investigations*	4,128	3,671
Various Contributors—*British Conference*	10	NIL
Fertilizer Sales Ltd.—*Research on Ruminant Fertilizers*	2,406	1,673
S. Aust. Woods and Forests Department, Australian Paper Manufacturers, W.A. Department of Forests—*Problems of Growth*, Pinus radiata	9,897	5,078
Australian Minerals Industries Research Association—*Purchase of X-Ray Spectrograph*	3,538	3,257
Australian Fertilizers Ltd. and Sulphide Corporation Ltd.—*Phosphate Requirements of Soils*	600	NIL
Commonwealth Fertilisers and Chemicals Ltd., Cuming Smith and Mt. Lyell Farmers Fertilisers Ltd., and Australian Fertilizers Ltd.—*Bacterial Fertilizers*	1,686	609
Dairy Produce Research Trust Account—*Moisture Balance of Soils on Lower Murray Swamps*	1,285	1,043
Various Contributors—*Building Foundations in South Australia*	3,995	1,756
Tasmanian Department of Health—*Foundation Investigations in Tasmania*	1,336	1
Launceston City Council—*Landslip Investigations*	288 Dr.	288 Cr.
Broken Hill Pty. Ltd.—*Jaspalite Beneficiation Project*	6,368	1,736
S. Aust. Housing Trust—*Research in Soil Mechanics and Land Use in Urban Areas*	480	431
Lime Manufacturers' Association of Australia—*Lime Stabilization of Soil*	625	467
Country Roads Board, Vic.—*Lower Yarra Crossing*	4,600	4,603*
Department of the Army—*Soil Stabilization Project*	29,267	19,599
Department of Works and the States' Roads Boards—*Subgrade Moisture Investigation*	1,902	1,899
General Donations (Soil Mechanics)	16	NIL
Australian Petroleum Exploration Association Ltd.—*Microbiological Prospecting for Oil*	683	2,081*
U.K. Colonial Office—*Visit of D. M. Lang*	—	100*

* Expenditure on this work in excess of receipts will be recovered in 1962–63

	Receipts 1961–62 & *Balances brought forward* 1960–61 £	*Expenditure* 1961–62 £
Packing Companies and Cooperative Dried Fruits Sales Ltd.—*Dried Vine Fruit Investigations*	3,465	541
N.S.W. Water Conservation and Irrigation Commission (Griffith Research Station)	11,429	9,251
Wright & Rain Ltd.—*Contribution to Overseas Visit of E. Hoare*	623	623
Dried Fruits Control Board—*Dried Fruits Investigations* ..	3,183	1,095
Nyah-Woorinen Dried Fruits Inquiry Committee—*Dried Fruits Investigations*	600	507
Special Revenue Fund—*Coomealla*	125	NIL
Special Revenue Fund—*Research Station, Griffith* ..	7,198	3,149*
Australian Meat Board—*Chilled Beef Shipment Experiments*	106	106
Metropolitan Meat Industry Board of New South Wales—*Meat Investigations*	584	513
Queensland Meat Industry Board and Australian Meat Board—*Meat Investigations*	1,788	1,731
Department of Primary Industry—*Fruit Fly Investigations* ..	3,750	3,682
Australian Apple and Pear Board, Australian Apple and Pear Shippers' Association, Fibreboard Development Council—*Contribution to Overseas Visit of E. G. Hall* ..	1,400	592
Apple and Pear Board—*Apple and Pear Investigations* ..	1,418	1,057
Egg Producers' Council—*Egg Quality Studies*	1,767	1,767
Australian Dried Fruits Association and Australian Dried Tree Fruits Committee—*Dried Tree Fruits*	678	399
Various Contributors (Food Preservation)	14,629	6,713
Broken Hill Pty. Ltd.—*Research on Tinplate Containers* ..	9,849	4,060
Australian Egg Board—*Egg Investigations*	1,509	706
Department of Primary Industry—*Spray Residue Investigations*	600	589
National Cottonseed Products Association of U.S.A.—*Contribution to Overseas Visit of F. S. Shenstone* ..	221	NIL
N.S.W. Department of Agriculture—*Fruit Storage Investigations*	2,329	2,274
Paper Companies and New Zealand Forest Products—*Paper Pulp Investigations*	8,364	7,437
General Donations (Forest Products)	4,231	1,161
Department of Territories—*Development of Pulp and Paper Industry in New Guinea*	3,116	2,912
Department of Territories—*Timber Utilization in New Guinea*	583	583
Australian Plywood Board—*Veneer, Gluing, and Plywood Research*	16,013	11,302
Government of Fiji—*Timber Research in Fiji*	4,454	2,339
Australasian Institute of Mining and Metallurgy (Mineragraphic Investigations)	4,077	583
General Donations (Ore Dressing Investigations) ..	1,478	1,413
Northwest Tantalum N.L. and Consolidated Zinc Pty. Ltd.—*Flotation of Beryl*	2,001	1,638
State Electricity Commission of Victoria—*Geological Consultations*	1,870	NIL
Miscellaneous Contributors (Mineragraphic Investigations) ..	237	NIL

* Includes £10 in respect of 1960–61 expenditure.

	Receipts 1961–62 & *Balances brought forward* 1960–61 £	*Expenditure* 1961–62 £
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission—*Radio Research Board Activities*	21,798	20,862
General Donations (Engineering Section)	200	NIL
Department of Works and Department of Labour and National Service—*Film on Building Research in Australia* ..	142	142
Consolidated Zinc Pty. Ltd.—*Thorium Project*	98	88
Consolidated Zinc Pty. Ltd.—*Contribution to Overseas Visit of T. R. Scott*	600	600
Miscellaneous Contributors (Chemical Research Laboratories)	8,330	NIL
State Electricity Commission and Gas and Fuel Corporation—*Clinkering of Brown Coal Ash*	2,050	1,131
Commonwealth Aluminium Corporation—*C.Z. Project* ..	2,525	2,525
Western Australian Chamber of Mines (Inc.)—*Cyanidation of Gold*	5,795	NIL
Union Carbide (Aust.) Ltd.—*Semi-polymers*	10,018	9,626
Cement and Concrete Association of Australia—*Cement Investigations*	15,712	7,706
Reserve Bank of Australia—*Fuel Cell Project*	7,000	880
Colonial Sugar Refining Co. Ltd.—*Sugar Research* ..	3,524	3,751*
Smith, Kline, and French Laboratories, U.S.A.—*Phytological Survey and Drug Plant Collection*	20,674	20,043
N.S.W. Government—*Fisheries Investigations*	590	466
South Pacific Commission—*Survey of Pearlshell Beds of Manihiki*	600	43
Department of the Navy—*Marine Fouling Investigations* ..	5,000	4,523
Electricity Commission of N.S.W.—*Fly Ash Program* ..	500	202
University of Western Australia (Mathematical Statistics) ..	200	200
Department of Supply—*Examination of Gauges*	3,118	3,118
General Donations (Physics)	40	40
General Donations (Metrology)	1,332	NIL
Machinability Donations Account (Metrology) ..	114	NIL
General Donations (Electrotechnology)	38	NIL
General Donations (Tribophysics)	165	50
Union Carbide (Aust.) Ltd.—*Catalytic Oxidation of Olefins*	5,775	2,970
H. C. Sleigh Ltd.—*Research on Solid Lubricants* ..	1,148	1,148
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries, and Colonial Sugar Refining Co. Ltd.—*Fibrous Plaster Research*	4,549	3,781
Paint Manufacturers' Association—*Paint Research on Plaster Surfaces*	140	140
General Donations (Building Research)	6,371	NIL
Cement and Concrete Association of Australia—*Concrete Research*	1,372	466
Whitelaw Monier Pty. Ltd.—*Research into Cement Tiles* ..	500	NIL
Jaywoth Besser Ltd.—*Efflorescence on Concrete Blocks* ..	1,439	35
Housing Commission of Victoria, Victorian Railways Dept., State Electricity Commission of Victoria—*Mould Infestation in Dwellings*	332	230

* Expenditure on this work in excess of receipts will be recovered in 1962–63.

	Receipts 1961–62 & *Balances brought forward* 1960–61	*Expenditure* 1961–62
	£	£
Dairy Produce Research Trust Account—*Silage Studies* ..	3,000	2,896
Radio Astronomy Trust	92,955	92,955
Department of Civil Aviation—*Radio Navigational Aids* ..	7,352	NIL
General Donations (Radiophysics)	225	200
U.S. National Aeronautics and Space Administration—*Radio Astronomy*	23,012	2,244
Various Contributors—*Rain and Cloud Physics Research* ..	8,000	NIL
Middleton & Co. Pty. Ltd.—*Calibration of Radiometers* ..	NIL	53*
Dairy Produce Research Trust Account (Dairy Research) ..	72,503	75,411*
General Donations (Dairy Research)	121	121
Leather Research—*Residual Funds of Australian Leather Research Association*	1,195	NIL
Wool Buying and Selling Account	15,067	14,971
General Donations (Protein Chemistry)	71	NIL
Donations for Worsted Processing Research	1,577	1,263
General Donations (Textile Industry)	229	NIL
Associated Woollen and Worsted Textile Manufacturers of Australia—*Blanket Freight Equalization Fund* ..	2,032	11
General Donations (Textile Physics)	2	NIL
General Donations (Coal Research)	4,685	NIL
Department of External Affairs—*Survey of Coal from North Borneo*	4,000	2,146
Colonial Sugar Refining Co. Ltd.—*Purchase of Special Equipment* (Coal Research)	250	196
Electricity Trust of S. Aust.—*Investigations into Boiler Gas Path Problems*	15,000	NIL
State Electricity Commission—*Brown Coal Investigations* ..	17,478	15,579
Petfoods Ltd.—*Food for Budgerigars*	79	NIL
Altona Survey Group—*Banding Stormy Petrels*	36	28
Department of National Development—*Kimberley Research Station*	8,238	7,992
Department of Territories—*Resources Survey in Papua and New Guinea*	47,700	39,251
Australian Meat Board—*Pasture Development in Central Australia*	5	NIL
Northern Territory Administration—*Rice Research* ..	50,834	50,247
Sundry Contributors (Commonwealth Scientific and Industrial Research Organization)	181	NIL
Science and Industry Endowment Fund	3,693	3,738*
Wheat Research Trust Account	58,014	52,526
Australian Minerals Industry Research Association—*Geological Microbiology*	6,191	4,816
	3,121,000	**2,808,566**

* Expenditure on this work in excess of receipts will be recovered in 1962–63.

Wool Research Trust Fund

Details of transactions during 1961–62 are as follows:

	£	£	£
RECEIPTS			
Balance brought forward from 1960–61		2,367 Dr.	
Received from Department of Primary Industry during 1961–62		2,143,367	**2,141,000**
EXPENDITURE 1961–62			
Investigations			
Biological Research—			
Animal Research Laboratories—			
Division of Animal Physiology, Ian Clunies Ross Animal Research Laboratory ..	289,079		
Regional Laboratory and "Chiswick" Field Station, Armidale, N.S.W.	99,481	388,560	
Division of Animal Health, McMaster Laboratory	47,766		
Animal Health Laboratory	8,367	56,133	
Division of Animal Genetics Sheep Breeding, Cunnamulla	42,496		
Animal Genetics Investigations, Sydney, including Genetic Resistance to Myxomatosis	54,760		
Sheep Breeding, McMaster Laboratory, McMaster Field Station, Armidale, Canberra, and Deniliquin	24,229	121,485	
Suspense (Overseas transactions)		1,640	567,818
Plant Industry—			
Headquarters, Canberra	104,389		
Regional Pastoral Laboratory, Falkiner Memorial Field Station, Deniliquin	50,286		
Field Investigations, Armidale	11,515		
Western Australian Investigations	60,996	227,186	227,186
Entomology—			
Field Investigations, Armidale		8,713	8,713
Division of Soils—			
Cobalt Work in Tasmania		6,969	6,969
Research Services—			
Agricultural Research Liaison Section		18,351	
Wool Publications		800	19,151
Division of Biochemistry and General Nutrition—			
Nutrition Laboratory, Adelaide		39,972	
Field Studies at Glenthorne, Robe, and Brecon, S. Aust.		25,394	65,366

	£	£	£
Wildlife Survey Section—			
Wildlife Investigations		51,572	51,572
Overseas Studentships		1,346	1,346
			948,121
Wool Research—			
Wool Research Laboratories—			
Protein Chemistry, Melbourne	222,379		
Textile Physics, Sydney	202,696		
Textile Industry, Geelong, Vic.	251,701		
Suspense (Overseas transactions)	5,653	682,429	
Chemical Research Laboratories—			
Chemical Physics	20,853		
Physical Chemistry	5,703		
Organic Chemistry	13,140	39,696	
Overseas Studentships		201	722,326
TOTAL INVESTIGATIONS			**1,670,447**
Capital Works			
C.S.I.R.O. EXPENDITURE			
Biological Research—			
Animal Research Laboratories—			
Laboratory Equipment	25,350		
Plant Industry—			
Laboratory Equipment	7,847		
Biochemistry and General Nutrition—			
Laboratory Equipment	7,790	40,987	
Wool Research—			
Wool Research Laboratories—			
Laboratory Equipment and Textile Machinery ..		86,015	
		127,002	
EXPENDITURE ON C.S.I.R.O. BUILDINGS BY DEPARTMENT OF WORKS			
Biological Research	59,909		
Wool Research	17,975	77,884	
EXPENDITURE ON BUILDINGS BY C.S.I.R.O.			
Biological Research	2,803		
Wool Research	212,627	215,430	
TOTAL CAPITAL WORKS			**420,316**
TOTAL EXPENDITURE			**2,090,763**
BALANCE CARRIED FORWARD TO 1962–63			**50,237**
			2,141,000

During the year £66,847 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 1961–62 miscellaneous receipts amounted to £89,314. Details of the receipts are as follows:

	£	£
Sale of Publications	7,527	
Sale of Equipment Purchased in Former Years, and Other Receipts	19,197	
Sale of Produce by Field Stations and Laboratories ..	27,299	
Royalties from Patents	6,022	
Testing Fees	17,741	
Sale of Animals	8,584	
Miscellaneous	2,944	**89,314**

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 £89,314 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			
Parkville Laboratory	255		
McMaster Laboratory	1,750	2,005	
Plant Industry			
Canberra Laboratories	6,507		
Ginninderra Experiment Station	4,483		
Development of the Phytotron	337,582	348,572	

	£	£	£
Tropical Pastures			
Spear grass	207		
Cooper Laboratory	309		
Brigalow	484		
Beerwah	4,723		
Samford Farm	3,109	8,832	
Entomology			
Ingham Field Station	1,147	1,147	
Administrative Office, Canberra	4,500	4,500	
Merbein Research Station			
Merbein	1,374		
Coomealla	708	2,082	
Griffith Research Station	1,104	1,104	
Soil Mechanics			
Syndal Laboratory	5,142	5,142	
Food Preservation			
North Ryde Laboratory	6,622		
Cannon Hill Laboratory	236	6,858	
Engineering	1,749	1,749	
Chemical Research Laboratories			
Site at Monash University	17,023		
Sugar Research Laboratory	6,260	23,283	
Fisheries and Oceanography			
Cronulla Laboratory	379	379	
Radiophysics			
Giant Radio Telescope	184,687	184,687	
Meteorological Physics			
Lysimeter Project, Aspendale	2,420	2,420	
Fuel Research			
Coal Research Laboratory	1,965	1,965	
Wildlife Survey Section	13,996	13,996	
Miscellaneous	362	362	
TOTAL TREASURY EXPENDITURE			**609,083**