COMMONWEALTH OF AUSTRALIA

REPORT OF THE COUNCIL
OF
THE AUSTRALIAN NATIONAL UNIVERSITY

FOR THE YEAR ENDING 31ST DECEMBER, 1959

By Authority:
(Printed in Australia.)

1960
THE AUSTRALIAN NATIONAL UNIVERSITY.


To His Excellency the Right Honourable Viscount Dunrossil, G.C.M.G., M.C., Q.C., Governor-General and Commander-in-Chief in and over the Commonwealth of Australia.

MAY IT PLEASE YOUR EXCELLENCY:

I have the honour to transmit to Your Excellency the report of the Council of the Australian National University for the period from 1st January, 1959 to 31st December, 1959, furnished in compliance with Section 33 of the Australian National University Act 1946–1947.

THE COUNCIL.

The Council met five times during the year in March, May, July, September and November. Dr. H. C. Coombs continued to act first as Deputy Chairman of the Council and then, when this title was changed, as Pro-Chancellor.

The terms of office of Senator J. A. McCallum, Senator Dorothy M. Tangney, Sir Kenneth Bailey, Sir Roland Wilson, Professor L. G. H. Huxley, Professor E. W. Titterton, Mr. H. Y. T’ien, Mr. C. R. Heathcote and Dr. G. B. Mackaness expired on 30th June, 1959. The membership of Mr. K. E. Beazley and Mr. P. E. Joske, elected by the House of Representatives, ceased on 14th October, 1959, on the dissolution of the House of Representatives.

Elections took place and appointments were made in accordance with the provisions of the University Act, and the following Councillors took office on the dates mentioned:—

As from 26th February, 1959:—

Members elected by the House of Representatives—
*Percy Ernest Joske, M.A. LL.M. (Melb.), Q.C.

As from 1st July, 1959:—

Members elected by the Senate—
Keith Alexander Laught, LL.B. (Adel.).
Dorothy Margaret Tangney, B.A., Dip.Ed. (W.A.).

Members appointed by the Governor-General—

Members elected by Convocation—
Sir Kenneth Bailey, C.B.E., M.A., B.C.L. (Oxon.), LL.M. (Melb.).
Noel George Butlin, B.Ec. (Syd.).

Members elected by Students—
Geoffrey Coleman, B.Sc. (Manc.), A.R.I.C.
David Bruce Heron, M.A. (N.Z.).

Members elected by Staff—
†Arnold Hughes Ennor, D.Sc. (Melb.), F.A.A.
Robin Allenby Gollan, M.A. (Syd.), Ph.D. (Lond.).

The following resignations from the Council were accepted by the Council on the dates mentioned:—

Professor J. A. Passmore, on 31st December, 1959.
Sir Ian Clunies Ross, on 13th March, 1959.

At a meeting held in accordance with the provisions of the University Act on 10th July, 1959, it was resolved to co-opt the following for the periods shown:—

The Right Honourable Viscount Bruce of Melbourne—2 years from 1st August, 1959.
Professor Sir Mark Oliphant—2 years from 1st July, 1959.

* The House of Representatives on 26th February elected these persons to fill casual vacancies on the Council of the Australian National University until 30th June, 1960, and to continue as members of the Council until the House of Representatives expires by dissolution or effluxion of time.
† To hold office from 1st January, 1960, to 30th June, 1961.
The University was honoured to confer the degree of Doctor of Laws, *Honoris Causa*, on Dr. C. E. W. Bean for his services to the nation in establishing archives, and the degree of D.Sc., *Honoris Causa*, on Sir Leslie Martin, a former Councillor of the University who has since become Chairman of the Australian Universities Commission.

The Commission visited the University in November and discussed the University's plans for future development, particularly in the three year period beginning 1961.

An architect was appointed for a building to accommodate the Research Schools of Social Science and Pacific Studies and preliminary drawings are being considered. Sir John Crawford accepted appointment as Director of the Research School of Pacific Studies and is expected to assume office late in 1960.

The Department of Radiochemistry was disbanded and arrangements made for the work to be carried on in other departments; Council approved the development of Geochemistry in the Department of Geophysics.

In December, 1959, the University was informed of the Government's decision that the Canberra University College should be associated with the University. Before the signing of this Annual Report a plan was submitted by the University and the College to the Prime Minister and adopted by the Government, providing for the continuation of the present research work of the University in an Institute of Advanced Studies and for the establishment of a School of General Studies to include the Faculties of the Canberra University College.

### Site and Buildings.

No major project was under construction during 1959.

Work was begun on an extension to University House to provide an additional 25 rooms. A building is in course of erection to house the 12 MeV tandem electrostatic generator of the Department of Nuclear Physics. A telescope hut and observers' quarters were built at the Mount Bingar field station of the Mount Stromlo Observatory.

Working drawings for the permanent building to house the University's library collection are at an advanced stage and it is hoped to call tenders and start erection early in 1960.

### Degrees Awarded.

The Degree of Doctor of Philosophy was conferred on Mr. D. E. Griffiths (Biochemistry), Mr. A. H. Morton (Particle Physics), Mr. T. R. Ophel (Nuclear Physics), Mr. A. F. Reid (Radiochemistry), Mr. B. D. Graham (Political Science), Mr. H. P. Harrison (Political Science), Mr. W. P. Hogan (Economics), Mr. J. S. McDonald (Demography), Mr. R. M. Martin (Political Science), Mr. J. D. Pitchford (Economics), Mohammed Anas (Geography), Mr. K. L. O Gillion (Pacific History), Mr. T. Langford-Smith (Geography), Mr. K. H. Lokan (Nuclear Physics), and Mr. V. Subramaniam (Political Science). Mrs. A. Gemmell (Microbiology) had the degree of Master of Arts conferred on her.

### Enrolments.

Fifty-two new research students enrolled in 1959 and the total number enrolled at the end of the year was 111. Of the new students 28 were Australians, six were from the United Kingdom, six from New Zealand, three from the United States, three from India, and one each from Singapore, The Netherlands, France, Indonesia, Pakistan and Japan.

### Staff Appointments.

Senior appointments and promotions were:

- Dr. D. C. Peaslee, Reader in Theoretical Physics,
- Dr. F. P. Dwyer, Reader in Inorganic Chemistry,
- Dr. H. A. McKenzie, Senior Fellow in Physical Biochemistry,
- Mr. H. E. Maude, Senior Fellow in Pacific History,
- Dr. D. R. Curtis, Senior Fellow in Physiology,
- Dr. W. H. Elliott, Senior Fellow in Biochemistry,
- Mr. A. L. Burns, Senior Fellow in International Relations.
Senior Staff Resignations—

Lord Lindsay, Reader in International Relations on appointment as Professor of International Relations at the American University of Washington.

Dr. J. S. Bastin, Fellow in Pacific History on his appointment to the Chair of History at the University of Malaya.

Seven Research Fellows resigned: one joined a New Zealand University, two joined the Commonwealth Public Service, one resigned to have a family, while three entered private employment.

Study Leave.

The following members of staff were on study leave for some part of the year:—

Professor Sir Mark Oliphant, Director of the Research School of Physical Sciences,
Professor B. J. Bok, Professor of Astronomy,
Professor W. D. Borrie, Professor of Demography,
Professor J. W. Davidson, Professor of Pacific History,
Professor Sir John Eccles, Professor of Physiology,
Professor K. J. Le Couteur, Professor of Theoretical Physics,
Professor P. H. Partridge, Professor of Social Philosophy,
Professor G. Sawer, Professor of Law,
Dr. M. S. Patterson, Reader in Geophysics,
Dr. L. U. Hibbard, Senior Fellow in Particle Physics,
Mr. H. J. M. Abraham, Senior Fellow in Astronomy,
Dr. W. Buscombe, Fellow in Astronomy,
Dr. J. H. Carver, Fellow in Nuclear Physics,
Dr. W. K. Joklik, Fellow in Microbiology,
Dr. C. A. Price, Fellow in Demography.

John Curtin School of Medical Research.

The Department of Biochemistry has continued its work on a number of problems in cell metabolism. These have been concerned with the chemistry and biological role of muscle constituents; with the enzymes concerned with folic acid and methyl group synthesis; with the formation and metabolism of a new amino acid metabolite and with investigations into the mechanism of enzyme synthesis in bacteria.

The work of the Department of Experimental Pathology concerned two general fields of research, cardiovascular disease and immunology. Further investigations were made in the role of lipid transport and metabolism in the aetiology of atherosclerosis, and immunological factors affecting the fate of virulent staphylococci and acid-fast bacilli after ingestion by phagocytic cells were studied.

The Department of Medical Chemistry has continued investigations between the structure and properties of amino-, hydroxy-, and mercapto-heterocycles. This has led to a number of correlations of potential value to biologists. These investigations dealt with members of the pyridine, quinoline, isoquinoline, azaindole, pteridine, pyrimidine and purine families. Studies on the behaviour of metallic ions under physiological conditions have been continued. Spectroscopic studies of the amide structure have helped to explain some outstanding anomalies in vinylogous amides.

Work in the Department of Microbiology is concerned with animal viruses. Using as models the poxviruses (large viruses), influenza (a medium-sized virus), and polioivirus and Murray Valley encephalitis virus (small viruses), problems of animal virology are being investigated at several levels of complexity. Work is still proceeding upon the epidemiology of myxomatosis and this disease is now being used as a model of evolutionary changes in viral infections.

At a lower level of complexity the mode of spread of viruses through the animal body is being studied by classical techniques and by the use of tagged (fluorescent) antibody.

The major theme of interest, however, is cell-virus interaction, a field which involves cytology as much as virology. A variety of techniques is being used in addition to the classical techniques of infectivity titration and immunology. Chemical, physical, and genetic methods are being used to elucidate the detailed structure of influenza virus; and site and time sequence of events in the infection of cultured cells by vaccinia virus. The study of mechanisms of virus reactivation is yielding particularly interesting results.

In the Department of Physiology, research work is in progress in the following fields:—

(i) Biophysical properties of nerve cells and on the nature of the synaptic excitatory and inhibitory action thereon.
(ii) The pathways and organization of nerve cells in the spinal cord.
(iii) Effects of nerve-cross union on the synaptic connections to nerve cells.
(iv) Pharmacological investigations on the central nervous system.
The transmission mechanism at the neuro-muscular junction.

Synaptic excitatory and inhibitory transmitters in the central nervous system.

The manner in which motor nerve cells control the contraction speeds of the muscles they innervate.

The effect of temperature changes on the hormonal control of water and salt metabolism.

The action of metabolic poisons on the electrical activity of the heart.

The Department of Physical Biochemistry has begun to take shape. By the end of the year the floor which it occupies had been furnished with the necessary general and special laboratories. The task of planning, ordering, obtaining and installing equipment has begun but will have to continue for some time. Work has begun in the Department on the denaturation of bovine haemoglobins and on the physical chemistry of casein. The Electron Microscope Unit has been made a part of the Department of Physical Biochemistry.

The Biological Inorganic Chemistry Unit, which has become a permanent section in the Medical School, has concerned itself with the fundamental chemistry of complex metal compounds and their application to biological systems.

Research School of Physical Sciences.

The Department of Astronomy continued to concentrate upon research on the Milky Way System, including studies of colours, magnitudes, spectra and radial velocities and stars in clusters, the Star Clouds of Magellan, and upon selected variable stars. The Observatory maintains and operates the Australian National Time Service. Necessary excavations for the construction of a large Coude Spectrograph for the 74-inch Reflector have been completed and work on the building and instrument itself is advancing. Major telescopes have been in continuous use throughout the year and a 26-inch Reflector has been installed near Griffith, New South Wales, as part of a scheme to determine the location for a Field Station with clearer skies than exist at Mount Stromlo. Sites in Western Australia, South Australia and Northern Territory, Victoria and New South Wales are under examination.

In the Department of Geophysics work has continued on the measurement of temperatures in the Earth's crust; on the direction of the Earth's magnetic field throughout geological time; on the magnetic properties of rocks; on the study of meteorites; and on various problems of igneous and a metamorphic petrology. A network of nine seismological stations has been established in conjunction with the Snowy Mountains Authority and the Sydney Water Board and a detailed study of earth tremors in South-East Australia is being made. Studies of the failure of rock material at various pressures are being made, and apparatus for studying phase equilibria at very high temperatures and pressures has been constructed.

In the Department of Nuclear Physics the major effort on equipment has been in relation to the installation of the 12-MeV tandem electrostatic generator. The machine should arrive in Canberra by mid-1960 and the generator should yield a beam before the end of the year.

Work has continued on the study of photo disintegration of medium weight nuclei. Under the heading of Fast Neutron Studies it has already been shown that the same mode of fission involving the emission of a fast α-particle occurs in the slow neutron fission of U-235, the photofission of Th-232 and U-238 and the fission of 135 and Th-232 with 2.5-MeV neutrons. Using 14.5-MeV neutrons the work now in progress will establish the relative probabilities of the various modes and the energy spectrum of the long-range α-particles.

In the Department of Particle Physics the bearings in the homopolar generator were completed and installed by August and during July and August preparations were made to test the bearings at full speed and under full magnetic load, by running the rotor without the generator casing.

At the end of 1959 a series of tests were made. The tests showed that there were features of the bearing which required improvements: extensive enquiries were made abroad and they showed that nowhere have bearings been made to carry such high loads with variable shaft speeds and reversal of the direction of the rotation, as is required in this generator. Nevertheless revised designs have been completed on the basis of experience gained during the tests and it is clear that the difficulties experienced can be overcome.

In the field of plasma physics, the fundamental approach to thermonuclear power, a small group has begun work. This is a new field to members of the group and some time was devoted to reading in the subject and to becoming acquainted with the literature. This together with discussions and lectures will assist in planning an experimental programme.

In the Department of Theoretical Physics the energy levels and corresponding internal structure of light nuclei have been further investigated with the nuclear shell model: specific predictions are made of a 3- level in C-18. The statistical theory of nuclear level density has been extended and compared with recent experiments. Studies have been made of charged particle motion in various electromagnetic field configurations with a view to application in gas discharges. The known elementary particles have been organized into a scheme of seven-dimensional charge space, and some detailed implications are being developed.
Research School of Social Sciences.

The Department of Demography continued its studies of pre-war and post-war immigration, including its detailed investigation into British immigrants. It also continued its work on the growth, structure and future projection of the Australian population and its investigations into the populations of the Pacific Islands and South-East Asia.

The Department of Economics’ central interest is in processes of economic growth and economic fluctuation. Research work is carried on within three sections of the Department. In economic statistics work continues on problems of social accounting, economic forecasting and the analysis of statistics of employment and unemployment. Research in economics continues in the theory of international trade and theoretical and statistical work on consumer demand; theoretical models of capital accumulation and economic growth; the Australian capital market; and studies of productivity, investment and the work force. In economic history, work on the growth of the Australian economy since 1860 has concentrated on three main lines, in studies of institutions, industries and aggregate economic development. The Department also made substantial progress in assembling a collection of basic research material under the care of Business Archives.

The work of the History Department in Australian history has continued on the lines reported last year. Important developments have taken place in the project for a Dictionary of Australian Biography. An Editorial Board centered on the National University has been set up, and a National Advisory Panel, made up of representatives from each of the State Universities, has been established to advise on all matters relating to the Dictionary. Working Parties have been formed in each State under the direction of the National Advisory member. Professor C. M. H. Clark and Mr. M. H. Ellis have accepted the joint editorship of Volumes I. and II. These cover the periods 1788-1825 and 1825-50. Arrangements with a publisher are being negotiated, and it is estimated that the first two volumes will reach the press by 1962.

A new and important development during the year was the foundation of a “consortium” of historians, with a membership drawn from various departments both of the University and Canberra University College. The aim of the consortium is to promote co-operation between historians irrespective of jurisdictional barriers. An experiment in joint lectures was begun and will be continued.

The Department of Law continued its work in public and private law along the same general lines as in 1958.

The year’s work in the Department of Political Science and International Relations was devoted to the furthering of the studies of elections and of the South-East Asia Treaty Organization and to the pursuit of other subjects by individual member rather than to the commencement of other team projects. Much of this individual research consisted of the further development of subjects which members of the Department had already examined, notably Church and State, the application of administrative theory and current strategic problems.

International Relations was separated from Political Science at the end of the year and transferred as a separate department to the Research School of Pacific Studies.

The work of the Department of Social Philosophy has been concerned with contemporary philosophical problems, history of ideas, the logic of the social sciences and problems of political and legal philosophy.

The Department of Statistics continued work on various aspects of random processes particularly “point” processes and diffusion processes in population genetics. Work was also done on meteorological problems and advice given to other departments on statistical analysis.

Research School of Pacific Studies.

During 1959 members of the Department of Anthropology and Sociology carried out field research among the urban population of Rabaul, the Chimbu of the New Guinea Highlands, the inhabitants of Aoba, New Hebrides, the Torres Straits islanders, aborigines in Arnhem Land and at Borroloola, and the Dusun of North Borneo. Linguistic research was carried out in the Sepik District of New Guinea. A Fulbright Scholar attached to the Department began work in the New Guinea Highlands.

The Department of Far Eastern History is now undertaking work both in the ancient and modern history of China and in the history of Japan. Particular attention is being paid to Japanese history from the XVIIIth Century onwards.

The Department of Geography has maintained the general interests indicated in the last report the main substantive items of research are perhaps Professor Spate’s study of The Fijian People: Economic Problems and Prospects, published as a Council Paper by the Government of Fiji, and the extended field work on the remarkable limestone topography of the Fitzroy basin in the Kimberleys.
Work on International Relations was conducted during 1959 in the Department of Political Science and of International Relations. The South-East Asia group prepared a book on SEATO. Research papers were published on nuclear defence and disarmament and NATO strategy.

In the Department of Pacific History research was continued into a variety of problems connected with the contact between Europeans and indigenous cultures, projects undertaken extending over an area from Malaya to Tahiti and in time from the age of exploration to the present day.

Financial.

Statements of Accounts are attached.

A grant of £2,830 was made to the University by the Commonwealth Bank's Rural Credits Development Fund to assist in research on the endocrine and, in particular, the adrenal physiology of sheep.

The Australian Atomic Energy Commission granted £953 for the continuation of the A.A.E.C. post-graduate studentship within the Department of Nuclear Physics of B. Mainsbridge.

The National Health and Medical Research Council has granted £2,348 per annum for Dr. A. Gottschalk; a grant of £1,174 was made for the period 1st July to 31st December, 1959.

The Rockefeller Foundation of America granted a sum of $10,000 for the purchase and shipment of research equipment and supplies for use in Department of Physiology. This sum is for use during a two-year period beginning approximately 1st March, 1959, after which time unexpended balance will revert to the Foundation. Equipment to the value of £1,045 was received in 1959.

A grant of £7,617 has been made by the Wool Research Trust Fund to cover cost of research in myxomatosis by the Department of Microbiology. A portion of the grant was to be used to finance research into functions of sheep in semi-desert areas.

A sum of £3,423 was granted to the University by the Commonwealth Scientific and Industrial Research Organization for research in Biological Inorganic Chemistry.

A grant of £250 was made to the University by the Commonwealth Scientific and Industrial Research Organization for the period of three months to enable Mr. F. H. Bauer to complete the writing of his report on the historical geography of the underdeveloped parts of Northern Australia.

The Department of Immigration granted a total of £10,000 over a period of three years (half to go in the salary of a full-time research officer and half in part-time assistance and in costs associated therewith) for field surveys and interviewing. £4,498 was received in 1959. (Amounts are to be sought annually.)

The Snowy Mountains Hydro-Electric Authority and the Metropolitan Water Board combined in Seismological activities, and asked the Department of Geophysics (A.N.U.), to undertake the interpretation of their seismic records. A grant of £2,000 per annum will be paid to A.N.U. for this work. £1,500 was received in 1959.

The U.S. Office of Naval Research entered into a contract with Dr. H. M. Johnson (Associate Professor of Astronomy at the State University of Iowa) for study at A.N.U. in the Department of Astronomy for one year from December, 1958 to December, 1959. A single grant of £2,690 plus travel allowance up to £493 was made by the Office, for Dr. Johnson.

The Commonwealth Office of Education paid £5,400 in 1959 as an advance against stipend and expenses for 1959. This was in accordance with the Commonwealth Post-Graduate Scholarships scheme. The amount of £5,400 was given for research and was split up as follows:—

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<tr>
<th>J.C.S.M.R.</th>
<th>Physics</th>
<th>Social Sciences</th>
<th>Pacific Studies</th>
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<td>£900</td>
<td>£2,700</td>
<td>£900</td>
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Total: £5,400

Contributions towards maintaining the Chair of Visiting Professor were received from:—

| Commonwealth Bank | £1,550 |
| English, Scottish and Australian Bank | £1,000 |
| Australian and New Zealand Bank | £850 |
| Rural Bank | £100 |
C.S.I.R.O. granted £3,250 to the Department of Physiology for sheep and wool research. £1,625 was received in 1959.

General Motors-Holdens Limited granted £4,300 for Post-Graduate Scholarships.

The Hon. Charles Banks and Mrs. Banks made a gift of £7,000 and asked that this should be used to further research in New Guinea.

Professor Davidson made a gift of £268 6s. 10d. towards the launching of a Journal of Pacific History.

The University of Adelaide under the E. M. Symon Bequest made £750 available towards anthropological research on aboriginal women.

Donations to the Vice-Chancellor's Discretionary Fund totalled £2,500.

Visiting Research Workers and Visitors.

A list of such Visitors during 1959 is given overleaf.

Statistics.

The statistical tables furnished to the Commonwealth in respect of the University operations in 1959 are given on pages 78–83.

The Research Schools, University House, the Library.

Full reports from the above are appended.

H. C. COOMBS,
Pro-Chancellor.
VISITING RESEARCH WORKERS.

The university was glad to afford facilities for the work of the following overseas research workers:

Sir Alexander Carr Saunders, formerly Director of the London School of Economics.
Professor R. Rossiter, University of Western Ontario.
Dr. K. T. Zwicky, University of Geneva.
Professor Yen, Chulalongkorn University, Thailand.
Dr. Walter Baade, Mt. Wilson and Palomar Observatories.
Professor Herman Bondi, University of London.
Dr. T. H. R. Skyrme, U. K. Atomic Energy Research Establishment.
Professor Lyou-Jin-Soon, Seoul National University.
Dr. W. Kozak, Nencki Institute of Experimental Biology, Warsaw.
Sir Donald MacDougall, Nuffield College, Oxford.
Dr. A. Igo, University of Edinburgh.
Professor W. H. B. Court, University of Birmingham.
Dr. E. S. Hodgson, Columbia University.
Mr. Norman MacKenzie, Social Science Research Council.
Sir Harold Jeffreys, Cambridge University.
Dr. F. Magni, University of Pisa.
Dr. E. O. Oscarsson, University of Lund.
Dr. T. Araki, Kyoto University and University of California.
Professor S. Bashkin, State University of Iowa.
Dr. N. G. Opdyke, Rice Institute, Texas.

VISITORS.

During the year the university was honoured by the visits of—

H.R.H. The Princess Alice of Athlone.
H.E. The Governor of New South Wales and Lady Woodward.

Among other overseas visitors to the University were—

Professor Linus Pauling, California Institute of Technology.
Professor A. A. Sandosham, University of Malaya.
Professor A. R. M. Lower, Queen’s University, Canada.
Hon. Lionel Brett, Member of Council of Royal Institute of British Architects.
Dr. C. Hooykaas, University of London.
Professor Sir Lindor Brown, University College, London.
Professor Marshall Stone, University of Chicago.
Professor E. G. T. Liddell, Oxford University.
Dr. V. K. R. V. Rao, Vice-Chancellor, University of Delhi.
Dr. G. Templeman, Registrar, University of Birmingham.
Professor T. B. L. Webster, London University.
Professor Vincent Harlow, Balliol College, Oxford.
Professor G. O. Davies, University of British Columbia.
Sir Sydney Caine, Director, London School of Economics.
Professor R. Fifield, National War College, Washington.
Dr. A. L. Goodhart, Master, University College, Oxford.
Professor R. E. Watters, University of British Columbia.
Professor C. F. Powell, University of Bristol.
Dr. Siddiqi, University of Karachi.
Professor K. J. Ivanov, Pro-Rector, Moscow University.
Dr. L. I. Sedov, Soviet Academy of Science.
Sir John Cockcroft, Master, Churchill College, Cambridge.
Professor M. G. P. Stoker, Glasgow University.
Sir Raymond Priestley, formerly Vice-Chancellor, University of Birmingham.
Dr. R. K. Anderson, Rockefeller Foundation, New York.
Dr. K. G. Heinze, Harvard Observatory.
Mr. Robert Davies, Harvard Observatory.
Professor T. Ropp, Duke University.
Dr. Dowuona, Registrar, University of Ghana.
The Sixth Commonwealth Defence Conference on Clothing and Stores.
Madame Subandrio, Wife of Indonesian Minister for Foreign Affairs.
Sir Gilbert Laithwaite, Permanent Under Secretary, Commonwealth Relations Office.
Sir Leslie Peppiatt, President, Law Society.
Dr. Garcia, Chairman, Philippine National Science Development Board.
H.E. The British Ambassador to the Philippines.
H.E. The British Ambassador to Saigon.
U. Myut Theiu, Chief Justice of Burma.
Mr. Justice Harlan, U.S. Supreme Court.
Earl De La Warr, President, Royal Commonwealth Society.
President Paik, University of Korea.
THE JOHN CURTIN SCHOOL OF MEDICAL RESEARCH.

Dean's Remarks.

Consequent upon the decision (see previous Report) to develop a Department of Physical Biochemistry, plans were completed for the fitting out of a floor in Wing C. The planned development has now been completed and under the guidance of Dr. H. A. McKenzie a considerable amount of physical equipment has already been installed. The Professor of Physical Biochemistry (elect), Dr. A. G. Ogston, F.R.S., was able to visit the School and to complete plans for staff increases which will be made shortly after he takes up permanent residence in Canberra in September, 1960.

Arrangements were also made for the transfer of the Electron Microscopist, Miss Margaret Briggs, from the Department of Biochemistry to the Department of Physical Biochemistry, where electron microscopy is more closely associated with the work in hand.

Following recommendations from the School Committee, Council has decided to continue the Unit of Biological Inorganic Chemistry as a permanent part of the research structure. As a result of this decision, Dr. F. P. Dwyer (formerly Visiting Reader) has been appointed Reader and the financial arrangements with Commonwealth Scientific and Industrial Research Organization referred to in the previous Report will be discontinued.

The School Committee has given considerable attention to the problem raised by the necessity of housing increased numbers of experimental animals. The present arrangements which involve the use of much experimental space in the Animal House Wings E and F are no longer satisfactory and the increased use of large experimental animals had led to a plan to vacate the small experimental farm at Dickson. As a consequence, plans have been prepared for a small animal breeding annexe by Mr. W. K. Whitten, Dr. B. Morris and Dr. W. V. Macfarlane in conjunction with the University Architect. It is hoped that these plans may be brought to fruition in the following year.

DEPARTMENT OF BIOCHEMISTRY.

Staff.

Professor .. .. .. .. A. H. Ennor, D.Sc., F.A.A.
Visiting Professor .. .. .. R. J. Rossiter, M.D., B.Sc., M.A., Ph.D., B.M., B.Ch., F.R.S.C., F.R.I.C.
Research Fellow .. .. .. D. I. Magrath, M.Sc., Ph.D.
Head Technician .. .. .. R. Adams

Student and Teaching Activities.

There are eight students, seven of whom propose proceeding to a Ph.D. degree: M. D. Doherty, B.Sc. (commenced 21st October, 1957), and I. M. Beatty, B.Sc. (commenced 4th March, 1958), who are engaged on research into the biochemistry and chemistry of the substituted guanidines; V. Whittaker, M.B., B.S. (commenced 4th March, 1957), and B. McDougall, M.Sc. (commenced 3rd March, 1958), who are working on the in vitro synthesis of thymidine; R. Porra, B.Sc. (commenced 16th June, 1958), who is working on biochemical problems associated with haem proteins; G. Coleman, B.Sc. (commenced 3rd January, 1958), who is working on protein synthesis in bacteria, and T. J. Gaffney, M.B., B.S. (commenced 9th February, 1959), who is working on the metabolism of the naturally occurring guanidines.

Miss A. M. Morgan, A.B., M.A., who is a Fulbright Scholar, was enrolled as a student (not proceeding to a degree) for twelve months from 6th August, 1959.

Throughout the year regular Departmental seminars have been held at fortnightly intervals and there have been regular weekly meetings of the Journal Club. In these, as in other Departmental ventures, excellent co-operation has been given by the student members, who are now responsible for the organization of such meetings.

Visiting Professor.

Professor R. J. Rossiter, Professor of Biochemistry at the University of Western Ontario, London Canada, was Visiting Professor from 16th February, 1959, to 7th December, 1959, during which time he was an active member of the research team which is working on the metabolism of the phosphorylated guanidines.
Mention has already been made in the previous Report of the possibility that lombricine contained serine with the D-configuration. This possibility has now been confirmed and the D-serine component separated and crystallized (Magrath, Ennor, Beatty, Rosenberg). This finding is of considerable interest because it represents the first occasion on which a D-amino acid has been unequivocally proven to be present in animal tissue.

The D-form of lombricine has been synthesized and has been shown to be identical in chemical and physical properties with those of the naturally occurring compound (Magrath, Beatty).

A study of some chemical properties of lombricine, such as its reaction with nitrous acid, has been made. The reaction mentioned provides a further interesting example of the occurrence of phosphoryl group migration during the hydrolysis of phosphodiesters. Further work on the copper-catalysed degradation of lombricine and SEP, reported earlier, supports the hypothesis that the reaction is one of elimination rather than simple hydrolytic fission. However, a detailed investigation has yet to be made (Magrath, Beatty).

The presence of D-serine in lombricine suggests that it, and perhaps other D-amino acids, may be present in earthworm tissue and investigations designed to determine this possibility are still in progress (Rosenberg, Ennor, Morgan).

Interest in lombricine centres also in the fact that it is an unusual molecule, being the O-phosphodiester of guanidinoethanol and D-serine, and work has continued on its biological origin. The idea was earlier advanced on theoretical grounds that the biological precursor of the molecule may be serine-ethanolamine phosphodiester (Ennor, Morrison). If so, it would be expected that this compound would be present in trace amounts in earthworm tissue.

Experiments with this end in view have been undertaken (Ennor, Rosenberg) and a compound with the expected properties was isolated and identified. The isolation was achieved by the use of ion-exchange resins and the procedure used made possible the isolation of lombricine in almost 100 per cent. yield. The amounts of diester obtained, however, whilst enough for positive identification, were not sufficient to enable identification of the serine component. Re-examination of the problem (Ennor, Rosenberg, Gaffney, Rossiter) has led to improved techniques and the isolation of enough material to prove conclusively that the serine component is also D-serine.

More convincing evidence that the diester is the precursor of lombricine has come from studies using radioactively labelled precursors. For this work large earthworms (Megascolides cameroni), weighing about 10 gm., have been used and it is now clear that C¹⁴-labelled serine and ethanolamine, as well as inorganic P³², are incorporated under living conditions into both the diester and lombricine. The amount of label which is found in the diester, however, is many times greater than that found in lombricine, as would be expected if the diester was the precursor. Preliminary experiments with C¹⁴-amidine labelled arginine are also convincing in the sense that the label has been found in the guanidine portion of the lombricine molecule (Ennor, Rossiter, Rosenberg, Gaffney). It is certain, therefore, that the diester is the precursor of lombricine and that a transamidination reaction involving arginine and the diester is responsible for lombricine formation.

The actual mechanism of formation of the diester is now being studied in isolated systems and it is hoped that experiments now in progress will illustrate the biosynthetic pathway (Ennor, Gaffney, Rosenberg).

While the N-phosphorylated derivative of lombricine has never been isolated as a pure compound, its undoubted presence in the muscle suggested that it was a phosphagen. Proof of this has now been obtained by isolation, for the first time, of the enzyme. Its properties are now being further studied (Ennor, Rossiter, Gaffney, Rosenberg).

An investigation of the composition of earthworm ribonucleic acid has been initiated and results so far have shown a rather unusual distribution of purine and pyrimidine bases in this ribonucleic acid. It is intended to fully characterize each nucleotide with respect to base, sugar and configuration of the glycosidic linkage. Preliminary work has also been carried out on the analysis of the acid-soluble nucleotide fraction obtained from earthworms (Magrath).

In a continuation of studies on the reaction of the vitamin derivative, tetrahydrofolic acid, with formaldehyde, evidence has been obtained for the chemical structures of the products of this reaction, and the equilibrium constant for this reaction has also been obtained (Blakley).

An enzyme has been purified two hundred fold from bacterial extracts which catalyse the reduction of dihydrofolic acid to tetrahydrofolic acid. The properties of the enzyme have been studied together with the inhibitory effects of analogues of folic acid and a new type of inhibitor formed by the breakdown of reduced TPN (Blakley, McDougall).

Further studies on thymidine and thymidylate synthesis have shown that the latter compound is the primary product of enzymic methylation reactions in both thymus extracts and bacteria (Blakley, Whitaker and McDougall). Methods of measuring thymidylate synthesis and the optimum conditions for it to occur in extracts of bacteria and of thymus have been investigated in some detail.
Previous reports described a new amino compound arising from either glycine plus glucose, or from threonine formed by washed suspensions of \textit{Staph. aureus}. The compound, tentatively identified as aminoacetone, has now been isolated in crystalline form as the salt of p-toluene sulphonlic acid and positively identified as aminoacetone by physical and chemical means (Elliott).

It was previously postulated that aminoacetone might be involved in a metabolic cycle in which the compound is deaminated to methyl glyoxal. Evidence in favour of this hypothesis has now been obtained. Although liver and kidney slices catalyse only a slow disappearance of aminoacetone, a rapid oxidation of this substrate takes place in ox plasma. The ox plasma enzyme has been purified and from the product of aminoacetone oxidation methyl glyoxal has been isolated as the crystalline methyl glyoxal 2: 4-dinitrophenylhydrazine. Ammonia and hydrogen peroxide are also produced. The work provides the first demonstration of methyl glyoxal formation by an enzymic reaction and as such gives a possible function for glyoxalase (Elliott).

Work has continued on amylase synthesis by \textit{B. subtilis}. A study of enzyme production in growing culture has been completed and in particular it has been proved that amylase is a true extracellular enzyme and not released by cell lysis. A study of the properties of the amylase synthesizing system of resting washed cell suspensions has been made. The effects of energy supply, nitrogen sources, amino acid antagonists, &c., have been investigated and work on cell free extracts has been started (Elliott, Coleman).

Previous work (Morrison, Doherty) indicated that an extract of rabbit skeletal muscle catalysed the quantitative release of creatine from N-phosphorylcreatine (PC) in the presence of low concentrations of DPN and consisted of two fractions which could be separated by isoelectric precipitation at pH 5.2. Similar results were obtained when the pH 5.2 precipitable fraction was replaced by either Mg$^{++}$-activated ATPase or apyrase. This suggested that the pH 5.2 supernatant fraction may catalyse a reaction between DPN and PC with the formation of a phosphorylated DPN derivative which could be hydrolysed by the pH 5.2 precipitate fraction, ATPase or apyrase. Such reactions would explain the quantitative release of creatine from PC.

Creatine release from PC could not be detected when PC and DPN (in low concentrations) were incubated with the pH 5.2 supernatant fraction, but could be detected when DPN was added in substrate quantities. The amount of creatine released was dependent on the DPN concentration and at the same time there was no release of inorganic P or destruction of DPN. These results make it appear likely that a phosphorylated DPN derivative was indeed formed. Attempts have been made to isolate this derivative, but it appears to be unstable, breaking down to ATP during the isolation.

Creatine release from PC is also obtained when DPN is replaced by DPNH$_2$, TPN or ADP release.

\textbf{Other Activities.}

Dr Blakley and Dr Elliott visited the University of Queensland from 22nd June to 26th June, and from 20th July to 24th July, respectively, to give courses of lectures to final-year and honour students in the Department of Biochemistry.

Dr Morrison attended and presented papers at meetings of the Australian Biochemical Society and A.N.Z.A.A.S. in Perth in August.

Professor Ennor attended a meeting of Deans of Medical Schools of Australia and New Zealand in Dunedin from 6th to 9th February.

Dr Elliott and Mr Coleman attended and presented a paper at the C.S.I.R.O. Symposium on Proteins held in Melbourne on 10th and 11th September.

Professor Ennor has been appointed Chairman of the Medical and Scientific Advisory Committee of the National Heart Foundation of Australia and a member of the Natural Sciences Selection Committee of the Nuffield Foundation and of the Sectional Committee for Medical Sciences of the Australian Academy of Science.

\textbf{Publications.}

Beatty, I. M. and Magrath, D. I.—

Beatty, I. M., Magrath, D. I. and ENNOR, A. H.—

Blakley, R. L.—

Collins, F. D.—
“Studies on phospholipids. 5. The separation of dinitrophenylated and methylated phospholipids by counter-current distribution.” \textit{Biochem. J.}, 72, 281.

Dawson, R. M. C.,* Elliott, D. C.,* Elliott, W. H. and Jones, K. M.*

Elliott, W. H.—
"Aminoacetone: its isolation and role in metabolism." Nature, 183, 1051

Jones, K. M.* and Elliott, W. H.—

Morrison, J. F. and Ennor, A. H.—
"N-phosphorylated guanidines." The Enzymes, 2, 89.

Rosenberg, H.—
"The detection of phosphates on chromatograms." J. Chromat., 2, 487.
"The occurrence of guanidinoacetic acid and other substituted guanidines in mammalian liver." Biochem. J., 72, 582.

Rosenberg, H. and Ennor, A. H.—

Rosenberg, H., Rossiter, R. J.,† Gaffney, T. and Ennor, A. H.—

DEPARTMENT OF EXPERIMENTAL PATHOLOGY.

Staff.

Reader . . . . . . . . . . . . G. B. Mackaness, M.B., B.S., M.A., D.Phil., D.C.P.,
Senior Fellow . . . . . . . . . . . . Bede Morris, B.V.Sc., D.Phil.
Head Technician . . . . . . . . . . . . J. Harding.

General.

Dr. Mackaness left in May for a year's study-leave at the Rockefeller Institute in New York.
Professor Courtice delivered the Edward Stirling Memorial Lectures in Adelaide in June.

Research Activities.

The research activities of this Department are concerned with two general fields, cardiovascular disease and immunology.

The increasing incidence of atherosclerosis and its most common clinical manifestation, ischaemic heart disease, has focused attention on the possibility that disorders in lipid transport and metabolism may contribute to the pathogenesis of these conditions. Three aspects of the problem of lipid transport and metabolism are being studied: the uptake and metabolism of triglycerides and unesterified fatty acids in various organs, the permeability of the vascular endothelium to various lipoproteins and the comparative physiology of lipid transport.

It is possible to inject radioactive labelled fatty acids and triglycerides intravenously into animals and measure the rate at which they are removed from the blood stream and their subsequent distribution and part in the various tissues. It is difficult, however, from studies in the intact animal to discover the role that any individual organ or tissue plays in these processes. It is known that the anatomy and physiology of the blood capillary membrane varies in different organs and the permeability characteristics of the vascular endothelium to lipids at any particular site may well be related to the metabolic requirements of the tissue cells themselves.

The liver is known to play an important part in fat metabolism and the uptake and metabolism of unesterified fatty acids and triglycerides by this organ have been studied (Morris). An isolated perfused liver preparation has been developed to enable the liver of the rat to be maintained in a relatively physiological state for several hours. This preparation will produce bile for periods up to 12 hr. and extract oxygen, particulate material and dyes such as B.S.P. Rose bengal from the perfusate in much the same way as does the liver of the intact rat.

A physiological emulsion of 14C-labelled triglyceride was obtained from rats in which a thoracic duct fistula had been established previously. These animals were fed 14C-labelled palmitic acid and the fatty chyle containing 14C-labelled triglycerides in the form of chylomicrons was collected from the fistula. This substrate was used in experiments with the perfused liver. Unesterified 14C-labelled palmitic acid was prepared as the fatty acid-albumin complex.

* Not a member of the Australian National University. † Visiting Professor.
The perfused liver was found to take up both labelled triglyceride and unesterified fatty acids and oxidize them to CO₂. About 30–40 per cent. of the unesterified fatty acid molecules present in the portal blood were extracted during a single transit through the liver, whereas only about 6 per cent. of the labelled triglyceride was removed. It appeared, however, that while most of the triglyceride which was taken up and retained by the liver a large proportion of the unesterified fatty acids were rapidly retransported after they were extracted from the perfusate.

The rate of oxidation of fat to CO₂ was found to be related to the dietary state of the rat from which the liver was obtained. Livers from starved rats were found to oxidize about twice as much triglyceride and unesterified fatty acids as did livers from fed rats. As the livers from starved animals produced significantly less total CO₂ than those from fed animals the differences in the oxidation of fat were even greater when comparisons were made on the basis on specific activity.

The effects of temperature, of perfusion pressure and of concentration of fat in the perfusate have been studied by the use of factorial methods. The efficiency of the liver for extracting fat has been found to be related to blood flow and temperature. There is evidence that the extraction efficiency of the liver falls off at concentrations of fatty acids above 0.25 mg./ml.

The production of CO₂ was also directly related to temperature and pressure, maximal production occurring at the highest perfusion pressures and temperatures. The specific activities of the CO₂ produced, however, showed a maximum at the highest perfusion pressure and the lowest temperature. This suggested that although increasing the temperature produced an overall increase in the metabolic activity of the liver, the oxidation of fat was relatively more efficient at lower temperatures.

The most widely accepted view concerning the accumulation of lipid in the intima of the aorta and other large arteries in atherosclerosis postulates that the lipid is derived from the circulating plasma. If this is so, the lipids which are present in the plasma as groups, or families of lipoproteins, pass through the vascular endothelium and accumulate in the subendothelial tissue. Experiments have been performed in which the permeability of the vascular endothelium to various lipid fractions was studied in different tissues (Courice).

Lymph was collected from the paws and the liver of rabbits in different states of lipaemia. Hypercholesterolaemia was induced by feeding cholesterol to the diet and hyperlipaemia by the intravenous injection of Triton WR-1339. All the various lipoprotein complexes of the plasma, including lipid particles, were present in these conditions in the lymph from the paw and the liver; in the lymph from the paw the total lipid content was on the average about 15 per cent. and in the liver about 40 per cent. of the plasma levels. When the capillaries of the skin were injured by scalding the paw, the lymph became quite milky in appearance if the plasma was milky and the lipid concentration rose to about 50 per cent. of the plasma levels. In rabbits fed cholesterol or injected with Triton WR-1339, large lipid particles, therefore, very rapidly passed through the injured skin capillaries. When lipaemia was produced by infusing an artificial fat emulsion which contained larger lipid particles than were found in other lipaemic states, there was only a very small increase in the number of these particles in the lymph, which remained macroscopically clear.

The permeability of the liver and skin vessels of the cat to lipids was also investigated after the intravenous infusion of artificial fat emulsions, homologous chyle and heterologous hypercholesterolaemic plasma. The results obtained were similar to those observed in the rabbit. These experiments show that the lipoproteins which have a high content of cholesterol, pass through the vascular endothelium and are present in the tissue fluid and lymph in fairly high concentrations. When the endothelium is damaged, the concentration of lipoproteins in the lymph is greatly increased. It would seem that a similar process may occur when these lipids are deposited in the intima of arteries.

Some comparative studies of fat transport have been carried out in fishes (Morris). These animals are known to have a very long potential life span and it is thought that they are not subject to the degenerative arterial diseases found so commonly in man. It has been shown that by eating unsaturated fatty acids, the level of cholesterol in the plasma of man can be significantly reduced and this had led to many investigations which concern the possible effect of diet on the development of atherosclerosis. The diet of many carnivorous and omnivorous fishes contains large amounts of polyunsaturated fatty acids as these fats are characteristic for marine animals. Analysis of the plasma of some 30 species of fresh and salt-water fishes has shown that many species have levels of cholesterol several times higher than the levels found in man. Individual fish have been found with cholesterol levels up to 1,400 mg. per cent. The characteristic feature of the plasma lipids of fish, however, is their small molecular size and high electrophoretic mobility. All the samples of fish plasma examined contained relatively high levels of phospholipids and it was thought that the association of phospholipid and cholesterol in the lipoprotein molecules assisted in stabilizing the lipoprotein complexes in solution in the plasma. Lipaemic plasma obtained from fish was always characteristic for marine fishes.

The large animal surgery has been equipped and work has started on the development of techniques for the collection of lymph and the study of problems of the physiology of the mammary gland in sheep (Lascelles and Morris).
Dr. Mackaness is working at the Rockefeller Institute on the immunological factors affecting the fate of organisms after they are ingested by phagocytic cells. In respect to virulent staphylococci, it has been found that 5 to 10 per cent. resist destruction within mononuclear phagocytic cells. Specific immunization produces neither cellular nor humoral changes which reduce the number of organisms that survive; although a factor appears which greatly accelerates the rate at which they are taken in by cells. The organisms which survive within cells appear to have been taken into cells which are less competent to destroy them. They do not survive because they differ from the majority in being more resistant to destruction. The reason for this apparent variation in the activity of phagocytic cells is being studied.

Publications.


Department of Medical Chemistry.

Staff.

Professor . . . . . . A. Albert, Ph.D., D.Sc., F.R.I.C., F.A.A.
Senior Research Fellow . . E. Spinner, M.Sc., Ph.D.
Head Technicians . . . . E. P. Serjeant (resigned 30th October), J. S. Harper (from 1st November; previously Senior Technical Officer, Grade I).

Student and Teaching Activities.

G. B. Barlin, M.Sc., was admitted to the degree of Ph.D. (General Motors-Holden Fellow) for his thesis: “Thiol-thione equilibria in heterocyclic mercaptans”. He then proceeded, on the award of a C.S.I.R.O. Travelling Studentship, to study heterocyclic kinetics under Professor N. B. Chapman at the University of Hull.

Three other students worked in this Department: S. Matsuura, M.Sc., from Japan, who enrolled in 1958; N. W. Jacobsen, M.Sc., from Western Australia, who enrolled on 12th January (subject: Methylation of aminopteridines and aminopyrimidines), and J. C. B. White, M.Sc., from New Zealand, who enrolled on 4th June (subject: Physico-chemical studies of substituted hydroxypyridines).

Seminars were conducted in the Department, fortnightly.

Four lectures on “The Nature of the Chemical Bond” were given in the Florey Lecture Theatre by Drs. Spinner and Perrin.

Research Activities.

Further studies have been made of the connection between structure and properties in hydroxy- and amino-heterocycles. This type of structure, common in drugs and in cell-metabolites, presents many paradoxical features which call for clarification.

A new peculiarity was discovered this year: x-hydroxy-groups in the pyridine series have an acid-strengthening effect on a second ionizable substituent. This reveals that these groups, previously classified as electron-releasing, are actually electron-attracting when the molecule is in the ground-state (Albert).
This Department is one of the few places in the world where the fundamental chemistry of pteridines, substances of considerable importance in cell-metabolism, is investigated. A study, which has extended through seven years, of the action of alkali and acid on hydroxypteridines has been completed by establishing the constitutions of the products formed from 2-hydroxypteridine (Albert and Reich).

The hydrogenation of all the mono- and di-hydroxypteridines has been effected by a variety of methods. In some cases the positions taken up by the entering hydrogen atoms have been established by synthesis (Albert and Matsuura).

Potentiometric study of the addition of one equivalent of dilute acid to 2-aminopteridine has revealed two consecutive changes, which are quantitatively reversed after neutralization by alkali. The insertion of methyl-groups in various parts of the molecule counteracts these changes, which is a peculiarity of the cation and appear to be a covalent hydration followed by ring-opening (Albert and Howell).

Quantitative investigation of the tautomism of mercaptoquinolines and -isoquinolines has shown that, no matter what position the mercapto-group occupies in the molecule, the equilibrium always favours forms in which the mobile hydrogen has migrated to the ring-nitrogen (Albert and Barlin).

Indoles having an extra ring-nitrogen atom are of interest as potential blockers of the hormone serotonin, particularly in the brain. The work begun in 1957 by Dr. T. K. Adler, with the support of the U.S.A. National Institute of Mental Health, has been completed. The spectra and ionization constants of all six parent azaindole have been measured, and correlated with structure. Similar studies have been made on napthyridines (Albert).

One of the commoner natural vitamins, B12 contains naphthiminazole in place of the benziminazole nucleus. This fact, and the inhibitory activity of naphthiminazoles on virus multiplication (see last year's Report), suggested the synthesis of further analogues. 6,7,8,9-Tetrahydro-naphth(1,2)iminazoles have now been made for the first time and are being examined by Dr. I. Tamm at the Rockefeller Institute, N.Y. (Brown and Harrison).

The fundamental pyrimidine studies of the Department, which date from its inception, are being continued. New preparative methods have been developed for nitro-cytosine and nitro-isocytosine. Nitouracil has been shown to favour the di-oxo form in aqueous solution. Several N-methylated derivatives of 4,6-disubstituted pyrimidines have been prepared for the first time. From these, new purines are being produced, which are contributing to understanding the mode of action of a mammalian enzyme, xanthine oxidase (Brown).

Following discovery of the marked inhibitory activity of N-phenylsydnone in experimental cancer of mice, four analogous substances have been prepared in quantity and are being screened by the Cancer Chemotherapy Center, Bethesda (U.S.A.). The 2-naphthyl-analogue shows some activity (Brown).

Methylation studies on amino-pyrimidines, -pteridines and -purines (a neglected field because of experimental difficulties) have been initiated. 4-Aminopteridine gave a strong base, 1,4-dihydro-4-imino-1-methylpteridine, which was hydrolysed to 2-amidino-, and 2-carbamoyl-3-methylaminopyrazine. 4-Dimethylaminopteridine gave the first quaternized pteridine to be described. Three pteridines from this series are being tested in leukaemia by Dr. W. Jacobson in Cambridge (Brown and N. Jacobsen). In collaboration with Dr. R. Blakley, a method has been devised for the determination of radioactively-labelled methyl iodide. The methylation of 4,5-diamino-2-mercaptopyrimidine was used for this purpose (Brown).

Studies of the behaviour of metallic ions under physiological conditions have been continued. Quantitative studies have been made of the equilibria involved in the hydrolysis of cupric ion, using a high-precision PH meter. This work was extended to the dismutation reactions of copper chelates, also the behaviour of cupric ion with histidine has been clarified and stability constants obtained (Perrin).

The oxidation-reduction potentials of metal complex ions have been interpreted in terms of current chemical theory, thus providing a basis on which to predict the likely magnitudes of potentials. Similar considerations have been found to explain changes in the absorption spectra and potentials of the metallloporphyrins and haemoproteins. Calculations have been made of the physical chemical changes which take place when agents which chelate calcium are supplied to nervous tissue by ionophoresis (Perrin).

Quantitative potentiometric studies have been begun on a number of heterocycles which show hysteresis effects during acid-base titration (Perrin). Recent nuclear magnetic resonance studies have led overseas workers to propose that amides are protonated at the oxygen rather than at the nitrogen atom, which conflicts with conclusions reached in this Department from vibration-spectral work (see last year's Report). The results have been reconciled by demonstrating that there is restriction to internal rotation in N-protonated amides (Spinner).

A study of the structures and tautomeric equilibria of substituted hydroxyppyridines, their cations and their anions, by ultraviolet, infrared and Raman spectroscopy, is in progress (Spinner and White).
Fully saturated $p$-substituents, such as $\alpha$- and $\beta$-halogeno-methyl and -ethyl groups, are capable of producing effects on the electronic spectrum of anisole that are as large as, or larger than, those of conjugatable unsaturated para-substituents. This is contrary to what is demanded by accepted theory, but an explanation has been found in terms of intramolecular London forces (Spinner).

The highly anomalous electronic spectrum of the cation of quinazoline in aqueous acid (compared to either aqueous neutral quinazoline or the 4-methylquinazoline cation) has been attributed to the covalent addition of water across the 3 : 4 bond in the cation. This explanation has been shown to be correct by a study of the electronic spectra of the cations of quinazoline and 4-methylquinazoline in anhydrous dichloracetic acid. A similar explanation was verified for anomalies observed with the cations of 2-aminopteridines that contain no 4-methyl substituent (Spinner).

A number of infrared spectra of materials isolated from tuberculous tissue were analysed for Dr. A. W. Pound of the Department of Pathology, Brisbane Hospital. The infrared spectra of oxamides and thio-oxamides were determined in a collaborative study with Drs. J. M. Swan and B. Milligan of the Wool Research Laboratories, Division of Protein Chemistry, C.S.I.R.O.

The degradation of pyrimidine to ammonia by alkali has been studied under graded conditions of temperature and concentration. A new method has been devised for the microdetermination of iodine in heterocyclic hydriodides. The advantage of this method is that prior destruction of the organic part of the molecule is unnecessary (Fildes).

Other Activities.

Professor Albert visited London in April upon receiving an invitation to chair the biological section of the International Conference on Co-ordination Chemistry, sponsored by the International Union of Pure and Applied Chemistry. He also lectured to the Sloan-Kettering Institute for Cancer Research, New York, on “Structure-action relationships”. Dr. Spinner read a paper at the Second Australian Spectroscopy Conference, Melbourne, on “The vibration spectra and structures of the hydrochlorides of urea, thiourea and acetamide”, and another at the A.N.Z.A.A.S. meeting, Perth, on “Factors influencing the stabilities of some unsaturated N-heterocyclic ions”. Dr. Perrin read two papers at the A.N.Z.A.A.S. meeting, “The binding of oxygen and carbon monoxide by haemoglobin”, and “Some misinterpretations in studying metal complexes”. Dr. Perrin took part in the Symposium on Haematin Enzymes, Canberra, sponsored by the International Union of Biochemistry.

Various substances (mainly acridines, pyrimidines, purines and pteridines) were despatched upon request to help the work of The Sloan-Kettering Institute for Cancer Research (N.Y.), The Polytechnic Institute of Brooklyn, the South Charleston Institute (Virginia), the Chester Beatty Institute for Cancer Research (London), The Hebrew University (Jerusalem), D.S.I.R. (New Zealand), C.S.I.R.O. (Divisions of Plant Industry, and of Fisheries). The Technical Laboratory was made available to C.S.I.R.O. for a month for preliminary processing of their new apple fruitlet hormone.

Of the 1,350 microanalyses performed during the year, 42 per cent. were for members of other Departments. Also, several infrared spectra, ionization constants, also 25 high-pressure hydrogenations were done for other Departments.

Publications.

During the year, the following work by members of the staff was published:


* Not a member of the Australian National University.
Kwietny, H.,* Levin, G.,* Bergmann, F.* and Brown, D. J.—“Mechanism of the enzymatic oxidation of purines.” *Science*, 130, 711.


“Spectrophotometric determination of iron as ferric acetate complex.” *Analyst. Chem.*, 31, 1181.


Spinner, E.—“The detection of thiocarbonyl groups by infrared spectroscopy.” *J. Org. Chem.*, 23, 2037 (1958).‡

“The vibration spectra and structures of the hydrochlorides of urea, thiourea and acetamide. The basic properties of amides and thioamides.” *Spectrochim. Acta*, p. 95.

**DEPARTMENT OF MICROBIOLOGY.**

**Staff.**

Professor . . . . . . . . . . . . . . . . . . . . . . . . . . . F. J. Fenner, M.B.E., M.D., D.T.M., F.R.A.C.P., F.A.A., F.R.S.

Reader in Virology . . . . . . . . . . . . . . . . . . . . S. Fazekas de St. Groth, M.D., Ch.B., Sc.M.

Senior Fellow . . . . . . . . . . . . . . . . . . . . . . . . . H. J. Cairns, M.A., M.D.

Fellows . . . . . . . . . . . . . . . . . . . . . . . . . . W. K. Joklik, M.Sc., D.Phil., C. A. C. Mims, B.Sc., M.B., B.S. (appointed 11th December, 1959; formerly Research Fellow).


Honorary Fellow . . . . . . . . . . . . . . . . . . . . . . . . A. Gottschalk, M.D., D.Sc., F.R.A.C.I., F.R.I.C., F.A.A.


Head Technician . . . . . . . . . . . . . . . . . . . . . . . . A. Logie, F.I.M.L.T.


Thesis . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Mrs. Anne Gemmell was awarded the degree of M.Sc. The title of her thesis was "Variation in Vaccinia Virus."

**Visits Abroad.**

Dr. I. D. Marshall was awarded a U.S. National Academy of Science Post-Doctoral Fellowship to work in U.S.A. for two years, and he has been granted leave of absence from his position as Research Fellow for two years from 28th April, 1959. He is currently working with Professor W. C. Reeves at the School of Public Health in the University of California at Berkeley.

Dr. W. K. Joklik left on 13th October, 1959, to spend nine months on study-leave at the Laboratory of Cell Biology, National Institutes of Health, Bethesda, Md.

* No is member of the Australian National University. † Work carried out in 1956. ‡ Omitted from 1958 Report.
The Department is concerned exclusively with research in virology, almost entirely with the animal viruses. Studies are being carried out at several levels of complexity: the reaction of individual cells to infection, the response of cell populations, the pathogenesis of viral infections in intact animals and the epidemiology and evolution of natural virus diseases.

Several approaches are being applied to our problems: biological (including genetic), chemical, and physical. On the whole, attention is focused on two virus groups, influenza and the poxviruses, with which a great deal of experience has now been accumulated.

**Epidemiology of Myxomatosis (Marshall).**

Work on the epidemiology of myxomatosis in Australian wild rabbits is being brought to an end. The overall pattern of change of virus and host animal is now clear. It is hoped that at intervals of about five years an assessment can be made of further changes, but the intensive investigations carried out since 1951 are no longer justified.

A test of the genetic resistance of wild rabbits at Lake Urana after seven years of exposure to myxomatosis showed that the upward trend in resistance apparent earlier has continued. The mortality rate produced by virus which originally killed 90 per cent. of inoculated rabbits has now fallen to about 30 per cent.

Strains of virus of all degrees of virulence continue to be isolated from natural cases of myxomatosis. It is possible that more virulent strains have been recovered during the current year than in the previous two years, but analysis is not yet complete and moderately virulent strains are still dominant.

Dr. Marshall has had the opportunity of investigating two outbreaks of myxomatosis in California. He has recovered several strains of virus from infected domestic rabbits, and all were shown to resemble Californian strains isolated in 1949 and to differ from the South American strains. Dr. Marshall also isolated the virus from the Californian brush rabbit, *Sylvilagus bachmani*, thus proving that this animal is a reservoir host in California.

**Analysis of the Growth of Viruses in Experimental Animals (Mims, Schell, Roberts).**

When viruses produce pathological changes in injected animals, without appearing to multiply, they are loosely referred to as being "toxic". Influenza virus is toxic in this sense when injected intracerebrally or intravenously into mice, because mice die in spite of the fact that there is no demonstrable growth of the injected virus. This toxic action of influenza virus has been investigated using the fluorescent antibody technique, and it has been found that the virus undergoes a single cycle of growth in injected mice. Although most of the virus produced cannot be detected by conventional methods of assay, it can readily be detected by the fluorescent antibody method. The exact cells which produced virus could moreover, be identified in tissue sections. After intracerebral injection there is growth of virus in the meninges, and especially in the ependymal lining of the ventricles. The toxic action is a result of this growth. After intravenous injection there is growth of virus in liver cells, and mice die because of the severe liver damage which ensues.

The fluorescent antibody technique has also been used to study the role of the reticulo-endothelial cell system in virus infections, and it is clear that, although these cells sometimes assist the pathogenic process and the spread of virus through the body, they are often of very great importance in resistance to infection.

In an analysis of the toxic effect of vaccinia virus on macrophage cells, the fluorescent antibody technique is being used in conjunction with autoradiography.

Dr. Schell's work on the differences in the response of susceptible and resistant mice to infection with mousepox has now been concluded. It has been shown that resistant mice are resistant because of the rapid rate at which they produce antibodies to the infecting virus. There is no evidence that the cells of resistant mice differ from those of susceptible mice in their sensitivity to infection. This is the first time that the effectiveness of the immune response has been demonstrated to be the physiological basis for innate resistance, though such relationships have frequently been postulated. Apparent anomalies in the patterns of resistance following different inoculation routes have been resolved, and a preliminary genetic analysis of the resistance character has been made.

**Genetics of poxviruses (Fenner, Woodroffe, Gemmell, Abel, Easterbrook).**

Studies of the genetics of poxviruses has been pursued at two levels. During studies on the reactivation of heat-inactivated poxviruses evidence was obtained that recombination sometimes occurred between the genetic material of the reactivating agent and the heat-inactivated virus. Results so far suggest that recombination occurs between closely related viruses, such as vaccinia, cowpox, rabbitpox, and ectromelia; but not between these and poxviruses belonging to other subgroups, like myxoma and the birdpox viruses.
Up to the present most genetic studies of animal viruses have used virulence as an important if not the only marker character. Virulence is a complex character under polygenic control and is unsuitable for what are still exploratory investigations in animal virus genetics. With several viruses of the vaccinia subgroups it has been found that strains which normally produce red (ulcerated) pocks on the chorio-allantoic membrane frequently yield pock variants which produce white (nonulcerated) pocks. Isolation and purification of a large number of these pocks showed that they differed from each other in their biological characters. Pairwise crosses between them often produced wild type pocks, showing that these white variants were one-step mutants of the wild type virus. From the results of pairwise crosses between eighteen white mutants it has proved possible to arrange the loci controlling them in a linear order, thus providing, for the first time, a map of part of the genome of an animal virus. There are still considerable technical difficulties in obtaining the sort of quantitative data that are required for proper genetic mapping, with map distances, but these have now been defined.

Methods have been worked out on the infection of suspended cells which give useful information on the growth cycle of vaccinia virus and should permit precise quantitative studies of the kinetics of reactivation and recombination.

A start has been made on the radiobiology of vaccinia virus infections. Multiplicity and cross-reactivation of vaccinia virus have been demonstrated and these phenomena are now being studied quantitatively.

Reactivation of Poxviruses (Joklik, Fenner, Woodroofe, Holmes).

It was briefly reported last year that the old observations of Berry and Dedrick, that heat-inactivated myxoma virus could "transform" active fibroma virus, had been extended to the vaccinia-rabbitpox system; and that the results could more properly be interpreted as reactivation rather than transformation.

This work has now been considerably extended. Tests with a wide variety of animal viruses showed that any member of the poxvirus group could reactivate any other heat-inactivated poxvirus, but that reactivation could not be demonstrated with active viruses belonging to other virus groups. It was also found that urea treatment, as well as heating, would produce reactivable particles.

Methods of assay of reactivable virus have been worked out, so that the effects of various chemical treatments on reactivability could be followed. Reactivable particles are relatively resistant to digestion with proteolytic enzymes, and the current picture of such particles is that their genetic material is intact, but that their protein shell has been injured by denaturing agents in such a way that they are unable on their own, to initiate infection. The entry of an active poxvirus into a cell which contains a reactivable particle appears to trigger off the exposure of the genetic material of the latter so that it can replicate.

Recent work with poxviruses inactivated with ultraviolet, $\gamma$ irradiation, and with nitrogen mustard suggests that such particles, which are themselves inactive, may reactivate heat-inactivated virus.

The Initiation of Infection by Vaccinia Virus (Cairns).

A study has been made of vaccinia virus infection, using staining with fluorescein-coupled antibody and autoradiography. As a result, the following conclusions have been reached.

Even when a cell receives several virus particles, only one particle converts the cell into a synthesizer of virus; once this act of conversion has happened many, if not all, the particles in that cell give rise to factories synthesizing virus protein and DNA. These factories, which are in the cytoplasm, all start operating at the same time.

Multiplication of Influenza Virus (Barry, Cairns).

Work has continued on the mechanism of incomplete virus formation, interference and multiplicity reactivation.

It has been conclusively established that influenza virus undergoes multiplicity reactivation; in other words, when several virus particles, which have been inactivated by ultraviolet light, share a host cell they may, by reshuffling their damaged parts, recreate one or more whole undamaged particles which can then proceed to multiply.

Defective (incomplete) virus is formed when there is more than one parent virus particle per cell. Thus, under conditions of multiplicity reactivation, incomplete virus is formed if the reshuffling of the constituent parts recreates more than one intact parent.

The multiplication of live virus in a cell may be interfered with if that cell has already received an inactivated particle. Several live particles can co-operate to overcome this defect in the cell, just as they may co-operate to overcome defects in themselves.

The Chemical Structure of Components of Influenza Virus (Laver).

It has been postulated that the influenza virus particle consists of an outer layer containing a number of identical protein sub-units, and a central portion consisting largely of nucleoprotein. Attempts are being made to degrade the virus so as to obtain these subunits in pure form, and to characterize them by chemical, physical and immunological methods.
For this purpose pure preparations of virus are essential, and a method has been devised for the purification of the LEE strain of influenza which involves the use of columns of DEAE-cellulose.

In order to obtain some insight into the number of different kinds of protein molecules present in the virus particle, an investigation has been commenced into the N-terminal amino acids present in the whole particle, and in the degradation products. Since the quantities of material available are very small it has been necessary to devise a micro method of N-terminal amino acid analysis, involving the use of $^{35}\text{S}$-labelled phenylisothiocyanate.

General Structure of an Influenza Virus Haemagglutinin Inhibitory Mucoprotein
(Gottschalk, Graham, Murphy).

Ovine submaxillary gland mucoprotein (OSM) is the most potent influenza virus haemagglutinin inhibitory mucoprotein tested so far. It was prepared in a chemically, electrophoretically and ultra-centrifugally homogeneous state. The carbohydrate-prosthetic group was detached by mild alkali treatment and isolated in an analytically pure form. Its molecular structure was shown to be that of the reducing disaccharide 6-alpha-D-N-acetylneuraminyl-N-acetylgalactosamine by elementary analysis, identification of its components, susceptibility to alpha-neuraminidase and by its periodate consumption. The prosthetic group constitutes 42 per cent. of the OSM molecule. Since the molecular weights of the prosthetic group and of OSM are 512 and about 500,000 respectively, it is concluded that about 400 individual prosthetic groups are attached to the protein core.

With regard to the linkage of the prosthetic group to the protein moiety it was established that the potentially reducing group of the disaccharide is joined to aspartic and glutamic acids by a glycosidic ester bond. This holds for 85 per cent. of the prosthetic group; the residual is most probably attached to serine and/or threonine in an O-glycosidic linkage.

The protein moiety of OSM was found to have an almost complete complement of amino acids; its characteristic features are low content of aromatic and sulphur-containing amino acids and relatively high content of hydroxy-amino acids. The amide nitrogen of OSM could only be determined after enzymic removal of its terminal neuraminic acid residues since even on mild acid hydrolysis the release of amide nitrogen was accompanied by the degradation of N-acetylneuraminic acid with liberation of about half its nitrogen in the form of ammonia. The true value for amide nitrogen of OSM is 0.34 per cent. of the total nitrogen.

OSM solutions (0.5 per cent. w/v) are rather viscous; the intrinsic viscosity is about 2.5.

Both the biological activity and the viscosity of OSM solutions are reduced by treatment with neuraminidase or with trypsin, the latter enzyme being more effective. Neuraminidase acts by removing 80 per cent. of the terminal neuraminic acid residues, trypsin by splitting the peptide bonds involving lysyl and arginyl residues of OSM.

OSM is visualized as an asymmetric structure, possibly or even probably an alpha-helix, which is prevented from assuming a closely packed, symmetric structure by the presence of multiple, strongly negatively charged prosthetic groups.

Multiplication of Polioviruses (Howes).

In cell populations infected with poliovirus most of the virus yield accumulates within cells as it matures, and is released gradually only after completion of maturation. A small fraction of the yield is released during the maturation phase.

The relation between the growth cycle in cell populations to that in single cells has been studied in terms of virus maturation and virus release. By analysing the virus content of single cells and groups of cells harvested at intervals during the maturation phase, maturation has been shown to be asynchronous in the cells of a population, even when these cells are multiply infected. Release from each cell occurs over a short time interval, but cells vary widely in the time at which they begin to release their virus yield.

Thus, although in cell populations maturation and release of part of the mature virus yield occur concurrently, in individual cells release normally begins sometime after completion of maturation, and there is no evidence that maturation and release can occur at the same time in the same cell. If release occurs following a lytic type change in the cell, the possibility that in some cells maturation is terminated prematurely or even completely prevented must be considered. In most cells, however, the virus yield is held within the apparently quiescent cell for a prolonged interval before release occurs. This intracellular retention phase in single cells is extremely variable, and this variability is responsible for the apparent gradual release of virus observed when the cycle is studied in cell populations.

Cells infected with multiplicities between 5 and 10 of two distinct poliovirus types usually yield only or predominantly one genotype. This result might be expected were asynchrony in replication of vegetative virus partly or wholly the cause of asynchrony in maturation.
The Neutralization of Viruses by Antibody (Lafferty, Witnell).

Further studies have been carried out on the neutralization of influenza and vaccinia viruses by specific antibody. It is clear from this work that these viruses react with antibody in a manner that is exactly analogous to the reaction of bacterial viruses with specific antibody.

When the virus is mixed with antibody there is a rapid reaction that leads to the formation of a loose combination between them. This union can be readily dissociated by dilution of the reaction mixture. The rapid reaction is followed by a relatively slow reaction which stabilizes the primary union. When this secondary reaction has taken place the rate of reactivation, on dilution in a medium of neutral pH, is extremely slow. However, the bond between the virus and antibody can be broken by treatment with ultrasonic vibrations, or by dilution in a medium of low pH.

Papain splits the antibody molecule into three pieces of approximately equal molecular weight. Two of these pieces each carry one of the active sites of the original molecule. When neutralizing antibodies are digested with papain the resultant monovalent antibodies will combine loosely with the virus particle, so neutralizing its infectivity, but are unable to stabilize this union. Thus the ability to undergo the secondary reaction seems to be dependent on the integrity of some part of the antibody molecule other than the active site.

Kinetic studies have revealed further complexities in the reaction mechanism. When the rate of formation of the stable union is followed, a small fraction of the virus particles are found to undergo this reaction at a very much slower rate than the remainder of the particles. This effect is not due to any inherent heterogeneity of the virus particles. Rather, it is due to a heterogeneity induced during the reaction. This fraction of the virus population has been called the protected fraction. The protected fraction can be divided into two sub-classes, the reversibly induced protected fraction and the host-cell induced protected fraction. The reversibly induced protected fraction consists of virus particles that have antibody loosely bound to their surface. The available evidence indicates that these loosely bound protecting antibodies may be able to form a stable bond with the virus particle but they do so at a much slower rate than "normal" antibody molecules. The host-cell induced protected fraction may vary from zero upwards depending on the cell system used to assay the virus. This protected fraction arises because a fraction of the virus particles have, firmly bound to their surface, antibody molecules that do not behave as neutralizing antibodies in the particular cell system used to assay the virus. However, it is possible to show that these antibody molecules will behave as neutralizing antibodies when tested in other cell systems.

Financial Support.

The Wool Research Fund made a grant of £9,578 towards the cost of investigations into myxomatosis in Australia and California.

Other Activities.

Mr. Howes gave a paper at the A.N.Z.A.A.S. meeting in Perth in August, 1959, and most members of the Department participated in the Inaugural Meeting of the Australian Society for Microbiology in Melbourne in May, 1959.

Professor Fenner gave lectures in Sydney, Melbourne and Adelaide; and he was elected a Fellow of the Royal Australasian College of Physicians in October, 1959.

Publications.

The following papers written by members of the Department were published during 1959:


"Genetic studies with mammalian poxviruses. II. Recombination between two strains of vaccinia virus in single HeLa cells.” Virology, 8, 499-507.

Fenner, F., and Cairns, J.—“Variation in virulence in relation to adaptation to new hosts.” The Viruses, 3, 225-49.


**DEPARTMENT OF PHYSIOLOGY.**

**Staff.**

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<tr>
<td>Reader</td>
<td>W. V. Macfarlane, M.D., M.A.</td>
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<td>Senior Fellow</td>
<td>D. R. Curtis, M.B., B.S., Ph.D.</td>
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<tr>
<td>Fellow</td>
<td>J. S. Coombs, M.Sc.</td>
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<tr>
<td>Research Fellows</td>
<td>Rosamond M. Eccles, M.Sc., Ph.D.</td>
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<tr>
<td>Research Assistant</td>
<td>D. N. Butler, B.Sc.</td>
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**Student and Teaching Activities.**

There are five students proceeding to a Ph.D. degree: R. A. Westerman, M.B., B.S. (commenced 6th January, 1958); J. W. Phillis, B.V.Sc. (commenced 17th February, 1958); J. I. Hubbard, B.Med.Sc., M.A., B.M., B.Ch. (commenced 5th November, 1958); M. Ito, M.D., Ph.D. (commenced 23rd February, 1959); R. Kinne, B.Sc. (commenced 1st July, 1959); and one to the M.Sc. degree, D. Butler, B.Sc. (commenced 5th January, 1959). Throughout the year there have been Departmental seminars, usually every week.

**Research Activities.**

Much of the work reported for 1958 was completed and written up in 1959 and some appears in the appended list of published papers, the remainder being in press.

It is generally believed that in mammals transposition of muscle function by appropriate nerve cross-union does not change the simplest reflex pathways in the spinal cord. In a reinvestigation, monosynaptic activation of motoneurones by afferent fibres from muscle was used as a test for any such plastic change that might occur. The nerves to the peroneal muscles (peroneus longus, brevis and tertius) and to the medial gastrocnemius were cross-united in aseptic operation in very young animals. Some months later the motoneurones supplying these and related muscles were identified and their monosynaptic connections investigated by intracellular recording. Of the 125 peroneal motoneurones examined intracellularly, 42 had monosynaptic connections from the physiological extensor muscles of ankle and digits, particularly from lateral gastrocnemius (37). By contrast, only 2 of 60 normal peroneal motoneurones had such aberrant connections from lateral gastrocnemius. Possibly the new monosynaptic

† Deceased.
paths are due to the sprouting of fibres that is effected by the degenerated central terminals of the chromotolysed ganglion cells, the chromatolysis resulting from the nerve section in such young animals. But the preponderance of lateral gastrocnemius connection suggests the operation of a more specific influence; on account of their innervation of medial gastrocnemius muscle the peroneal motoneurones specially attract synapses from the most closely related synergist, lateral gastrocnemius. The operation of a specific influence is further suggested by the absence of aberrant connections from the functionally unrelated hamstring muscles despite the proximity of many hamstring motoneurones to peroneal motoneurones in the seventh lumbar segment. If the postulated specific influence can be substantiated by further experiment, it would provide the basis for explanations of the development of specific pathways in the central nervous system, but the manner of its operation would raise fundamental problems (J. C. Eccles, R. M. Eccles and F. Magni).

New lines of investigations on the biophysics of synaptic action were essayed. Brief current pulses were applied through an intracellular electrode to measure the excitability of motoneurones during excitatory and inhibitory synaptic action. The time course of action was correlated with the electrical change. The ionomic composition of motoneurones was changed by passing currents through intracellular microelectrodes filled with strong solutions of KCl, KSO4, NaCl, Na2SO4. The two barrels of a double microelectrode were filled with different salts so that the effect of various ionic injections could be studied on the same motoneurone. Such investigations on the inhibitory synaptic action have led to a revision of earlier concepts of the ionic movements responsible for the inhibitory action, the Cl ion being much more important than the K+ ion. The ionic mechanism of the after-hyperpolarization following a spike potential has been studied by the same technique (J. C. Eccles, R. M. Eccles and M. Ito). A comparable technique is also being used in comparing the effectiveness of various anions as a substitute for Cl ion in inhibitory synaptic action (T. Araki, M. Ito and O. Oscarsson).

The cells of origin of the ventral spinocerebellar tract have been located and studied by recording with intracellular microelectrodes. The various pathways responsible for excitatory and inhibitory action have been examined. During repetitive synaptic activation there was often a very large increase in synaptic efficacy. This potentiation at frequencies of 10 to 100/sec. undoubtedly contributes to the high frequency with which the tract fibres will follow peripheral stimulation (J. C. Eccles, J. I. Hubbard and O. Oscarsson).

Though the recurrent inhibition of motoneurones through motor axon collaterals and Renshaw cells has been extensively investigated, there has hitherto been no comprehensive study of the field from which any one species of motoneurone draws its recurrent inhibition, and consequently there has been much speculation on the function and significance of this inhibition. Intracellular recording has been employed in measuring the recurrent inhibition produced in motoneurones supplying different muscles by volleys in the motor fibres to all these various muscles. It was of particular significance that the motoneurones of slow tonic muscles had much larger recurrent inhibitions than other motoneurones, for it would ensure that these muscles would be relaxed during powerful quick movements. Various other factors were defined that controlled the pattern of recurrent inhibition (R. M. Eccles, A. Iggo and M. Ito).

In normal physiological conditions the junctions between nerve cells (synapses) and neuromuscular junctions have to transmit impulses often at high frequencies for considerable times. Systematic studies have therefore been made of the way in which repetitive activity affects the liberation of the chemical transmitter substances at these junctions. It has been found that there is depressed liberation during and after low frequencies (0.3 to 20/sec.) of activation, but with higher frequencies there is a very remarkable process of transmitter mobilization, which reaches its maximum at about 300/sec. This process is of great value in enabling these junctions to operate effectively, even at frequencies that occur under extreme stress (J. I. Hubbard, neuromuscular junctions; D. R. Curtis and J. C. Eccles, central synapses).

Investigations on the effects of disuse of synapses have been extended by studying the effect of tenotomy either alone or combined with plaster immobilization. It was surprising to find that some weeks after tenotomy reflexes were increased as compared with the control side, which is the reverse from the predicted effect of disuse (R. A. Westerman). The effect of tenotomy is also being investigated on the synaptic relays from muscle afferent fibres to the dorsal and ventral spinocerebellar tracts. Plastic changes in the synaptic connection in the spinal cord have also been examined after spinal section in very young animals. Reflex responses to electrical stimulation of skin nerves have generally been increased in size and duration, the flexor reflex in particular being increased (W. Kozak and R. A. Westerman).

Pharmacological investigations upon the nature of chemical synaptic transmission have been continued. These studies have been carried out by applying individual chemical substances ionophoretically from one barrel of a multibarrel electrode on to the external surfaces of single cells within the cat spinal cord whilst simultaneously recording the cell responses by means of another barrel of the same electrode. The structural features necessary for the excitant action of certain acidic amino acids and for the depressant action of related neutral amino acids have been elucidated. By the use of ionophoretically applied calcium chelating agents, certain possible correlations have been brought to light between the actions of the excitant amino acids and disturbances to calcium-ion-membrane interactions. Much work has been directed toward the establishment of whether or not the actions of the excitant amino acids have physiological significance with regard to synaptic transmission, but it has not yet been possible to produce evidence from which an unequivocal answer to this important question can be made. Possible connections between the excitatory actions of these amino acids and certain
convulsive disorders have been pointed out in publications. The mechanism of action of the amino acids is being further investigated using the isolated spinal cord of the toad, on which tissue certain of the compounds have an action apparently different from that observed upon single cells in the cat spinal cord. Parallel with the study of amino acids, the testing of various substances present in tissue extracts has continued. In addition, the actions of many compounds of clinical and pharmacological importance have also been investigated by the ionophoretic technique. Of the substances occurring in tissue extracts only the amino acids and certain choline esters have been found to be active in the cat spinal cord, the choline esters being specific agents for the excitation of Renshaw cells in contrast to the amino acids which manifest their excitant or depressant action upon interneurones as well as upon Renshaw cells. Many of the clinically and pharmacologically important compounds were found to have actions upon the cholinergic transmission to Renshaw cells, but only atropine and procaine have any effect upon interneurones and motoneurones. These two substances depressed the sympathetically and chemically (by amino acids) evoked responses of all three types of spinal neurone. The physiology and pharmacology of the activation of Renshaw cells by volleys in the dorsal root has also been investigated and evidence adduced for the participation of more than one transmitter agent in the synaptic activation of these cells (D. R. Curtis, J. W. Phillis and J. C. Watkins). The determination of the amino acid structure-activity relationship has necessitated the testing of a wide range of structurally related amino acids. Many of these have been synthesized, including some highly active new compounds (D. N. Butler and J. C. Watkins).

Work in Oxford showed that in man heat caused the urinary retention of sodium, and to a lesser extent, of potassium and water before there was a rise of body temperature or onset of sweating. These changes, however, could be reversed in the heat by lying down. Adrenalin is probably involved in this short-term regulation and there is evidence that aldosterone is not. Chromatographic estimations of cortisol, cortisone and aldosterone were made in relation to the effects of heat. The assay of antidiuretic hormone has been refined by Miss Kinne by the use of cortisol to produce a reliable diuresis, and by automation. Tritium has been employed to estimate total body water and water turnover. In a cool environment, total body water was found in man to be less than in the tropics, and the turnover rate changed from a half-time of 20 days in Canberra to a half-time of 5 days in Julia Creek. Tritium was used to determine the body water and water consumption of sheep in the tropics, as well as the course of events during dehydration (W. V. Macfarlane).

The duration of the action-potential of atrial, ventricular and conus cells of the heart has been reduced by hypoxia and by agents interfering with glycolysis, the cytochrome system, the oxidative production of ATP, and with ATP breakdown. The action-potential of sinus cells is little changed by the agents. On the other hand, the generator potential is prolonged by interference with oxidative metabolism. It seems likely that active transport is involved in both the plateau and the sinus potential (W. V. Macfarlane and K. Zwicky).

Other Activities and Overseas Visits.

Sir Lindor Brown, Professor of Physiology, University College, London, was a visitor to the Department for a week in May, and Professor E. G. T. Liddell of the Physiology Department, Oxford, spent some days in the Department in October.

After six months’ work on heart cell potentials in New York during 1958, Dr. W. V. Macfarlane took part in the Xlth International Congress of Tropical Medicine at Lisbon. He lectured in the medical and veterinary schools of Amsterdam, Utrecht and Wageningen Universities in Holland as a guest of the Netherlands Institute of Cultural Relations. At the Ciba Foundation in London, a Discussion Meeting was organized with Dr. Macfarlane speaking on "Climatic Physiology". Papers were presented at two meetings of the Physiological Society. Lectures were given in Oxford, Liverpool and Edinburgh Universities and Dr. Macfarlane was guest speaker at University College, London. The Agricultural Research Institute, Rehovot, Israel, invited Dr. Macfarlane to Israel to give an account of his work on tropical livestock. A lecture was also given at the Beilinson Hospital, Tel Aviv, on cardiac cellular potentials, and liaison established with the Arid Zone Research Institute, Beersheba. Dr. Macfarlane attended the A.N.Z.A.A.S. conference in Perth and presented papers on Physiological adaptation in the evolution of tropical sheep; Repolarization in cardiac and muscle cells; and Factors affecting sodium excretion in the heat. Dr. W. V. Macfarlane is Chairman of the Tropical Climatology Committee of the International Society of Boclimatology and a member of the Arid Zone Panel of UNESCO.

In May, Dr. D. R. Curtis attended, by invitation, a conference on Inhibition in the Nervous System and gamma aminobutyric acid (GABA) at the City of Hope Medical Center, Los Angeles, and gave a communication. He visited the Physiology Department, Melbourne University, by invitation, and gave three lectures. He went overseas on leave in September to take up a position for one year as Visiting Professor of Physiology at the Downstate Medical Center, State University of New York.

During his period of study-leave from 25th March to 13th November, 1959, Mr. J. S. Coombs was a Visiting Scientist for six months at the National Institutes of Health, Bethesda, U.S.A., where he was primarily engaged on the development of electronic equipment for physiological purposes. He also visited several laboratories in the U.S.A. and England, and attended a conference at Atlantic City.
In December, Dr. Rosamond Eccles left for eight months on a Wellcome travel grant to be Sharpey Scholar in Physiology at University College, London, where she will be helping to develop the techniques of intracellular recording from nerve cells.

Sir John Eccles was elected to an Honorary Foreign Membership of the American Academy of Arts and Sciences. He visited U.S.A. for three weeks in February and March as Squibb Centenary Lecturer, and gave a lecture entitled, “Problems of organization and plasticity at the simplest levels of the mammalian nervous system”, at eight Medical Schools: Johns Hopkins; Temple; Duke, Alabama; Texas, Galveston; Texas, Dallas; Baylor; San Francisco, as well as additional lectures at most centres. He later was overseas for eight weeks attending by invitation three conferences in South America in August and giving four communications: the 21st International Physiological Congress in Buenos Aires; a C.I.O.M.S. conference on Brain Mechanisms and Learning at Montevideo; a UNESCO conference on Electrogenesis at Rio. In September, he contributed to a symposium on "Function and Structure of the Cerebral Cortex " at the second International Meeting of Neurobiologists at Amsterdam, and also gave a communication at the Oxford Meeting of the Physiological Society. In addition, several lectures were given at Rio and in England, and he has also lectured at Sydney University.

**Publications.**

During the year the following work by members of the staff was published:—


“Further observations on the controlled differentiation of muscle.” *J. Physiol.*, 148, 78P.


“Repetitive synaptic activation.” *J. Physiol.*, 149, 43-4P.


“The depression of spinal neurones by γ-amino-α- butyric acid and β-alanine.” *J. Physiol.*, 146, 185-203.


“Monosynaptic excitatory patterns and the connections of group Ia afferent fibres from muscle.” Symposia and Special Lectures. XXI International Congress of Physiological Sciences, Buenos Aires, pp. 87-93.


Eccles, J. C., and Krnjevic, K.—“Afferent fibre potentials in the spinal cord.” *J. Physiol.*, 146, 31-2P.

“Some post-tetanic changes in primary afferent fibres.” *J. Physiol.*, 148, 22P.


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* Not a member of the Australian National University.


"Synaptic actions in motoneurones by afferents which may evoke the flexion reflex." *Arch. ital. Biol.*, 97, 199-221.


Kiraly, J. I., and Krnjevic, K.—"Some retrograde changes in function of nerves after peripheral section." *Quart. J. exp. Physiol.*, 44, 244-57.

Krnjevic, K., and Miledi, R.—"Presynaptic failure of neuromuscular transmission." *J. Physiol.*, 148, 56P.


**DEPARTMENT OF PHYSICAL BIOCHEMISTRY.**

**Staff.**

Professor ... ... ... ... A. G. Ogston, M.A., D.Phil., F.R.S. (from 1st October, 1959).

Senior Fellow ... ... ... H. A. McKenzie, M.Sc., Ph.D., F.R.A.C.I. (from 4th May, 1959).

Electron Microscopist ... ... Margaret Briggs, B.Sc. (from 30th May, 1955; Research Fellow).

**Student and Teaching Activities.**

Mr. M. Davies, B.A., was appointed from 1st October, 1959, to work in the first place with Professor Ogston at Oxford. Mr. M. A. W. Thomas, B.Sc., came from Sydney with Dr. McKenzie to work in this Department, though he remains a candidate for the M.Sc. in the University of Sydney.

**Research Programme.**

Work in Oxford has continued the investigation of substances and systems related to connective tissue. The particular problems in hand are: the effects of hyaluronic acid on the distribution of other substances in solution; the effects of hyaluronic acid and of collagen on the diffusion of other substances; and the problem of the association of hyaluronic acid with proteins.

Most of the biological and chemical properties of proteins and enzymes depend in some way on the patterns in which the polypeptide chains are folded in the native molecule and the state of aggregation of these molecules. A study is being continued of conformation and aggregation changes. During the year the effect of temperature in the aggregation of the ß-lactoglobulins and the effect of the denaturant, urea, on different beef haemoglobin types have been studied.

Milk is a significant item in the human diet. Many aspects of its chemistry and biochemistry remain obscure. A study is being made of the physical chemistry of casein and the mode of action of the milk-clotting enzyme, rennin.

The Electron Microscope Unit now forms part of this Department. The electron microscope has continued to be used in collaborative studies with the C.S.I.R.O. Division of Entomology and the Division of Plant Industry. A detailed study has been made of the fine structure of one region of the alimentary tract of Lucilia (the Australian sheep blowfly) larva. This region consists of a mosaic of two cell types and this investigation will provide a basis for study of other regions of this complex tissue which is of considerable histochemical interest. A determination has been made of the size and shape of a plant virus (Cauliflower Mosaic Virus), which has been purified by Dr. M. F. Day of C.S.I.R.O. The morphological changes in vaccinia virus following various enzymic and chemical treatments have been studied in collaboration with members of the Department of Microbiology. The microscope continues to be used for particle counts of vaccinia and influenza viruses.

* Not a member of Australian National University Staff.
Other Activities.

Dr. McKenzie has acted as honorary adviser to the C.S.I.R.O. Physical Chemistry Unit in the University of Sydney; Honorary Lecturer in the Biochemistry School, University of Sydney; and Laboratory Assessor for the National Association of Testing Authorities.

Publications.


BIOLOGICAL INORGANIC CHEMISTRY SECTION.

Staff.

Reader . . . . . . . . . . . . . . . F. P. Dwyer, D.Sc., F.R.A.C.I.
Research Fellow . . . . . . . . . A. M. Sargeson, B.Sc., Ph.D.
Visiting Research Fellow . . . . . . B. A. Bolto, M.Sc., Ph.D.
Honorary Research Assistant . . . . J. W. Hogarth, B.Sc.
Technician . . . . . . . . . . . . I. K. Reid

Students.

Four students are engaged in research work for the Ph.D. degree. They are: J. A. Broomhead, M.Sc. (March, 1958, kinetics of racemization and dissociation reactions); D. A. Buckingham, M.Sc. (March, 1959, chemistry of osmium complexes); T. MacDermott, B.Sc. (absolute stereospecificity in multi-dentate chelate molecules); B. Bosnich, B.Sc. (kinetics of substitution reactions in octahedral complexes). F. L. Garvan, B.Sc. (on leave from the University of Sydney), completed his Ph.D. thesis on the metal complexes of aminopolycarboxylic acids early in the year. Each student and members of the staff contributed two one-hour seminars during the year.

Research Programme.

The work of the section is concerned with fundamental chemical studies, the synthesis of metal complexes and their application in a number of biological fields. Bacteriological studies on over a hundred metal complexes have been conducted in the Departments of Physiology and Bacteriology at Melbourne University and by Dr. G. Mackaness at A.N.U. Several iron and nickel compounds have been found to have a high order of activity against M. tuberculosis in vitro surpassing isonicotinic acid hydrazide, the best of the modern therapeutic agents, by a factor of ten. However, two series of experiments with infected mice and guinea-pigs showed that these complexes when given orally or intraperitonally had no therapeutic value. Presumably the drugs do not reach the infected sites in vivo. Several of the metal complexes have been found to be active against penicillin-resistant S. aureus at very low concentrations (2-5 microgrammes/ml.) and to induce a permanent mutuation in the organism.

A number of platinum compounds have been prepared containing optically active ligands and separated into the enantiomorphic pairs (Sargeson). The preparation of the substance d-propylenediaminebis(α-propylenediamine) platinum (IV) chloride has demonstrated that different optical forms of a chelating molecule are not incompatible in metal complexes, as proposed in the principle of stereospecific limitation (Sargeson). The ethylenediaminebis(oxalato) cobaltate (III) ion has been synthesized for the first time and resolved with active cis-dinitrobis(ethylenediamine) cobalt(III) chloride (Reid). The analogous complex anion l-propylenediaminebis(oxalato) cobaltate(III) has also been synthesized and separated into its optical forms, as part of the project dealing with stereospecificity (MacDermott). A very large number of osmium complexes have been synthesised for the first time (Buckingham). Because of their very high X-ray opacity and capacity to scatter electrons, these complexes are intended for use in locating the sites of attachment of metal complexes in general, to protein. The study of kinetics of substitution in ruthenium complexes, with labile aquo and halogen groups, is being undertaken as a fundamental approach to the use of these substances as inhibitors of sulphhydryl enzymes (Bosnich). It is already known that they are active against a number of micro-organisms. During the year, Dr. B. Bolto (on leave from C.S.I.R.O., Melbourne, in order to gain experience in the techniques of metal complex chemistry), has studied the synthesis of electrically conducting metal polymers.

* Not a member of the Australian National University.
Other Activities.

Members of the group have assisted the Editorial Board of Inorganic Syntheses (U.S.A.) with the checking of a number of proposed synthetic methods (Hogarth and Reid). The Liversidge Lecture and a symposium lecture on the optical activity of metal complexes were given at the A.N.Z.A.A.S. Meeting at Perth, and a paper was presented at the Haematin Enzyme Conference in Canberra (Dwyer). Dwyer also acted on the sub-committee for nomenclature of the American Chemical Society.

Publications.

The following papers written by members of the section were published during 1959:

- Dwyer, F. P. and Sargeson, A. M.—“The resolution of the tris-(thio-oxalato) complexes of Co(III), Cr(III) and Rh(III).” *J. Amer. Soc.*, 81, 2335.
- Dwyer, F. P. and Garvan, F. L.—“The preparation of 1,2-propylenediaminetetraacetic acid and its resolution through the cobalt(III) complex.” *J. Amer. Chem. Soc.*, 81, 2955.

ANIMAL BREEDING ESTABLISHMENT.

Staff.

W. K. Whitten, B.Sc., B.V.Sc.

General.

More than 30,000 animals were again produced during the year.

Research Activities.

The action of a pure neuraminidase on the biological activity of purified follicle-stimulating hormone was examined. Experiments were carried out to determine which environmental factors modify the sexual periodicity of mice. The conditions necessary for cleavage of mouse ova in culture were determined.

Publication.


* Not a member of the Australian National University.
A steady volume of publication of the results of scientific investigations carried out in the School in all departments (58 papers) gives concrete evidence of the growing research effort and of standards achieved. Graduates from the School have won recognition and employment in positions of importance abroad.

There is a rapidly increasing need for further accommodation for the work on the School, both on the University site and at Mount Stromlo Observatory. The buildings are now fully occupied and it will become increasingly difficult to house research students who need both laboratory space and offices.

Considerable further capital expenditure is necessary in the next year or two for equipment for the Observatory and its field station, for geophysical investigations and to make full and effective use of the 12 MeV Tandem Accelerator provided for the Department of Nuclear Physics with a special grant from the Government. These needs are not for the initiation of new ventures but to enable existing work in almost all fields to be carried further in the future. Scientific work in almost every field is becoming increasingly expensive, but this is an inevitable consequence of the great speed of advance in the natural sciences at the present time. It is to be hoped that the coming amalgamation with the Canberra University College, with its own rapidly growing science departments, will not prejudice the necessary development of the activities of the School. This is the only organization outside C.S.I.R.O. devoted wholly to the advance of the fundamental physical sciences in Australia.

DEPARTMENT OF ASTRONOMY.

Staff.

Professor of Astronomy and Director of Observatory  Bart J. Bok, Ph.D.
Reader and Assistant Director  A. R. Hogg, D.Sc., F.Inst.P., F.A.A.
Readers  S. C. B. Gascoigne, M.Sc., Ph.D.
T. Dunham Jr., Ph.D.
Head of Time Service (Senior Fellow)  H. J. McK. Abraham, M.Sc.
Fellows  W. Buscombe, M.A., Ph.D.
H. R. F. Gollnow, Dr. Phil.
A. Przybylski, Dr.sc.tech., Ph.D.
Research Engineer (Fellow)  K. Gottlieb, Dip. Ing.
Research Fellow (on leave)  A. W. Rodgers, B.Sc., Ph.D.
Departmental Assistants  J. M. Basinski.
E. Heron.
P. M. Morris.
Honorary Professor  R.v.d.R. Woolley, O.B.E., M.Sc. (Capetown), M.A.,
Research Students  R. A. Bell.
A. A. Neylan.
J. B. Whiteoak.

There have been no major staff changes during 1959.

Mr. J. D. Balfe, Lecturer in Physics at the Royal Military College, at Duntroon, has completed his two years at Mount Stromlo Observatory, where he was seconded to act as a Scientific Officer in the Time Service.

Dr. B. E. Westerlund continued in residence as the Uppsala Observer and holds the rank of Honorary Fellow in the A.N.U.

Mr. C. E. Jackson continues in residence as the Yale-Columbia Observer.

Dr. W. Baade of Mount Wilson and Palomar Observatories was a Visiting Professor at the A.N.U. for six months, March to September.

Dr. H. M. Johnson left in December to return to the United States after 14 months at Mount Stromlo Observatory. He held the rank of Visiting Fellow in the A.N.U. and worked at the Observatory under a contract with the U.S. Office of Naval Research.

Dr. W. G. Tifft has been at Mount Stromlo as the holder of a U.S. National Science Foundation Fellowship. He is a Visiting Research Fellow in the A.N.U.
One staff member and one scholar are at present overseas. Dr. Rodgers left in August on a one-year leave of absence—possible to be extended to two years—to take up an appointment as a Carnegie Fellow at the Mount Wilson and Palomar Observatories. In September Mr. Bell went to England, where he is engaged upon research under the direction of Professor H. Bondi at Kings College, London University.

Dr. Buscombe returned in January from his study leave, and Mr. Abraham returned in May. Both spent the major part of their study leaves in Canada, Dr. Buscombe at the University of Toronto, Mr. Abraham at the Dominion Observatory in Ottawa.

Visitors.

During the year the Observatory had many distinguished visitors among them, from overseas, Professors H. Bondi and J. D. McGee from Great Britain, Dr. G. Westerhout from the Netherlands, Professor J. C. Bolton, Dr. A Boggess and Dr. J. E. Kupperian from the United States.

Instrumental Developments

The most important development of the year was the completion and placing into operation of the 26-inch Reflector at the new Mount Bingar Field Station near Yenda, New South Wales, a feat for which the Workshop and Design Staff deserves great credit. The primary mirror of the Reflector is a thick-ribbed honeycomb disc of pyrex, which was made available to us, upon the advice of Dr. Dunham, by the Fund for Astrophysical Research in the U.S.A. A 10-inch secondary was ground and polished in the Observatory optical shop to specifications laid down by Dr. Dunham and Dr. Gascoigne, with Dr. Dunham in charge of all tests. Use was made of the equatorial mounting of the 20-inch Catts Reflector which was redesigned to take the much heavier new 26-inch tube. Included in the renovation were provisions for electrical focussing of the secondary, for automatic rewinding of the weight-driven clock and for electrical slow motion in Right Ascension. The construction work was carried out in the Workshop. The erection of the telescope at Mt. Bingar was completed on December 22 and observing began in earnest on the night of December 25.

The 74-inch replacement mirror arrived in October and, after aluminising, was installed without difficulty in the telescope. The replacement mirror is performing well. The original 74-inch mirror is ready for shipment to Grubb Parsons, where its residual astigmatism will be removed. New lifting gear for the observing carriage of the 74-inch dome, designed at Mount Stromlo and manufactured by Grubb Parsons, arrived in December and will be installed early in 1960, on conclusion of the observing season for the Magellanic Clouds.

A new paraboloid 50-inch, f/4 and secondary arrived at Mount Stromlo during December, and will be installed during 1960. The combination is designed to operate as a Cassegrain arrangement at f/18. The telescope tube has been re-designed to take the new optics and work on the reconstruction is now under way. Initially the 50-inch Reflector will be used wholly for photoelectric photometry and, together with the Bingar 26-inch Reflector it should help to ease the pressure on observing time on the 74-inch reflector.

With the Coude building approaching completion, Dr. Dunham and his associates are making every effort to proceed with the construction of the spectrograph itself.

The design of the grating cradle has been completed and the cradle is under construction. A worm sector of high precision, 90 inches in diameter, is being machined at the Ordnance Factory at Bendigo, Victoria, to provide accurate rotation of the grating cradle for photo-electric scanning of stellar spectra. Individual gratings in their mounts will be quickly interchanged by means of V-blocks for defining, so that work can be carried out with maximum efficiency in different regions of the spectrum.

The main frame of the spectrograph has been completed, together with the slit plate, which is supported on a heavy A-frame on each side. The mounting for the 36-inch mirror of the 120-inch camera has been completed. Work is in progress on the designs for the slit unit, the collimator and the plate holder for the 120-inch camera. Every effort is being made to complete the essential parts of the instrument, so that the 120-inch camera and the 8-inch Meinel Schmidt camera can be used soon after the housing is completed.

A grating with a high efficiency ruled with 600 grooves per mm., over an area of 150 x 190 mm. and blazed in the second order yellow, has been received from Dr. H. Babcock at the Mount Wilson and Palomar Observatories. This grating can also be used in the third order blue-violet, and will be the first grating to be installed in the new spectrograph. A four-grating mosaic is also being made, by Bausch and Lomb, by cementing with high precision two replica gratings with rulings 160 x 212 mm. to each of two backing plates. These will be aligned accurately with each other in the mechanical mounting. The four gratings have been made, and the mosaics will be delivered in the near future. They will be blazed in the second order blue-violet.

The Zeiss-Newtonian spectrograph on the 74-inch reflector has continued to give problems of temperature control. To overcome these, the outside metal parts which could not be insulated have been covered with a half-inch thick layer of foam rubber and the slit has been enclosed with a half-inch thick plate of balsa wood carrying in its centre a small quartz window. These improvements serve
The University Library: A view from the south-west.

The new library is designed to house 300,000 volumes—in open book stacks for the most part. There will be reading accommodation for some 140 readers.

The building will consist of a three-storey block containing the book stacks, with a single storey section adjoining. There will also be a lower ground floor extending beneath the whole building.

The library will be constructed with a reinforced concrete frame sheathed from the ground floor level with sawn stone. The single storey portion will be covered with concrete vaulting overshadowing extensive expanses of glass window. The roof covering will be of copper.

Inside, the main staircase will be finished in marble and the floors generally will be of Vinyl tiles to minimize noise. The air will be kept free of dust by mechanical ventilation and this system will also provide air-conditioning in summer and winter.

The Architects for the work are:

The Office of John F. D. Scarborough, 125 Powlett-street, East Melbourne, and
Max Collard and Guy Clarke, 40 Miller-street, North Sydney (Architects in Association).
the further purpose of protecting the slit head and accessories from dust. A Walsh Hollow Cathode Tube to replace the Fe-arc, the tube kindly made available by its inventor Mr. A. Walsh of the C.S.I.R.O. in Melbourne, has been tested. The tube is proving most efficient, with neon as a carrier gas which permits its use in the red as well as in the photographic end of the spectrum.

An order has been placed with the Davidson Manufacturing Company of Pasadena, California, for the purchase of a Nebular Spectrograph, principally to use at the Newtonian focus of the 74-inch reflector. The instrument is similar in design to those used at Mount Wilson and Palomar Observatories; delivery is expected during 1960.

The new collimator and camera objective for the Cassegrain spectrograph on the 30-inch Reynolds reflector were finished in the course of the year by the Defence Standards Laboratory in Melbourne, but installation in the spectrograph is being postponed until a suitable break occurs in the current observing programmes.

The impersonal setting device for the comparator used in measuring stellar radial velocities has been completed. It serves to bisect by photoelectric means broad absorption lines—especially in the spectra of early-type stars.

In photoelectric photometry, the emphasis continues on improvement of the basic equipment. Dr. Gascoigne and Dr. Tifft have developed simple techniques for off-setting and guiding for use on faint stars. Several new amplifiers have been placed into regular service and four identical integrator units, the prototype of which is now in regular use, are being constructed. One of these is now being adapted to serve as an exposure meter for spectrograms. For purposes of photoelectric photometry, stars to twentieth magnitude are now within reach of the equipment. It is intended to construct shortly a full-scale off-set photoelectric photometer, with two channels following a design of Dr. H. L. Johnson. Photoelectric photometry with interference filters is being made by Dr. Gascoigne and Mr. Whiteoak, but difficulties have been experienced in obtaining adequate reproducibility. A complete set of interference filters for a Strömgren Photometer has recently arrived from the United States.

A new tube sensitometer was constructed for photographic photometry of emission nebulae by Dr. Johnson. It has been used extensively in connexion with Dr. Johnson's work on the 8-inch Meinel Schmidt camera.

The testing of the newly arrived photographic emulsions has continued. With Kodak officials in Sydney and in Rochester, N.Y., and with excellent co-operation from Qantas Airways and Australian Customs Officials and Officers from the Department of Trade, a system has been worked out that permits rapid transport of the Stromlo Kodak plates completely refrigerated from Rochester to Canberra.

Buildings and Grounds.

The major new development of the year was the completion of the Mount Bingar Field Station. The two buildings at the site are a telescope hut, which houses the 26-inch reflector and a small workshop and a small observer’s residence, providing transient living accommodation for four people. The access road to the top of Mount Bingar (height 1494 feet.) was provided by the Carrathool Shire Council and electricity was laid on without charge by the Murrumbidgee County Electric Council. The water supply will ultimately be rain water from the roof of the cottage but the Water and Irrigation Commission, with headquarters at Griffith, New South Wales, filled our tanks for a start. Without whole-hearted, prompt and efficient co-operation from all local groups and councils, it would have been impossible to have the Field Station in operation as scheduled a few days before Christmas. Special thanks go to Mr. E. R. Hoare of the C.S.I.R.O. Irrigation Research Station in Griffith, upon whose advice the staff depended heavily in all local matters.

The bottlenecks in the construction of the Coude spectrograph building at the base of the north pier of the 74-inch reflector have been overcome, with the end of building construction in sight for May 1960. The construction of the Coude pit in the hard rock made it necessary to set off nearly 1,000 small dynamite blasts very near to the large telescope. The walls of the Coude building will be of concrete nine inches thick, with circulating water pipes embedded in them, six inches apart, to equalize temperatures above and below the ground. Electrical heating wires will be installed on the outer surface of the concrete to equalize as far as possible, the heat loads on the individual surfaces. On the west side of the Coude building a small instrument room will be provided.

The new electronic, optical and photographic workshop is now in regular use.

The access road to the top of Mount Stromlo has been sealed, which thus provides staff, residents and visitors with a well-graded, all-weather road of excellent quality.

The most immediate need for the future is still a fair-sized office building, half of it with space for a Conference Room and offices for staff, students and visitors, and the other half for the Time Service. Another urgent need is for renovation of the Observatory Library rooms.
The National Time Service.

The National Time Service has continued to make astronomical time determinations and to provide the time signals for transmission by Belconnen Naval Wireless Station. The National Time Service also continues to measure and report on time signals received by radio, and on clock signals received by land line from the National Standards Laboratory, Sydney, the Postmaster-General's Research Laboratories, Melbourne, and the Adelaide Post Office.

The additional transit observations for the extended I.G.Y. programme were continued until July. The Transit Instrument has been equipped to give printed times in milliseconds.

Towards the end of the year, an increasing amount of time was devoted to the measurement and reduction of PZT observations for relative corrections to the star places. There was very little instrumental trouble with the PZT during the year and it became necessary to have the measuring machine in operation continuously.

Mr. Boots and Mr. Grenot are preparing the programmes for the IBM 610 electronic computer expected at Mount Stromlo on February 1st, 1960, so that it will calculate the apparent declinations and times of transit of the PZT stars, and reduce the observations for clock correction and latitude variation.

Comparisons between the clocks and the PZT have been simplified by driving the PZT from the clock for which corrections are being observed, instead of from the independent tuning fork. The counter chronometer has been modified so that it presents the sum of the readings.

Equipment has been built in the Observatory Electronics Section so that the standard frequency transmissions on 16 kc/s from GBR Rugby can be received and compared against the standards in the Observatory. Mr. Balfé is in charge of this project. A new receiver and a cathode ray oscilloscope have been installed for the more accurate measurement of time signals.

The Moon Camera was brought into operation in June by Mr. Balfé, who continued with regular observations. There was evidence of coma but the results obtained proved quite satisfactory. The U.S. Naval Observatory has already measured almost all available plates. Mr. Balfé has completed a Master's Thesis for the University of Queensland in which he reports on the results of these two researches.

During the Third Term the Time Service held weekly colloquia concerning techniques, and monthly meetings about future plans. Projects in hand concern a programme machine and digitised measuring machine for the PZT and greater stability in transmitted radio signals.

Research Activities.

Dr. Hogg continues his photoelectric studies on seven galactic clusters, NGC 3228, 4755, 5281, 6025, Melotte 227 and IC 2391, and the previously unreported cluster near NGC 5764. Work is continuing on the cluster NGC 330, which is part of the Small Magellanic Cloud. These studies lead to age and distance determinations for these star clusters. The photography of all galactic star clusters south of $-50^\circ$ has been completed and the Atlas is now in preparation for publication. A large-scale photographic map (scale 10 seconds of arc per mm.) of the Small Magellanic Cloud has been prepared from 74-inch Reflector photographs. Standard magnitude and sequence work has been continued in the Small Magellanic Cloud and (as part of a plan initiated at the Kapteyn Astronomical Laboratory in Holland) for a field near the galactic centre.

Dr. Gascoigne's observational work in the Magellanic Clouds has been confined almost entirely to deriving the colour-magnitude arrays for clusters. This has necessitated developments in the methods for photoelectric photometry and, in association with Dr. Tifft, and with the aid of a makeshift off-setting device on the 74-inch, it has been possible to extend measurements to about 20th magnitude. A preliminary result indicates that the colour-magnitude array for NGC 1783, in the Large Cloud, is very similar to that found by Arp for NGC 419 in the Small Cloud. The wide field photometer has again been used for the photometry of globular clusters, and in spite of instrumental difficulties this programme is now near completion. With Mr. Whiteoak, experimental observations have been made with interference filters but difficulties have been experienced in obtaining adequate reproducibility. It is expected that these will be resolved when the Strömgren photometer, the filters for which have now arrived, is placed into operation.

Considerable progress has been made with the catalogue of variable stars in the Large Magellanic Cloud. Most of the technical problems associated with the reproduction of Uppsala-Mount Stromlo Atlas of the Magellanic Clouds have now been overcome, and the first batch of charts is ready for circulation. These two projects have been undertaken as a contribution towards the work on the I.A.U. Sub-Commission on the Magellanic Clouds. The Atlas consists of thirteen charts, four covering an area of $6^\circ \times 6^\circ$ around the Small Cloud, and nine covering about $10^\circ \times 10^\circ$ around the Large Cloud. These charts consist of prints of yellow-sensitive plates taken by Dr. Westerlund with the Uppsala Schmidt telescope, enlarged about 34 times to a scale of 34 seconds of arc per mm. The limiting magnitude is about 18.5. The first set will have, ruled by hand, right ascension and declination for 1950, and the Harvard X and Y grid. In later sets, intended for general distribution, these co-ordinates will be impressed photographically. Each set will be accompanied by a bibliography of finding lists, lists of NGC objects, &c.
Dr. Dunham’s efforts toward the completion of a Coudé Spectrograph for the 74-inch Reflector have already been noted.

Professor Bok and Dr. P. F. Bok have completed the observational work on standard sequences for Selected Areas 141, 158 and 193 and the van Wijk Sequence in the Large Magellanic Cloud. Mrs. Basinski is carrying out supplementary photographic studies from plates taken with the Uppsala Schmidt telescope. The results for an extended region near Selected Area 141 (South Galactic Pole) are nearly ready and additional photoelectric standards have been provided to assist in the elimination of errors in magnitudes and colours due to unevenly-sensitized emulsions and instrumental corrections. With the 36-inch Reflector at Mount Bingar, the Boks have begun a programme (transferred from the 30-inch Reynolds Reflector) of photoelectric photometry of selected bright members of Associations in the Large Magellanic Cloud, notably in Shapley’s Constellation III. Bok has continued his researches on the spiral structure exhibited in the Southern Milky Way.

At the request of Mr. F. M. Bateson, Director of the Variable Star Section of the Royal New Zealand Astronomical Society two standard sequences, one in the region of Z Cha (from \( \text{mv} = 8.5 \) to 14.0), the other in the region of EK Tr A (from \( \text{mv} = 10.0 \) to 14.0), for variable star work were derived by combined photoelectric and photographic methods.

Dr. Gollnow is making every effort to complete his share in the major radial velocity programme (Scorpio-Centaurus moving cluster, selected stars in the N30 Catalogue of Stellar Positions, Theta Carinae cluster) before going overseas in 1961.

As the second phase of an extended study of the Scorpio-Centaurus Association, undertaken in 1954, Dr. Buscombe and Miss Morris have prepared for publication new radial velocity measures for 120 bright-B stars. Revised orbital elements have been derived for the spectroscopic binary cariniae. Alpha Octantis (FK3 programme), known since 1914 as a velocity variable, shows double absorption lines at some phases, originating in the atmospheres of two nearly identical giant F stars, revolving in a period of 9.073 days. Measures of 24 new spectrograms have made possible the computation of orbital elements.

Miss Morris has extended spectral classification on the MK system to 150 more stars, for many of which additional spectrograms are being secured, as radial velocity measurements may show that some of these are also members of the Sco-Cen Association. Luminosity classification of B stars from 74-inch Newtonian spectrograms is also under way in Selected Area 193 (Carina) and the Small Magellanic Cloud. Dr. Buscombe is a member of the new Sub-Commission on Stellar Classification of the International Astronomical Union.

A manuscript catalogue and bibliography of A stars with peculiar spectra, compiled by K. Brewer in 1953, has been forwarded to Meudon for inclusion in a summary publication which C. Bertaud is editing. The complete bibliography of Wolf-Rayet stars, formerly compiled by O. C. Wilson, has been brought up to date for 1950-59. Miss Morris has compiled a 4-page supplement to our Memoir No. 14 based on new parallax data for southern stars of high velocity, kindly made available by Miss L. F. Jenkins of Yale University, and recent determinations of radial velocities.

Dr. Przybylski is rounding off his major radial velocity programme jointly with Dr. Gollnow. He has obtained spectra for classification purposes for more than 100 southern high-velocity stars, two-thirds of his first-priority list. About 30 per cent. of the available spectra have been classified, but additional standards are still required. He has prepared a tabulation of focal settings for all combinations of prisms and cameras for the Zeiss-Newtonian spectrograph on the 74-inch reflector.

Dr. Rodgers was at Mount Stromlo only until August, when he left to go overseas. He completed his work on the Southern Coalsack and transferred his standard sequence for the Coalsack region to the cluster NGC 4609, for which he has completed a photographic study using the Uppsala Schmidt telescope and the 5-inch Zeiss camera on the Oddie telescope. In his work on H II Regions, the major effort (with Mr. Whitsoak and Miss H. H. Bailey) was in connexion with the preparation of the 8-inch Schmidt Atlas of the Southern Milky Way and the blinking of plates for H II Regions—for all of which positions had to be measured. Work on the Magellanic Clouds included a study of H II Regions in the Small Cloud and a joint study with Dr. Westerlund of classification from objective prism spectrograms obtained with the Uppsala Schmidt telescope.

Dr. Westerlund continues to work in close collaboration with the Mount Stromlo staff and scholars. He writes as follows about his work, mostly with the Uppsala Schmidt telescope:—

“The infra-red surveys for M, C and S stars in the Galaxy and in the Magellanic Clouds have continued. Classification has been completed in four regions in the Large Magellanic Cloud with a limiting infra-red magnitude of about 13.8. Colour-magnitude arrays for the brighter stars in some parts of these regions are being established also in B and V. A survey of the Large Cloud for Wolf-Rayet stars and planetary nebulae has been carried out in co-operation with Dr. Rodgers. A region of about 100 square degrees centred at the Southern Coalsack has been searched for emission objects. Photometry of these objects is being carried out. The 30-inch Reynolds reflector has been used for photoelectric observations in the UBV system, mainly for establishing magnitude
sequences. The 74-inch reflector has been used for photographic observations of some regions in the Large Magellanic Cloud. Photography of planetaries found in the Uppsala Schmidt surveys has begun in co-operation with Mr. Gottlieb."

Dr. Johnson's primary programme concerned an H-alpha photometric survey of the Southern Milky Way, with two additional pass-bands for comparison purposes. The Atlas presents the results in the form of isophotic charts for each centre. He also made spectrographic studies of emission nebulae; notably he obtained a hydrogen to helium abundance ratio for 30 Doradus in the Large Magellanic Cloud. Several smaller researches dealt with galactic and extragalactic studies.

Dr. Tiff reports that photoelectric colours and magnitude have been measured to magnitude 20 for a region near NGC 121 in the Small Magellanic Cloud. This sequence serves as a basis for extensive photographic studies in the sections and nearby regions. Work in the Large Cloud, photographic and photoelectric, has been well begun, primarily in a region near the west end of the principal bar. During the winter period photoelectric and photographic observations were obtained to magnitude 16 for the galactic clusters NGC 2818 and NGC 4349. Some observations were also obtained for the galactic globular cluster NGC 4372.

Mr. Bell left to go overseas in September. Up to the time of his departure, he continued observational and theoretical research on his thesis topic of white dwarf stars. Eight white dwarfs have now been observed spectroscopically with the Zeiss spectrograph on the 74-inch reflector. Six of these are of the DA type with hydrogen lines of varying strength, one is a DF star and another is a λ4670 star. All of these stars have been observed at least once photoelectrically with the 30-inch reflector and other suspected southern white dwarfs have also been observed with this instrument. The proper motion of the λ4670 star, L 145-141, indicates that it is associated with the λ4670 stars W 219 and L 879-14, observed by Greenstein, and the DC star L 1363-3, also observed by Greenstein. These four stars are probably the products of a type II supernova explosion. If this supposition is correct, then it will have far-reaching consequences for research on supernova explosions and the amount of material present in newly-formed stars which have been "processed" by a supernova explosion. Since February 1959, much work has been done on modifications to the mass-radius relation of Chandrasekhar caused by degeneracy of the nuclei and the effects of the electrons being squeezed into the nuclei at very high pressures. This work is now being pursued at King's College, London University, under the direction of Dr. F. A. E. Pirani.

Mr. Whiteoak and Miss Bailey are faced with the difficult task of preparing jointly with the Observatory's photographer, Mr. Hunt, the Southern Milky Way Atlas from plates made with the 8-inch Meinel-Pearson camera. The making of the six large-scale mosaics (18 prints each) requires close collaboration but the end is fortunately in sight. In association with Dr. Rodgers and Mr. C. T. Campbell, Mr. Whiteoak has completed a Catalogue of H-alpha Emission Regions in the Southern Milky Way. Mr. Whiteoak's project (doctoral thesis) is the adaptation of the Crawford narrow-band system of Strömgren photoelectric photometry to the southern skies, with the II Scorpio Association high on the priority list. UBV photometry and spectral classification are well advanced for the stars in the II Scorpio Association. Researches on the Theta Carinae cluster are being rounded off in close co-operation with Dr. Gollnow and Dr. Przybylski.

**Student Activities.**

During the year 1959 one scholar resigned and two new appointments were made.

For the second year a series of nine seminar courses has been provided for scholars. The first two-year cycle has thus been completed. The lectures on Hydromagnetics by Dr. Martyn formed an essential link in the department's limited programme of advanced teaching.

The programme of summer vacation scholars is now in its third year, with ten students, representing the Universities of Queensland, Tasmania, Sydney and Adelaide, in attendance. The pattern follows that established during the first two years, with, as one major feature, a special programme of weekly survey colloquia.

**The Site Testing Programme.**

The records for 1959 show that there were 196 nights suitable for observation at Mount Stromlo Observatory. Again, on many nights observations were stopped by clouds. The 74-inch reflector was in operation during 1959 for 1613 hours, with only about two thirds of this time suitable for photoelectric work.

Much time and effort has been spent on a survey to locate a site for a suitable field station for Mount Stromlo Observatory. In March, 1959, it was decided to occupy forthwith a site on top of Mount Bingar in New South Wales, which is to serve as a Control Station for a period of at least two years. Other sites which it is intended to test are near Condoblin (Mount Boona) and Coonabarrabran (Sidings Springs Mountain) in New South Wales, and Mount Arapiles near Natimuk, Victoria.

The first regular photoelectric work was begun on Mount Bingar on the evening of December 25th, and it is encouraging to note that the night skies were close to perfection on six of the remaining seven nights of the year, with photoelectric work possible until dawn on five nights. The seventh night
was hazy with passing clouds, but slit spectroscopy could have been done on that night with 50 per cent. efficiency. The seeing was good to excellent, with some deterioration after midnight but recovery generally before dawn. These first nights came at the height of the season for observation of the Large Magellanic Cloud. The constant of extinction for visual light averages \(0.15 \pm 0.02\) (p.e.).

Mount Bingar is located approximately 1,000 feet above the level of the plain, 25 miles from the town of Griffith, New South Wales, in the heart of the Murrumbidgee Irrigation Area, and 14 miles from the small town of Yenda, New South Wales. According to observations of night cloudiness at 9 p.m., made by Mr. E. R. Hoare, 53 per cent. of all nights have been cloudless at Griffith since regular observations were begun in June, 1958. A clear night at 9 p.m. is generally followed by a clear morning.

Observations of night cloudiness are now under way at 20 selected sites in Australia. The attached tabulation shows the percentages of nights which are cloudless at 9 p.m. according to records obtained to date. Observers are asked to record also whether or not the morning skies were clear following a clear night as recorded at 9 p.m.

The sites in New South Wales and Victoria are of immediate interest to Mount Stromlo Observatory as potential sites for a Field Station. The sites in Western Australia, South Australia and Northern Territory have been selected to provide a basis for future Australia-wide coverage in the survey. For a continent as vast as Australia, and with as yet far from complete meteorological coverage, at least two years of observations of night-cloudiness are needed before detailed observations relating to astronomical seeing can be justified.

In all preliminary planning, the Observatory has depended greatly on the Report on the results of the Yale-Columbia Site-Testing Survey for Australia, which became available in 1959. To supplement the material of this report, two major trips have been made to survey the situation on the spot, one to South Australia and another to Western Australia.

The South Australian party visited early in August the region of Mount Woodroff in the Musgrave Range, and obtained the assistance of the Ernabella Mission in South Australia and of the meteorological officers at Giles, across the border in Western Australia, and at Alice Springs, Northern Territory, in securing 9 p.m. observations of night cloudiness for this very promising area. A similar excursion is planned for January 1960, to the section of the Flinders Range in South Australia, where it is hoped to start early in 1960 regular observations of 9 p.m. night cloudiness.

The Western Australian expedition took place in September, immediately after the A.N.Z.A.A.S. meeting in Perth. One party visited the region to the north west of Perth, establishing 9 p.m. night cloudiness observations at the base of Mount Singleton (a very promising site), and Mount Yagahong. The other party covered the section west of Perth all the way to Kalgoorlie and, as a result of this survey, 9 p.m. night cloudiness observations are now being made regularly at the base of Mount Burges and of Mount Grey.

### MONTHLY DISTRIBUTION OF NIGHTS CLOUDLESS AT 9 P.M. FOR TEST SITES OF MOUNT STROMLO OBSERVATORY

<table>
<thead>
<tr>
<th>Site,</th>
<th>1958</th>
<th>1959</th>
<th>Average clear nights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jun</td>
<td>Jul</td>
<td>Aug</td>
</tr>
<tr>
<td>Mount Stromlo, Australian Capital Territory</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Griffith, New South Wales</td>
<td>66</td>
<td>50</td>
<td>43</td>
</tr>
<tr>
<td>Waston's Trig, New South Wales</td>
<td>43</td>
<td>53</td>
<td>41</td>
</tr>
<tr>
<td>Lake Cargelligo, New South Wales</td>
<td>33</td>
<td>37</td>
<td>31</td>
</tr>
<tr>
<td>Aletown, New South Wales</td>
<td>20</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Coopahbarrahan, New South Wales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrabri, New South Wales</td>
<td>45</td>
<td>87</td>
<td>57</td>
</tr>
<tr>
<td>Natimuk, Victoria</td>
<td>44</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>Island Bend, New South Wales</td>
<td>35</td>
<td>54</td>
<td>30</td>
</tr>
<tr>
<td>Hind Koeduku, New South Wales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jindabyne, New South Wales</td>
<td>43</td>
<td>57</td>
<td>40</td>
</tr>
<tr>
<td>Giles, Western Australia</td>
<td>50</td>
<td>71</td>
<td>63</td>
</tr>
<tr>
<td>Ernabella, South Australia</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Alice Springs, Northern Territory</td>
<td></td>
<td></td>
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<tr>
<td>Mt. Singleton, Western Australia</td>
<td>72</td>
<td>65</td>
<td>78</td>
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<tr>
<td>Mt. Yagahong, Western Australia</td>
<td>43</td>
<td>81</td>
<td>57</td>
</tr>
<tr>
<td>Kalgoorlie, Western Australia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coolgardie, Western Australia</td>
<td>50</td>
<td>74</td>
<td>77</td>
</tr>
<tr>
<td>Mt. Grey, Western Australia</td>
<td>53</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>Perth, Western Australia</td>
<td>57</td>
<td>35</td>
<td>60</td>
</tr>
</tbody>
</table>
The Observatory records here its special indebtedness to the State Governments of South Australia and Western Australia, which assisted in many ways. The Observatory is also greatly indebted for assistance, special reports and the loan of equipment, to the Director of the Meteorological Bureau in Melbourne, the C.S.I.R.O. Division of Meteorological Physics and to the Weapons Research Establishment at Salisbury, S.A.

Dr. Hogg has been appointed the Australian member of a Working Committee on Astronomical Sites established this year by the International Astronomical Union.

The IBM 610 Computer.

During 1959, the staff and scholars felt increasingly the need for some readily accessible fast computing machinery. Facilities available in Sydney and Melbourne are insufficient for day-to-day needs and the decision was made to rent an I.B.M. 610 for an initial period of one year, starting on February 1st 1960.

In October, five staff members and scholars attended a week's training course offered by I.B.M. (Australia) Ltd.

Lectures, Travel and Public Relations.

Dr. Baade, Dr. Tifft, Dr. Johnson, Mr. Whiteoak and Dr. Bok attended the A.N.Z.A.A.S. meeting in Perth. They participated in a Symposium on "Radio and Optical Studies of Our Own and Other Galaxies" and delivered three public lectures. Dr. Gascoigne and Dr. Dunham attended an Optics Symposium, and Dr. Gollnow a Spectroscopic Conference, both in Melbourne. During 1959, Dr. Bok again lectured extensively in Sydney, Melbourne, Brisbane, Perth, Hobart and Armidale, N.S.W., addressing in each place University groups and Amateur Astronomical Associations. A special brief course of University Lectures was delivered at the University of Tasmania. Dr. Hogg gave a public lecture in Sydney and Dr. Gollnow one in Melbourne. The demand for public lectures by the Observatory staff continues to develop.

Dr. Hogg has been appointed a Scientific Adviser to the Museum of Science and Industry in Melbourne. Dr. Bok is a member of the National Committee on Space Research established by the Australian Academy of Science.

Several members of the Observatory Technical staff assisted in a course of nine adult Education Lectures in Astronomy delivered by Dr. Buscombe at the Canberra University College. These were attended by 65 people.

During the visit of Professor Bondi, a two-day symposium was held at the Research School of Physical Sciences on "The Cosmological Problem". Apart from Professor Bondi, the principal speakers were from the Radiophysics Laboratory of the C.S.I.R.O. in Sydney and from Mount Stromlo Observatory. Approximately 100 were in attendance at the sessions, including a delegation of 25 from Sydney.

The programme of bi-weekly colloquia has continued, with variations dictated by the presence of distinguished visitors.

In August Dr. A. Boggess and Dr. J. E. Kupperian from the U.S. National Aeronautics and Space Administration visited Mount Stromlo for several days to discuss the feasibility of one or more rocket flights from Australia for the purpose of studying ultraviolet radiations from the Magellanic Clouds and emission nebulae of the Southern Milky Way.

During 1959 close working collaboration was maintained with the C.S.I.R.O. groups in Sydney and elsewhere, and with the Sydney Observatory. Almost all staff and scholars spent some days in discussions at Sydney, and in return there were frequent visits of shorter and longer duration from colleagues in Sydney.

The programmes of catering for the considerable demands for visits to the Observatory has followed the pattern outlined in earlier Annual Reports. Again nearly 1,700 people visited the Observatory at night and it is estimated that the number of daytime visitors has been well over 15,000. The co-operation of the staff in the running of the monthly Visitors Nights is much appreciated.

The Mount Stromlo booklet continues to be a best seller (at 2s. 6d. when purchased at the Observatory, 3s. by mail) and has run through three more printings of 2,500 each. Mr. Lojkine has completed the text for a new edition. To inform visitors of the possibilities available to them a printed leaflet outlining the programme of visits has been issued. Because of the great demand for photographs of the Observatory and of celestial objects, a set of a dozen photographic postcards, which sell for 9d. each or 7s. 6d. a dozen, has been produced.

Publications.

Bok, B. J.—"The Arms of the Galaxy". *Scientific American*, 201, 93, 1959.


DEPARTMENT OF PARTICLE PHYSICS.

*Staff*.

Professor .......... M. L. Oliphant, K.B.E., M.A., Ph.D., F.A.A., F.R.S.
Senior Fellows .......... W. I. B. Smith, B.Sc., Ph.D.,
Electronics Engineer .... D. Robertson, B.Sc., Ph.D.
Fellow .......... E. K. Inall, B.E., Ph.D.
Research Engineers (Fellows) .... P. Carden, B.E.,
Research Fellows .......... R. A. Marshall, B.Sc., B.E., S.M.
Engineer (Research Fellow) .... B. F. Wadsworth, M.E.

*The Proton Synchrotron.*

The cyclotron has been fully assembled in its final site for injection into the large machine. The control racks are temporarily installed inside the cyclotron shielding, and must be shifted to the final control room before a full energy beam is obtained. A number of changes and improvements have been made during the re-assembly including the provision of beam positioning azimuth copper blankets, new dees, a new beam splitter of graphite and a new graphite deflector in the extraction system, improvements in the vacuum refrigerated baffles, and mechanical improvements in the magnet and dee system to improve stability. The energy of the machine has been raised from 7.5 to 8.0 MeV. Further improvements have been made to the optics of the ion source including an arrangement which
injects the proton beam into a naturally focussing phase and gives improved beam quality. Projects yet to be undertaken include stabilizing of the dee voltage and the deflector voltage, and precise extraction and steering of the beam after extraction from the cyclotron and prior to injection into the synchrotron.

Radiofrequency System.

During 1959 the experimental version of the low power section was completed. It is now being built in its final form.

Over the range of frequency from 0.97 to 4.5 mc., the tracking error was reduced from ±1.0% to ±0.1%. This was done with a photoformer, and three of them will be used in the final version to reduce the error to ±1% everywhere.

The monitoring equipment proved invaluable in measuring small tracking errors. It is completely transistorized and an engineered version of it is now being constructed.

All the ferrite has been delivered and tested. There has been no further progress on the high power section.

All the constructional and insulating work on the complete casing assembly has now been finished and it has been assembled outside the magnet. The NaK supply and drain manifolds have been completed and lined with epoxy-resin.

The bearings in the generator were completed and installed by August and through July and August preparations were made to test the bearings at full speed and under full magnetic load, by running the rotors without the generator casing. For these tests carbon brushes were mounted to take the place of the NaK motor jets. During September measurements were made to check the axial magnetic forces on the rotors. These proved to be very well balanced, forces of about 1,600 tons on each side of a rotor being balanced to leave a nett force of about 20 tons i.e. half the weight of the rotor.

Further measurements showed that the magnetic axis of the magnet coincided with the geometric axis to a high degree of accuracy, such that if the rotors were centred geometrically, no significant improvement in magnetic balancing was possible.

The following series of tests on the bearings was run at the end of 1959. Firstly the top rotor was run up to 40 r.p.m. then the bottom one was run to 300 r.p.m. and the method of dynamic breaking by feeding the stored energy back into the electricity mains was checked. The friction losses in the bearings was found to be somewhat less than expected.

The bottom rotor was then accelerated to 420 r.p.m. and a bearing failed bringing the rotor to rest in 1 ½ minutes. This failure has now been shown to be due to a small error in the machining of the bearing pads. Although this error was previously measured and recorded it was not known that it would be significant, and in order to save time it was not rectified. The effect of the incorrect shape of the bearing pads was greatly influenced by the fact that the pad face was of bronze and by the presence of a magnetic field normal to the shaft. This resulted in eddy currents flowing in the moving steel shaft and in bronze pads, so causing rapid heating as soon as the oil film was penetrated.

The results of all the tests carried out between August and December showed three features of the bearing which required improvements.

(a) The pad faces needed to be made of non-conducting material and to a high degree of accuracy to an improved design.
(b) The whole system of rotor support comprising bearings, shaft, and shaft to rotor joint, needed to be made more rigid.
(c) The clerical insulation needed to be improved.

With these results in mind the bearing design was reviewed in the light of modern engineering practice and extensive enquiries abroad. This showed that nowhere have bearings been made to carry such high loads with variable shaft speeds and reversal of the direction of rotation, as is required in this generator. Nevertheless revised designs have been completed on the basis of experience gained during the tests and it is clear that the difficulties experienced can be overcome.

The whole of the high pressure NaK and gas system has been checked for leaks and made good. The helium mass-spectrometer leak-detector has proved invaluable for this and has been in frequent demand for use by members of other departments.

The electrical wiring for the control of the operation of the NaK system has been installed, and this is now ready for testing. This wiring involves some 400 connections between the control panels and the generator structure. The hydraulically controlled valves which will regulate the flow of NaK to the jets have been installed and passed as satisfactory.

The bus bars have been designed and about one quarter of them assembled. The four main switch units are nearing completion.

Three types of load for testing the homopolar generator have been considered in detail. These are a water cooled resistive load made of steel strip submerged in a tank of water, a water electrolyte load which could be used without the main switch being required, and an inductive load having the
same inductance and resistance as the air cored magnet of the synchrotron. The components for the
inductive load are to hand and the electrolytic load could be made at short notice if required. It is
possible that the inductive load could be built by the time the generator is ready to deliver a current pulse.

Plasma Physics.

A small group led by A. H. Morton commenced work on plasma physics, the fundamental
approach to thermonuclear power, at the end of 1958. As plasma physics was a new field to members
of the group the first half of the year was devoted mainly to reading in the subject and becoming
acquainted with the literature. Throughout the year discussions and informal lectures were held on
topics of general and particular interest in order to short circuit detailed reading by all members of the
group as well as to assist in planning an experimental programme.

During the latter part of the year designs and drawings were completed for a heavy current
discharge tube, a 400 kw. air-cored magnet, to be used initially in conjunction with the discharge tube,
a 2-ton steel magnet with 10-in pole tips and 4½ inch gap.

The discharge tube and air-cored magnet will be used to study electric arc discharges powered by
a 1 m. watt source, in order to gain experience in control and measuring techniques preparatory to using
the homopolar generator as a source.

Some preliminary experiments were carried out involving observation of the behaviour of a
discharge in crossed electric and magnetic fields. The cyclotron magnet was available for these
experiments for a short period. This work will continue on completion of the two ton magnet.

Consideration was given to various methods for achieving a low inductance energy storage system.
It was hoped to obtain a source which could be discharged in the order of 10⁻⁷ sec. A model, lumped
impedance line, was made which would discharge into a matched load with a rise time of 3 x 10⁻⁸ sec
and a pulse length of 10⁻⁷ sec. However the energy storage of such a system, when matched to a load
suitable for ionizing and heating a gas, was too small to make it practicable.

General Departmental Activities.

L. U. Hibbard and J. Blamey have been on study leave during part of the year, the former at
the C.E.R.N. Laboratories, Geneva, and the latter at the Radiation Laboratory, Berkeley, California.

Professor Oliphant attended the International Conference on High Energy Physics in Kiev in
July and was present as the guest of the General Atomics Division of General Dynamics Corporation at
a seminar on plasma physics at La Jolla, California, in June.

L. U. Hibbard attended the Rutherford High Energy Laboratory Symposium at Harwell and
the Few Nuclear Conference at University College, London, in July. He represented this Laboratory

W. I. B. Smith attended a conference on cyclotrons with fixed frequency at Sea Island, Georgia,
in February.

Specialized colloquia and discussions have been held regularly throughout the year and members
of the department have given lectures and conducted colloquia in other centres.

Publications.

D. S. Gemmel, A. H. Morton, W. I. B. Smith.—“ Gamma radiation from capture of 5 to

D. S. Gemmel, A. H. Morton, E. W. Titterton.—“ A Study of the Giant Resonance regions
of Be⁸ and C¹² through the inverse reactions Li⁷ (p, γ) Be⁸ and B¹¹ (p, γ) C¹³.”
Nuclear Physics, 10, 33-44 (1959).

W. I. B. Smith and H. A. Morton.—“ Improved Cyclotron Performance from Control of
Initial Ion Motion “. Nuclear Instruments and Methods, 4, 36-43, 1959.

DEPARTMENT OF NUCLEAR PHYSICS.

Staff.

F.R.S.A., F.A.A.

Fellows . . . . . . . P. B. Treacy, B.Sc., Ph.D.

Research Fellows . . . . . . W. E. Turchinetz, B.Sc., M.Sc., Ph.D. (Left July
1959).


Fulbright Research Fellow . . S. Bashkin, (arrived November, 1959 for one year).
Research Students and Teaching Activities.


After an absence of 18 months Dr. T. R. Ophel returned from Harvard University, U.S.A. and was appointed as a Research Fellow.

Under the Fulbright Scheme, Professor S. Bashkin has come from the State University of Iowa, U.S.A. for one year commencing November, 1959.

Mr. D. S. Gemmell, has completed his Ph.D. thesis and has left to take up a junior fellowship at Atomic Energy Research Establishment, Harwell, England and Mr. K. H. Purser is at present completing his Ph.D. course and will submit a thesis early in 1960.

During the year regular colloquia and research meetings were held and a number of specialised courses were presented for the research students.

Research Equipment.

The three accelerating machines have been heavily loaded with experimental work throughout the year and breakdowns have been of minor consequence. The major effort on equipment has been in relation to the installation of the 12 MeV Tandem Electrostatic generator. By the end of the year the bulk of the mechanical work on the machine had been completed at the High Voltage Engineering Corporation plant in Burlington and final assembly will be made early in 1960. In collaboration with the California Institute of Technology and the H.V.E.C., the machine, together with the C.I.T. machine, will be used to prove the principle of double-tandem machine operation using neutral ion injection; it is hoped to achieve 18 MeV from the combined machines. This work is not expected to delay either delivery or acceptance tests which are scheduled for March–April 1960.

The machine should arrive in Canberra by mid-year and erection will commence immediately; providing unforeseen difficulties do not arise the generator should yield a beam before the end of the year.

Detailed designs have been made of the target area layout, shielding facilities and control arrangements. Among the auxiliary equipment studies have been made of high resolution particle spectrometers and one—a wedge field double focussing device capable of deflecting 25 MeV protons—has been placed on order with Pacific Electric Motors. Consideration is being given to obtaining a high precision, large solid angle, 180° spectrometer and it is hoped that funds will be made available for this purpose during the coming year.

Difficulties have been experienced in the course of multiple coincidence experiments at low coincidence rates due to random fast pulses arriving via the power lines; it has proved to be impractical to filter these out and a separate "clean" a.c. source run at constant load has become essential. Suitable equipment will be installed during 1960 to cater for a load of approximately 20 kw. and lines will feed to various laboratories which require clean a.c.

Research Programme.

Fast Neutron Studies.—(1) Cross sections for the interaction of 14.5 MeV neutrons with Cu, Mn and Co have been measured. The latter two provide essential data for nuclei near to the magic number 28. Activation techniques were used and the following results obtained:

\[ ^{64}\text{Cu}(n, 2n)^{64}\text{Cu} = (1030 \pm 95) \times 10^{-27}\text{cm}^2 \]
\[ ^{54}\text{Mn}(n, 2n)^{54}\text{Mn} = (825 \pm 185) \times 10^{-27}\text{cm}^2 \]
\[ ^{52}\text{Mn}(n, p)^{52}\text{Mn} = (27 \pm 5) \times 10^{-27}\text{cm}^2 \]
\[ ^{58}\text{Co}(n, 2n)^{58}\text{Co} = (855 \pm 165) \times 10^{-27}\text{cm}^2 \]
\[ ^{59}\text{Co}(n, p)^{59}\text{Fe} = (80 \pm 23) \times 10^{-27}\text{cm}^2 \]
\[ ^{56}\text{Co}(n, p)^{56}\text{Mn} = (29 \pm 6) \times 10^{-27}\text{cm}^2. \]

(2) A triple coincidence counter telescope for the study of the energy spectra and angular distributions of reaction products from 14.5 MeV neutron bombardments of a variety of elements has been constructed. Provision has been made to determine E/\text{d}x for individual particles to enable deuterons to be distinguished from protons and the equipment has been brought into operation. Preliminary results for (n,p) reactions from Al\text{137} and Ni\text{58} have been obtained and there is some evidence for deuteron emission.

(3) Work in this laboratory has already shown that the rare mode of fission involving the emission of a fast \( \alpha \)-particle occurs in the slow neutron fission of U—235, the photofission of Th\text{232} and U\text{238} and the fission of U\text{238} and Th\text{232} with 2.5 MeV neutrons. To determine what effect, if any, the initial nuclear excitation may have on the probability of this form of ternary fission, irradiations, using 14.5 MeV neutrons, have been carried out. Nuclear emulsion methods were employed, desensitisation
techniques being used to prevent blackening of the emulsions by the high yields of recoil protons caused by the fast neutron flux. Considerable difficulty in obtaining adequate thorium loadings with solutions having pH values near to that of emulsion (7) was experienced but satisfactory exposures were eventually obtained. The 14.5 MeV fast neutron ternary fission of both Th\textsubscript{232} and U\textsubscript{238} has been observed in the experiments and the work now in progress will establish the relative probabilities of the various modes and the energy spectrum of the long range α-particles.

Capture Gamma-Ray Studies.—(a) The region of nuclear excitation in Be\textsuperscript{8} between 0 and 14 MeV has been investigated through the reaction Li\textsubscript{7}(p,γ)Be\textsuperscript{8*}(α)He\textsuperscript{4}. By studying the α-particle spectrum recorded in coincidence with γ-rays from this reaction, it was hoped to shed further light on the existence or non-existence of the controversial levels in the region. The γ-rays were detected with a 5-inch diameter × 4-inch long NaI(Tl) crystal and the α-particles with a 0.004-inch thick CsI crystal. To avoid having a foil between the target and the CsI crystal, a magnetic field of 5.4 kilogauss was used to sweep scattered protons away from the crystal. The apparatus was arranged so that the 9 MeV α-particles from the Li\textsubscript{7}(p, α) reaction (and also direct light from the target), did not reach the crystal. The results obtained indicate that, apart from the 2.9 MeV state, there are no additional levels between the ground state and 7 MeV excitation fed with γ-rays with intensities greater than 5% of the 14.8 MeV group. It was shown that the shape of the 2.9 MeV level, can be fitted satisfactorily with a dispersion formula provided a large value of the reduced width of the level is assumed.

(b) Angular distributions of the 17.6 and 14.8 MeV γ-ray lines from the Li\textsubscript{7} (p, γ) spectrum have been measured at 50 keV intervals, using 10 to 20 keV thick targets, from well below the narrow 440 keV resonance to the neighbourhood of the 1.03 MeV resonance. Separation of the γ-rays corresponding to the ground state and 2.9 MeV state show the angular distributions to differ markedly in the neighbourhood of the two resonances. This arises from interference between the resonant and non-resonant radiations which are of opposite parity. The existence of a Cos\textsuperscript{2}θ term in the angular distributions above Ep\textsubscript{γ} = 460 keV is attributed to d-wave interaction. The results do not lead to definite conclusions on the nature of the 1030 MeV resonance, but are not inconsistent with it being J = 1\textsuperscript{-} with channel spins 1 and 2 in the ratio 1:5; the resonant radiation being of the form (1 + a cos θ) but probably mixed with steadily rising d, p and s-wave contribution in the non-resonant background.

The Polarization of Protons from (d, p) Reactions.—The degree of polarization of the protons resulting from (d, p) reactions and its dependence on bombardment energy and angle of emission, should give an indication of the nature of the interaction producing the protons. It has been shown that a thin carbon scatterer may be used to analyse polarized proton beams— the asymmetrical distribution of the scattered protons being a measure of the initial polarization. Such an analyzer has been used in a series of experiments to investigate the C\textsuperscript{12}(d, p) C\textsuperscript{14} reaction from this point of view. It consisted of a polyethylene foil of 25 μ thickness. Protons scattered from this through angles of 45° on either side were counted by two detectors consisting of 10 thou. thick CsI crystals attached to 2-inch Dumont photomultipliers.

The 1.2 MeV H.T. set was used to bombard a carbon target with deuterons at energies from 750 keV to 1100 keV and observations of the resultant protons were made at angles of 45°, 90° and 135° to the forward direction. Analysis of the results obtained is not yet complete but it appears that large and rapidly varying polarizations are present.

Photonuclear Studies.—(a) Work with the 33 MeV Synchrotron:—

(1) The V\textsuperscript{51}(γ, α)Sc\textsuperscript{47} reaction has been studied by induced radio-activity up to gamma-ray energies of 32 MeV. The cross section has a maximum value of 0.95 mb at a gamma-ray energy of 21.5 MeV and an integrated cross section to 32 MeV of 12 ± 2 MeV-mb. The statistical model gives a satisfactory interpretation of the ratio of the V\textsuperscript{51}(γ, α) cross section to the V\textsuperscript{51}(γ, n) cross section measured by Goldberg and Katz. It is probable that this interpretation can be applied to the (γ, α) yields from other middle-weight nuclei but it is not appropriate for the heavy nuclei (Z > 40). It appears likely that the roughly constant (γ, α) yields observed in the heavy nuclei arise from direct electric dipole interactions with performed "alpha-particles" in the nuclear surface. Further experiments to test this assumption are in progress.

(2) Work has continued on the study of photodisintegration of medium weight nuclei. The activation method has been employed. In this method reaction cross sections are determined from measurements of the intensity of the induced radioactivity in targets irradiated in the X-ray beam of the 33 MeV electron synchrotron. An NaI(Tl) crystal gamma-ray spectrometer and a Hutchinson Scarratt 100-channel pulse height analyser are used for this purpose.

The irradiations and measurements of the radio-isotope yields for chromium targets have been completed and, at present, data on zinc and iron is being obtained. This work will complement the results for titanium and for nickel, previously obtained in this laboratory. Because the elements being investigated consist of four or five isotopes, for each of which one or more of the reactions (γ, n), (γ, 2n), (γ, p), (γ, np) may lead to a radio-isotope, the result activity may be a mixture of activities with different half lives. Since the X-ray flux from the synchrotron is continuous in energy range up to the energy of the circulating electrons when they hit the internal target, the reaction cross-section, as a function of photon energy, cannot be obtained directly but as a result of a series of measurements at different photon end point energies. The yield of radio-isotopes for irradiations over the range (in 1 MeV steps) 14–33 MeV give curves from which the cross-sections can be determined as functions of photon energies.
In order to reduce the time wasted on mechanical numerical analysis and the derivation of cross-sections from the raw data, programmes were prepared for the I.B.M. 650 computer installed at the I.B.M. centre in Sydney and for Silliac at the University of Sydney. The analysis was divided into three parts—

(a) Reduction of recorded gamma-ray spectra to decay curves.

(b) Analysis, by the method of least squares fitting, of the decay curves into their component activities leading to yield curves for each isotope.

(c) Analysis of yield curves to get reaction cross-sections.

Programmes (a) and (b) were prepared for use on the 650 and (c) on Silliac. The three programmes were successfully used for the reduction of the titanium data. However, it was decided that a more economical programme (a) could be developed by using a more basic form of coding than the simple automatic system FORTRAN. The new programme has been written and is in the testing stage.

(b) Monochromatic Radiation:

- Monochromatic Radiation:
  - (γ, n) cross-sections of Cu^{63}, Zn^{64}, Sb^{121}, Pr^{141} and Ta^{181} are being measured at 17.6 and 14.8 MeV using resonance and non-resonance Li\(^7\) (p, γ) radiation. An activation method is employed—annihilation quanta are detected by a 2-inch × 1-inch NaI crystal except for Ta where the K X-ray is detected. A 5-inch × 4-inch NaI crystal monitors the γ-flux and all measurements are relative to Cu^{63} which is being measured absolutely. The data are now being processed and results to better than 5% accuracy are expected.

Other Problems.

(a) Californium-252, a man-made transuranium element having an α-particle half-life of 2.2 years, also undergoes spontaneous fission. Approximately one fission occurs for every 38 α-particles and this element is therefore highly suited to the investigation of the possibility of spontaneous ternary fission which has never been observed. Through the courtesy of the Radiation Laboratory of the University of California a 1-milli-microcurie source of Cf\(^{252}\) has been loaned to the Department to carry out the experiment. The source arrived at the end of the year and experiments have begun.

(b) An investigation has been made for the quantitative determination of small quantities of oxygen present in beryllium metal in solid solution or present as BeO. The work was done in collaboration with the Metallurgy Section of the Australian Atomic Energy Commission, Lucas Heights. The A.A.E.C. are studying the effects of oxygen on the mechanical properties of beryllium and are endeavouring to produce high purity beryllium by vacuum distillation. The oxygen content can be estimated by bombarding a Be sample with 960 keV protons and counting the 4 MeV α-particles from the strong O\(^1{/\text{°}}\) (p, α) reaction. The α-particles are counted with a thin CsI crystal, a thin foil being placed between target and crystal to stop scattered protons and also the large number of lower-energy α-particles from the Be\(^4\) (p, α) reaction. The only background effect of importance is the presence of a Be\(^0\) film on the surface of the sample. Electron diffraction studies have shown the oxide film to be less than 10 Angstroms thick and this places a lower limit on the amount of oxygen detectable by the (p, α) method at about 10 p.p.m.

General Departmental Activities.

Dr. J. H. Carver returned from study-leave in the United Kingdom on 29th May, 1959, while Dr. W. E. Turchinetz, who has been elected a Sloane Research Fellow of M.I.T., left for the United States of America in July, 1959.

Two of our students have been awarded Harwell Fellowships—Dr. K. Lokan, Harwell Senior Fellowship, and Mr. D. S. Gemmell, a Junior Fellowship. Lokan left for the United Kingdom in April, 1959, and Gemmell in December.

At the Perth meeting of A.N.Z.A.A.S., Professor E. W. Titterton presented a paper entitled “Fission Physics” and he later gave a series of lectures on recent developments in nuclear physics to the staff and research students of the Department of Physics at the University of Western Australia.

During the year Professor Titterton attended a number of meetings of the Defence Research and Development Policy Committee, the National Radiation Advisory Committee and the Scientific Advisory Committee of the Atomic Energy Commission.

Publications.

Carver, J. H.—“Distribution of partial radiative widths in Cu\(^{65}\) following proton capture in Ni\(^{56}\).” Physical Rev. Letters, 3, 559, 1959.


“Radiative deuteron capture Zn\(^{64}\) (d, γ) Ga\(^{66}\).” Nuclear Physics, 11, 400, 1959.


DEPARTMENT OF THEORETICAL PHYSICS.

Staff:

Professor K. J. Le Couteur, M.A., Ph.D.
Reader D. C. Peaslee, Ph.D.
Fellow F. C. Barker, M.Sc., Ph.D.
Research Fellow L. J. Tassie, Ph.D.
Research Students E. Bradford, B.Sc.

Research Activities.

Nuclear shell model calculations with a potential well of finite depth have given some justification for a simpler approach, based on the use of an harmonic oscillator potential well with an extra term in the Hamiltonian that depends only on the configuration of the state. This has been applied to nuclei with A = 15 - 18 and leads to reasonably good agreement with the energies of the lower states, including some excited configurations. It also shows a need for modification in the well of finite depth used previously (F. C. Barker).

Re-analysis of available experimental data has indicated that the previous spin assignment (1−) for the lowest negative parity state of C12 may be incorrect, and a further experiment has been suggested which may lead to a definite spin value. This experiment is being undertaken in the Nuclear Physics Department (Barker, Bradford and Tassie).

An analysis is being carried out on the angular distribution of gamma rays in the Li7(p, γ)Be8 reaction. This is to be related to the experimental work done by the Nuclear Physics Department at the Australian National University (E. Bradford).

The energy density of excited states of nuclei has been investigated, summarizing the results of recent experiments in this field and extending the theory of high energy cascades from earlier work. Some disagreement is possible between high energy and low energy data for heavy nuclei, and a search is being made for a unifying assumption in this field. In co-operation with Dr. T. H. R. Skyrme, on a

* Not at the Australian National University.
visit from Harwell, an investigation was made of the difference between a nucleus regarded as a set of particles, each of which interacts with the average of the others, and a more accurate solution allowing for the effect of individual nucleon states on one another (D. W. Lang and K. J. Le Couteur).

A programme has been completed to allow yield curves from the electron synchrotron to be analysed in Silliac (D. W. Lang).

Motions of charged particles have been studied under various magnetic and electric field conditions with extension of Alfvén's work to obtain the exact drift velocity of a charged particle moving in an inhomogeneous magnetic field. The theory of arcs and pinched linear gas discharges has been applied to a steady-state linear gas discharge, cooled by longitudinal heat flow and bremsstrahlung power radiation.

Under present consideration is the problem of a convergent gas discharge of relevance to operation of the homopolar generator (P. W. Seymour).

The organization of elementary particles according to a scheme of seven-dimensional charge space has been continued and incorporates all presently known particles but the photon and graviton, with no unfilled slots, so that it predicts the absence of further elementary particles of the types now known. The baryon mass differences are qualitatively interpreted as follows: (1) the major differences, $\Sigma - \Sigma$ and $\Sigma - N$, are of "intrinsic" origin, not to be derived solely from interactions; (2) the minor difference, $\Sigma - A$, arises from interference between two different types of baryon-boson interaction. Detailed implications of these assumptions are under present study (D. C. Peaslee).

Previous work on electron excitation of collective nuclear transitions is being extended to include excitation of rotational levels and the effects of finite proton size. Although the scattering of relativistic electrons by a Coulomb field is known theoretically to sufficient accuracy, there remains some doubt about the effect of the screening by the atomic electrons of the Coulomb field of the nucleus, and especially about this effect on the asymmetry factors for the scattering of polarized electrons. Calculations are being made on the scattering of electrons by atoms, using the Dirac equation for the electrons and the Hartree field of the atom. The summation of the Mott scattering series has been programmed for the I.B.M. 650 computer and a preliminary computation has been carried out (L. J. Tassie).

Other Activities.

Professor Le Couteur has been on study leave in Europe, spending considerable time at the European Center of Nuclear Research (Geneva) and at the Atomic Energy Research Establishment (Harwell). He attended a recent meeting on plasmas and thermo-ionsics at Uppsala.

Dr. Tassie presented a lecture series on relativistic wave mechanics before his departure to assume a Weizmann fellowship in Israel.

Mr. Lang attended a course in Sydney on the operation of the I.B.M. 610.

Publications.


Department of Radiochemistry.

Staff:

Senior Fellow . . . . . H. Berry, M.Sc. (Tech.).
Fellow . . . . . . . . R. Mills, M.Sc., Ph.D.
Mass Spectrometrist . . . . J. R. Richards, M.Sc., Ph.D.
Research Student . . . . E. W. Godbole, M.Sc.

The partition of the Department of Radiochemistry between the Departments of Geophysics and Particle Physics is now effective. The present report, therefore, constitutes the final joint report of the research sections of this department.

It is anticipated that the research programme on geological age, together with current work on mass spectrometry, will continue as part of geophysical research while electrolyte diffusion research and nuclear chemical work will proceed, until other arrangements can be made, in the Department of Particle Physics.
Accommodation.

Completion of the extension to the existing rock sampling laboratory has now provided the Department with a combined storage and minerals separation laboratory which is compact and which contains all rock preparation equipment. Sample processing which was interrupted during building operations, is now well under way.

A small workshop has also been constructed in the main building to take advantage of unused corridor space.

Research Activities.

Analytical Section.—Until the research work of the section is formulated and aligned with that of its new department, the immediate working programme continues to be concerned with the determination of geologic ages of Australian rocks. At the moment, as the result of the considerable interest shown by geologists of the Snowy Mountains Authority, the granites and gneisses in the locality of the T.1 and T.2 Power Station projects are under investigation. This work is an extension of that undertaken during the year on the Happy Valley granite mass for which a tentative age has now been derived.

Figures determined by the lead-alpha and uranium-lead methods based on separated zircon, indicate an age for this mass approximating to 330 ± 20 million years which would imply that emplacement took place in Devonian or early Silurian rather than in Ordovician times as has been generally supposed.

Interest now lies in the metamorphic rocks intruded by this granite and a sampling programme has recently been conducted in the area for further dating tests.

In collaboration with the Bureau of Mineral Resources, experimental figures, which require confirmation, have also been obtained for rocks in the Darwin–Katherine locality and at Cloncurry. These are of pre-Cambrian age and have already been studied by potassium-argon and rubidium-strontium dating methods at the Massachusetts Institute of Technology.

In the techniques associated with the zircon method of dating considerable work has been done not only in the analytical field but also in improving the separation of the mineral. The acquisition of more suitable sampling and processing equipment has resulted in a five-fold increase in recovery efficiency, despite extremely small crystal parameters. This improvement has been effected without sacrifice of crystal purity. The present aim is to isolate sufficient of the mineral from each rock to carry out an isotopic assay of the lead present as this considerably increases the reliability and value of the zircon method of dating.

Accurate and sensitive (better than 1 p.p.m.) techniques for the chemical determinations of lead and uranium in zircon have been established but a reliable method for thorium still eludes our efforts. In a new approach, however, appreciable progress has been made with a method in which thorium is effectively separated from the predominating bulk of associated zirconium by ion exchange on a resin column and is finally evaluated radiometrically. The final stage is still under investigation.

Meanwhile, thorium figures required to complete current age determinations have been obtained by X-ray fluorescent spectrography in collaboration with Mr. W. Roberts of the Bureau of Mineral Resources. This method is growing in popularity particularly for elements which are difficult to separate and determine by wet chemical methods. It has the merit of being rapid and non-destructive to the sample and on this account is being investigated as a method for simultaneous quantitative determination of Pb, U and Th in zircon as a guide in subsequent chemical analysis.

Mass Spectrometer Section.—After an initial period spent on the measurement of $^{18}O$ abundances, a project, undertaken while the instrument was still set for low mass work after the adjustment of the new tube, the work on lead isotope abundances has been continued.

The stage has been reached where duplicate preparations of tetramethyl lead from the same sample yield answers which agree to within a few parts per thousand and where a satisfactory chemical procedure is now being carried out as a routine. Early measurements, on samples synthesized last year and stored until the instrument was operating satisfactorily, showed that further work on the chemical procedure was required before this was attained. There still remains a number of matters of chemical interest which would repay further elucidation, but these no longer affect the results. It was also discovered that a further alteration to the amplifier system was required before this was operating satisfactorily.

A series of measurements is currently being made on lead samples, mostly galena, from the Northern Territory and other parts of Australia. It is intended shortly to submit for publication the techniques developed for this work, after which it is hoped to convert the mass spectrometer to the solid-source method of measurement. This conversion should materially increase the rate of production.

Two manuscripts covering aspects of this work have been submitted for publication during the year.

Physical Chemistry Section.—Tracer-diffusion measurements on $Rb^+$ and $Cs^+$ ions, in various supporting electrolytes, were completed early in the year. A study of $Na^+$ ion diffusion, using the new continual monitoring method was also completed. The results of these experiments demonstrated that
the Onsager limiting law was valid at high dilution and the law could be extended to higher concentrations by inclusion of an ion-size parameter. Diffusion studies on non-electrolyte molecules, as an aid to investigating the nature of viscosity in solutions, were also begun, with the measurement of the self-diffusion of pentaerythritol. The equation for concentration-dependent diffusion devised by Blackwell and Mills was generalized and applied to a novel type of experiment which uses radio-isotopes to measure salt diffusion coefficients.

The fuel cell problem is also under study in this section, to see if useful fundamental experiments can be undertaken. The section has the equipment necessary to study ionic mobilities in molten salts and this would seem the best line of attack. The construction of a working molten salt fuel cell is also being considered.

Eight manuscripts covering various phases of the section's work have been submitted for publication during the year.

**Nuclear Chemistry Section.**—The work of this section this year has been essentially a co-operative one with the Nuclear Physics Department. Several radio-chemical separations have been developed and various compounds have been prepared for inclusion in photographic emulsions. The rare earth separations, described in last year's report, have been dropped meanwhile. Although separations could be made, the times required made them impracticable for use in the activation experiments which were planned.

**Publications.**


**Department of Geophysics.**

**Staff.**

<table>
<thead>
<tr>
<th>Position</th>
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<tbody>
<tr>
<td>Reader</td>
<td>M. S. Paterson, B.E., Ph.D.</td>
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<tr>
<td>Fellows</td>
<td>Germaine Joplin, D.Sc., Ph.D.</td>
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<td></td>
<td>E. Irving, M.A., M.Sc.</td>
</tr>
<tr>
<td>Senior Research Fellow</td>
<td>E. A. Ringwood, Ph.D.</td>
</tr>
<tr>
<td>Visiting Fellow</td>
<td>N. A. Opydyke, Ph.D.</td>
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<tr>
<td>Research Fellows</td>
<td>H. Doyle, B.Sc.</td>
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<td>J. F. Lovering, M.Sc., Ph.D.</td>
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<td>F. D. Stacey, Ph.D.</td>
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<tr>
<td>Research Assistant</td>
<td>Katrine Urquhart, B.Sc.</td>
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<tr>
<td>Research Students</td>
<td>L. Howart, M.Sc.</td>
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<td>D. S. Kemsley, M.Sc.</td>
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<td>I. MacDougall, B.Sc.</td>
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<td>P. M. Stott, M.Sc.</td>
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<td>D. H. Tarling, B.Sc.</td>
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<td>W. A. Robertson, B.Sc.</td>
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<tr>
<td>Fulbright Student</td>
<td>E. A. Flinn, S.B.</td>
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**Travel and Study Leave.**

Dr. Paterson left in August, 1959, for a year's study leave to be spent mostly in the University of California. Dr. Joplin returned from study leave in August, 1959. Professor Jaeger visited the United States of America and Canada in November–December, 1959, to investigate modern methods for the determination of ages of rocks.

**Research Activities.**

A number of new methods for measuring the thermal conductivities of rocks by transient methods has been developed. Some of these have applications to corresponding problems in hydrology.
A study of conduction of heat or diffusion in regions which divide into several branches has been made which has important applications in neurophysiology. An investigation of the problem of diffusion from a point source with simultaneous reaction has also been made.

Temperature and thermal conductivity measurements have been made for a number of mines and drill holes throughout Australia and values of the heat flux from about 25 sites in Australia will shortly be computed.

Deformation of Rocks and Minerals.—Previous studies of the fundamental principles of rock mechanics have been extended. A large number of measurements on the behaviour of artificial joint surfaces has been made at confining pressures of up to 1,000 atmospheres. A careful study of the initiation of failure at low confining pressures has been made with the conclusion that a shear criterion of failure is always adequate. A simple extension of the classical Coulomb-Navier criterion for failure has been made which covers orthotropic or bedded rocks and this has been studied experimentally. A series of laboratory experiments designed to test the "flat jack" and other methods for measuring stresses in underground openings has been begun.

The investigation of the work-hardening of copper and zinc crystals in alternating tension and compression has been completed and showed a very marked dependence on orientation and plastic strain amplitude.

A study of recrystallization of plastically deformed marble is in progress. Preliminary results show a tendency to recrystallization into smaller crystals, development of larger crystals being prevented by the existence of voids between the grain boundaries.

The most important work which has been done is a careful study of the changes of length which occur in polycrystalline rock specimens which have been deformed at a high confining pressure when the pressure is decreased. This is a very curious and fundamentally important effect probably due to the interaction of two sets of intercrystalline stresses due, respectively, to elastic and plastic anisotropy. Anomalous changes of density also occur in polycrystalline rocks and have been measured. These effects do not appear to occur in single crystals of calcite.

Meteorite Studies.—Thermo-magnetic studies of the metal phases in iron meteorites have been made in collaboration with L. G. Parry of the University of New South Wales. An interesting by-product of this work has been an estimate of the temperatures of iron meteorites during flight and of their loss of mass by ablation.

The distribution of trace-elements in tektites has been studied and an attempt made in collaboration with the Broken Hill School of Mines to produce artificial tektites. Both major and minor constituents in these latter have been measured.

An attempt was made to count the rate of impact of micrometeorites on equipment carried in a "Long Tom" high altitude rocket. The equipment worked perfectly but no impacts were observed. This result is in agreement with other recent work.

An investigation of phase and chemical relationships among the minerals of stony meteorites has been completed. Extensive optical and X-ray data for the olivines, pyroxenes, taenite and kamacite of 28 chondrites have been obtained. This has enabled the chemistry of these objects to be placed on a systematic footing and some specific conclusions regarding their origin to be drawn. As a by-product of this work, diamonds have been found in the Novo Urei stone, whilst the presence of appreciable quantities of metallic silicon in solid solution in the metal phase of Pillistfer and Indarch is strongly indicated. This is of some significance in view of recent theories which suggest that the earth's core may contain silicon metal as an important constituent.

Oceanography.—Operation of a number of tide and long ocean wave recorders which were installed during the International Geophysical Year has been continued. A study of the variation of mean and steric sea level at these stations during the I.G.Y. has been completed.

Palaeomagnetism.—The survey of palaeomagnetic directions of Australia rock formations has been continued. Work on the Tertiary, Permian and Carboniferous of New South Wales is well under way. Work has been commenced on granite and other intrusions of ages varying from Devonian to Tertiary. In addition to this work on Australian rock formations, studies are also being made on rocks from Aden, Scotland, North America and Antarctica, the latter in collaboration with Dr. Bull from the Victoria University of Wellington. The Antarctic results, the first from this continent, are interesting in that they give results consistent with the hypothesis of continental drift which suggests that Antarctica and Australia once formed a single land mass with the other Southern continents. The Aden results, which are from rocks of Recent or Quaternary age, confirm that the earth's field has been approximately a dipole in recent times and also provide evidence of reversals of polarity in this field. This is the first confirmation from low latitudes of these two features of the Earth's main field.

Equipment has been expanded considerably; the alternating current "washer" has been in operation for some time and the thermal "washer" should be completed next year. An intensive laboratory study of the important question of stability of rock magnetism is being made, in particular the connexion between stability under field and laboratory tests is being studied.
Petrology and Geochemistry.—Extensive collections of type material of granites and related rocks have been made in Europe and North America. Several papers on the genesis of granites are in the press. Further work has been done on the granites of north-west Queensland.

The study of the granophyre at Red Hill in Tasmania by chemical and optical methods is now almost complete. Trace-element determinations have now also been completed. A careful investigation of the process of differentiation in the Tasmanian dolerites is being carried out.

An extensive series of measurements on trace-element concentrations in basic and calc-silicate rocks from north-west Queensland has been made.

The petrology and geochemistry of granitic, eclogitic and perioditic inclusions in deep-seated igneous pipes in Australia and South Africa is being studied. Rubidium-strontium ages of these inclusions are being determined in collaboration with Dr. Compston of the University of Western Australia. This work is of considerable importance in connexion with theories of the nature of the rocks of the upper mantle and lower crust.

Phase Equilibria at High Pressures.—A "squeezer" type apparatus capable of pressures up to 100,000 atmospheres and temperatures up to 1,000° C. has been constructed and is in operation. Studies of high-pressure silicate and germanate polymorphs will be carried out. Investigations of phase equilibria in the systems Mg₂GeO₄-Ni₂GeO₄ and Mg₂GeO₄-Co₂GeO₄ have been completed. Data obtained enabled the stability of Mg₂GeO₄ spinel to be predicted at high pressures. A study of the stability of the meteorite mineral merrilite (3CaO.Na₂O.P₂O₅) was initiated by high temperature, optical and X-ray methods. This has been abandoned for the moment, due to difficulties encountered in achieving equilibrium.

Rock Magnetism.—Work on magnetostriiction has been extended to a larger number of rocks and confirms earlier results. It is found that thermo-remanent magnetization has the same direction as the field inducing it irrespective of directed stresses up to 1,000 Kgm. per cm². Isothermal remanent magnetization behaves similarly. Anomalous results have been obtained with a few magnetically anisotropic metamorphic rocks, which are unsuitable for paleomagnetic work.

Magnetic anisotropy of rocks has been studied in detail by the Torquemeter method. It has been found possible to distinguish and measure separately shape and crystalline anisotropies of the magnetic grains in rocks. It has been established that the anisotropic deflection of remanent magnetism in igneous rocks is negligible but that in some metamorphic rocks anisotropy is very pronounced. Preliminary work on the correlation of magnetic anisotropy with geological structure has shown that the axis of anisotropy lies in the plane of foliation where this is apparent.

The magnetic anisotropy of several chondritic meteorites has also been studied and found to be directly correlated with compaction.

The magnetic properties of rocks and dispersed powders have been explained in terms of a multidomain grain theory. An experimental programme on dispersed magnetite powders, intended to test the theory, is in progress.

Seismology.—The network of nine stations established by the Australian National University, the Snowy Mountains Authority and the Sydney Metropolitan Water Board is now in full operation. Subsidiary stations have been established at St. Michael's College at Inveralochy and at Mount Bingar Observatory.

A programme for the location of near earthquakes using the I.B.M. 650 computer has been developed. This not merely locates the origin of the shock but specifies the accuracy of this determination. Small shocks are now being located in south-east Australia at the rate of about 25 per annum with, in addition, a large number of less accurate determinations. After a very few years it may be hoped that it will be possible to correlate these positions with the local geology. In conjunction with officers of the S.M.A. a very careful study of the relatively intense (magnitude 5.5) "Berriedale" earthquake of 18th May has been made. Long period recorders have been installed at three stations in order to study phase velocities of surface waves and thus to obtain an indication of crustal structure. Arrangements have been made with a number of quarries in the region which occasionally fire relatively large shots to allow the timing of these; by using observations on these a set of travel times for the region is obtained as well as information about crustal structure.

List of Publications.


“The analysis of aquifer test data or thermal conductivity measurements which use a line source.” J. Geophys. Research, 64, 561, 1959.


Ringwood, E.—“Genesis of the basalt-trachyte association.” Beitrage zur Mineralogie und Petrographie, 6, 346, 1959.


RESEARCH SCHOOL OF SOCIAL SCIENCES.

DIRECTOR'S REMARKS.

During the past year the research staff of the School has numbered 37, of whom 25 held permanent appointments. Of these 25, seven—almost one in three—received during the year offers of chairs in America, England or (in one case) Australia. While mobility of staff between universities, both within and beyond Australia, is generally to be welcomed, stability of permanent research staff is a great advantage to the School in its present phase of growth, particularly as the policy of the School aims at a regular turnover of non-permanent staff. Consequently, it is satisfactory that in five out of the seven cases mentioned above the offer of chairs elsewhere was declined.

It appears plain from these figures both that the School is now well known overseas and that the opportunities which it offers are highly valued by its members. These were considerations that had to be borne in mind when the announcement was made late in 1959 that the Australian National University and the Canberra University College would join forces. It was essential, in the interests of the College and the University, that the identity and character of the Research Schools should be preserved within the new academic structure. The work of constitution-making is not yet quite finished but the indications are that it will prove generally satisfactory. There will be no curtailment of existing opportunities of research and post-graduate teaching. In addition, there are good grounds for hoping that the association with the College will be fraternal and fruitful.

A great deal of thought was given during the year to the work and organization of the School and some changes were made. Academic business is now for the most part the concern of the full Faculty, rather than of a small Faculty Board. Experience of these new arrangements suggests that they entail no loss of efficiency and a marked increase in the flow of ideas. Some of these ideas—for example, on the recruitment of staff and students—have not as yet been fully translated into policy; but others have been worked out in some detail. The School has decided that candidates for the Ph.D. degree must have henceforward more systematic class work, in addition to their thesis writing, than most of them have had in the past. Provision has been made for a teaching M.A. as a prelude to the doctorate. It may be that the plans for this degree will be modified in large measure following upon the new relationship with the College, and that alternative means will be found of broadening and strengthening post-graduate education. The intention is to build upon and improve upon past practice. Starting from the first term of 1960, a printed list of lectures and seminars will be issued regularly. Some of these lectures and seminars will deal with research methods and techniques, others with background subjects, others with broad problems and topics. Some of them will be open to students for the M.A. as well as for the Ph.D. degree, and possibly at times to the more advanced B.A. Honours students, when (as is hoped) the College begins to attract students of this quality.

In the coming year, co-operation is bound to grow at departmental levels between the School and the College. It is important that ways and means should be sought at the same time of maintaining and improving co-operation with the School of Pacific Studies. An event of great importance for that School, as well as for our own and for the whole University, was the appointment of Sir John Crawford as Director. He will take up his duties in the second part of 1960.

Following his appointment, and the departure of Lord Lindsay to take up a chair at the American University, Washington, International Relations was transferred to the School of Pacific Studies. International Relations is a field of study of common concern to both the neighbour Schools. There are many other such fields in which it will be essential in the years ahead to maintain and improve the working partnership between the Schools.

This partnership will be symbolized by the new building which they will jointly occupy. The choice of architect was a difficult and anxious task which aroused a good deal of controversy. Messrs. Mockridge, Stahle and Mitchell were finally chosen and the prospects are that they will have their sketch plans ready in March or April, 1960.

During the year the number of post-graduate students enrolled for the degree of Ph.D. in the School was 39. Two students were enrolled for the degree of M.A. The degree of Ph.D. was awarded to seven students.

In 1959 the School enjoyed the company of two Visiting Fellows from England, Sir Alexander Carr-Saunders, formerly Director of the London School of Economics and Political Science, and Professor W. H. B. Court of the University of Birmingham. They both made progress with their own writing and contributed generously to seminars and to the research work of individual students. Sir Alexander was good enough to discuss with us our problems as a School and his reflections were a timely and useful catalyst.

The School also derived much pleasure and profit from the presence of the following Visiting Fellows from Australian Universities: Miss K. Woodroffe (Adelaide), Professor I. Bowen (Western Australia), Mr. H. R. Anderson (Queensland), Professor J. A. La Nauze (Melbourne). Sir Donald MacDougall of Nuffield College, Oxford, spent six months in the Department of Economics as Visiting Professor of Economics and Finance.
An event of great importance for the School, as for the whole academic community of Australia, was the constitution of the Universities Commission. It now has before it the School’s plans of development for the triennium 1961–63. They include new ventures in the History of Ideas and Sociology. Apart from these, one question of the greatest importance has been raised—the expansion of the School’s activities in the direction of “the Humanities”.

### Department of Demography.

**Staff:**

- **Professor**: W. D. Borrie, M.A.
- **Fellows**: C. A. Price, M.A., D.Phil.
- **Research Fellow**: R. T. Appleyard, M.A.


During the year the Department was fortunate in having the help of Sir Alexander Carr-Saunders who attended departmental seminars and discussions during his six months’ visit to the University.

The Department also received a short visit in March from Mr. Halvor Gille of the Population Branch of the Economic and Social Division of the United Nations. He led seminars on the work of the Population Branch and on problems confronting the United Nations Economic Commission for Asia and the Far East.

In July Professor Borrie left for abroad on study leave and Dr. Price was appointed Acting Head of the Department during his absence.

**Students and Teaching.**

The following pursued courses in the Department as candidates for the Ph.D. degree:

- **Mr. H. Y. T’ien**, finished his study of differentials in family structure in relation to economic status and mobility, submitted his thesis, and has now taken a position as Assistant Professor in Sociology in the University of Wisconsin, United States of America. His admission to the degree of Ph.D. has been recommended.
- **Mr. F. L. Jones**, B.A., who had already spent a year as a departmental assistant, was awarded a scholarship in March to study “The Italianate Community in Carlton, Melbourne”. He has completed all the general statistical work involved and most of the preparatory work for his extensive field survey in Carlton early next year.
- **Mr. J. C. Caldwell**, B.A., received a scholarship in March to study “Population Pressures in South-East Asia with particular reference to Malaya”. After preliminary reading and examination of statistics, Mr. Caldwell left Australia in August for Bangkok; there he worked for some months with the statistical section of the United Nations Economic Commission for Asia and the Far East before going on to detailed field investigations in Malaya.

During the year the Department organized three series of weekly seminars. In the first term members of the Department, together with two of the staff of the Canberra University College, gave analytical reviews of recent demographic studies. In the second term the Department, with members of the Bureau of Census and Statistics, discussed Australian demographic data with particular reference to Census material and vital and immigration statistics. The third series of seminars, which were led by Dr. Zubrzycki, and included participation by members of the staff of the Sampling Division of the Bureau of Census and Statistics, reviewed the methods and uses of sample surveys in population research in particular, and more generally in other branches of the social sciences.

**Research Programme.**

Until his departure on study leave in July, Professor Borrie, with Mrs. Rodgers, continued work on the distribution and structure of the Australian population with particular reference to the growth of population since 1947. In this connection they completed two articles and a preliminary draft of a small book that will discuss changes likely to occur before 1975 in total population, the growth and structure of the work-force, marriage and families, and the young dependent and aged dependent groups.
Dr. McArthur continued her studies of the populations of the Pacific islands and in August and September re-visited several territories to collect extra material relating to Census enumerations and vital statistics. In January, in response to an invitation to assist with a Census of population in the British Solomon Islands Protectorate, she also visited Honiara for discussions with the High Commissioner and his staff. There it was decided to enumerate sample areas only and after her return to Canberra Dr. McArthur selected the areas and designed the Census. The Census was carried out in November, 1959, will be tabulated in Australia, and will, it is hoped, be published in 1960.

As formerly, much of the Department's work related to various immigration studies. In the study of post-war immigrants under the supervision of Dr. Zubrzycki the main developments were—

(1) Preparation for publication of the manuscript setting forth the statistical analysis of post-war immigration.

(2) Further examination of records relating to displaced persons in Australia. In this connection Mrs. Wilson visited Tasmania to study the records of the State government and Hydro-Electricity Commission, and drafted more than half a monograph provisionally entitled "The Displaced Persons in Australia".

(3) Continuation of the content analysis of the foreign-language press: by December a three-year "run" of twelve selected papers was completed and an index started of foreign-language newspapers, both pre-war and post-war.

(4) The interview and processing stages of the survey of immigrants in the Latrobe Valley, Victoria. The 540 interviews took six weeks early in 1959 and were conducted by eight students of the Department of Social Studies, University of Melbourne, under the supervision of Dr. Zubrzycki and Mr. Jones. By December more than 300 tabulations of this interview material had been completed by the I.B.M. Processing Centre in Sydney and extensive analytical work carried on in the Department.

In England Mr. Appleyard continued organizing the survey of British emigrants to Australia. By October, when he had left to return to Canberra, Mr. Appleyard had completed his examination of British emigration policy, had collected much background material relevant to the settlement of British immigrants in Australia, had supervised the administration of a lengthy questionnaire to a sample of about 1,000 assisted emigrants leaving for Australia (the bulk of the interviews being carried out by the Social Survey Division of the United Kingdom Central Office of Information), and had conducted field interviews and gathered other data relating to a study of British migrants who had returned from Australia to Britain. Mr. Appleyard also visited The Hague to interview Dutch emigration authorities, and benefited from their experience in a similar research project. He also visited the International Labour Office, and the International Committee for European Migration in Geneva to gather comparative material relating to emigration policy and the emigration potential of Europe.

While on study leave in Canada and the United States of America Dr. Price continued his research on old-established ethnic minorities, spending some time investigating the Greek community of Toronto, the German settlements of Pennsylvania, and the Yugo-slav settlers of California. After his return to Canberra in June Dr. Price continued writing his history of southern Europeans in Australia.

To assist the general research work of the staff and students, and to aid population research in Australia generally, the department started the compilation of an Index of demographic material under the charge of Mrs. Nicholson. Though largely based on "Population Index"—the quarterly bibliography produced by the Office of Population Research, Princeton University—it will gradually increase its references to Australian and New Zealand material and to older works not covered by the Princeton publication.

Other Activities.

In May, Professor Borrie addressed the Statistical Society of New South Wales on Population Projections in Market Research. Later, after his departure from Canberra in July, he spent some time working with Mr. Appleyard in London and attending the International Population Union Conference in Vienna. In September he left London for Princeton University, United States of America, where he had been invited to become Visiting Professor of Demography for the semester period September, 1959, to June, 1960.

During the year other staff members participated in a number of seminars and conferences. Dr. Zubrzycki read a paper on immigration to Sections F and J of the A.N.Z.A.A.S. Conference in Perth and led a seminar in the Department of Psychology of the University of Western Australia. He also prepared a paper on ethnic segregation in Australian cities for the International Population Conference in Vienna, and co-operated with the Department of National Development in preparing a map showing distribution of immigrants for the Atlas of Australian Resources; subsequently Dr. Zubrzycki drafted a Commentary to accompany the map.

While in America on study leave Dr. Price led four seminars on immigration at the Universities of California (Los Angeles), Ohio and Pennsylvania, and visited a number of population institutes and departments dealing with demographic studies and research.
Support of Work.

The Department acknowledges the generous help of the following organizations: the Department of Immigration for its financial and other assistance in connection with the study of post-war British immigrants; the State Electricity authorities of Victoria and Tasmania for help in connection with the study of immigrants in the Latrobe Valley and Tasmania; the Bureau of Census and Statistics for help in departmental seminars; the United Nations E.C.A.F.E. organization in Bangkok for help with Mr. Caldwell's work in South-East Asia; the United Kingdom Department of Labour and Overseas Migration Board for their help with Mr. Appleyard's British migration study.

Publications.


DEPARTMENT OF ECONOMICS.

Staff.

Professor ... ... ... ... T. W. Swan, B.Ec.
Visiting Professor of Economics and Finance ... ... ... ... Sir Donald MacDougall, C.B.E., M.A.
Reader in Economic Statistics ... ... ... ... H. P. Brown, B.A.
Reader in Economic History ... ... ... ... N. G. Butlin, B.Ec.
Reader in Economic Theory ... ... ... ... I. F. Pearce, Ph.D.
Fellow ... ... ... ... A. R. Hall, Ph.D.
Senior Research Fellow ... ... ... ... F. H. Gruen, M.A., M.Sc.
Research Fellows ... ... ... ... J. A. Barnard, Ph.D.
... ... ... ... K. H. Burley, Ph.D.
... ... ... ... W. E. G. Salter, Ph.D.
Research Assistants ... ... ... ... S. Zyweczak, Dr.Ec.
... ... ... ... M. Gough, B.Sc. (Econ.).
... ... ... ... R. J. Inall

Two members of staff returned from study leave during the year: Professor Swan from India where he collaborated with Dr. I. M. D. Little of Nuffield College, Oxford, in a programme of research concerning Indian economic development sponsored by the Center for International Studies, Massachusetts Institute of Technology; Dr. Hall from Ceylon, where he acted as Colombo Plan Consultant in the preparation of Ceylon’s ten-year plan of economic development.

Sir Donald MacDougall of Nuffield College, Oxford, was Visiting Professor of Economics and Finance under an arrangement made possible by a group of Australian banks. He visited most of the Australian universities, where he delivered lectures and conducted seminars.
During the year the Department acted as host for substantial periods to a number of visitors from other universities. These included Dr. Max Corden and Professor J. A. La Nauze (both from the University of Melbourne), Professor W. H. B. Court (University of Birmingham) and Professor Jin-Soon Lyou (Seoul National University).

Students.

Five students continued their courses on the following topics: the economics of drought; the concept of income in accountancy and economics; the growth of railways in South-Eastern Australia; non-life insurance in Australia; and the development of Warrah. One new student was accepted to work in the field of international trade, with particular reference to Australian post-war experience. The Department undertook joint supervision with the Department of Pacific History of a student working on economic development in Western Samoa. Mr. Colin Forster completed his thesis on Australian industrial development in the 1920's and was admitted to the degree of Ph.D.

Public Service Fellow.

Mr. S. F. Harris of the Commonwealth Department of Trade became the Department's first Public Service Fellow, engaged upon research into the history and implications of Australian import licencing.

Research.

The Department's central interest is in processes of economic growth and economic fluctuation. Research work is carried on within three sections of the Department. In economic statistics, Mr. Brown continues his work on problems of social accounting, economic forecasting and the analysis of statistics of employment and unemployment. Research in economics continues in the theory of international trade and theoretical and statistical work on consumer demand (Dr. Pearce); theoretical models of capital accumulation and economic growth (Professor Swan, Dr. Pearce and Dr. Salter); the Australian capital market (Dr. Hall); studies of productivity, investment and the work force (Dr. Salter and Mrs. Gough); and studies of technical change in Australian agriculture (Mr. Gruen). In economic history, work on the growth of the Australian economy since 1860 has concentrated on three main lines, in studies of institutions, industries and aggregate economic development. This includes the history of individual business and of the pastoral industry (Dr. Barnard); the Australian coal industry (Dr. Burley); the process of capital formation and economic development since 1860 (Mr. Butlin and Dr. Zywczak).

Dr. Barnard completed and submitted for publication his business biography of T. S. Mort.

Other Activities.

Seminars in economic history and economic theory were conducted within the Department during the year. Some members of the Department participated in Professor Sir Keith Hancock's Wool Seminar, and Dr. Barnard is editing the volume in which the proceedings of that Seminar will be published.

Mr. Butlin and Dr. Pearce paid a visit to the University of Tasmania, in the course of which they lectured and conducted seminars.

Professor Swan was elected President of the Central Council of the Economic Society of Australia and New Zealand.

Publications.

Brown, H. P.—"The Australian male work force." Economic Record, April, 1959.


"The production function and the durability of capital." Economic Record, April, 1959.


Lyou, Jin-Soon.—"On tariff protection: Prof. R. Nurkse's infant protection argument and his three reservations." The Australian Quarterly, XXXI, 3, 46-56.


Theses.

During the year the following thesis was submitted and deposited in the library after examination for the degree shown:

Colin Forster. For Ph.D. "Australian Industrial Development 1920-1930."

Department of History.

Professor .... W. Keith Hancock, Kt., M.A., F.B.A.
Reader .... L. F. Fitzhardinge, B.Litt., M.A.
Fellows .... R. A. Gollan, M.A., Ph.D.
D. A. Low, M.A., D.Phil.
Research Fellows .... G. C. Bolton, M.A.
Mrs. Ann Mozley, B.A.

Students and Teaching Activities.

Of the nine students working for the Ph.D., eight were listed in the 1957 or 1958 Reports. The one addition is E. P. Waters, who is investigating "Popular Culture in Australia, c. 1850 to 1950, with special reference to relationships between bush songs and the songs of urban popular entertainers." Two additional scholars have been appointed, and will take up their scholarships early in 1960. They are P. D. Reeves and J. Broomfield, both of whom will work in the field of modern Indian political history. Three scholars left the University, during the year, at the completion of their scholarships; K. R. Bowes, P. J. O'Farrell and J. M. Tregenza. Mr. Tregenza submitted a thesis for examination, which satisfied the examiners. Mr. T. L. L. Suttor resigned his scholarship at the beginning of 1959 to take up a position as Lecturer in History in the Canberra University College. His six terms of residence were accepted by the Board of Graduate Studies as meeting the requirements of the Courses and Degrees Rules under Section 14 (3). Mr. Suttor expects to submit his thesis early in 1960.

During the year Professor C. M. H. Clark, of the Canberra University College, has assisted in the supervision of scholars.

Research Programme.

As reported in 1958 the research programme has been extended beyond the field of Australian history into a number of areas of Commonwealth History. Professor Hancock and Dr. Low continue their work on Africa. As noted above, two students have been appointed to work on Indian History. On the other hand, work in Australian History is being continued by Mr. Fitzhardinge, Dr. Gollan and Mr. Bolton. Important developments have taken place in the project for a Dictionary of Australian Biography. An Editorial Board centered on the National University has been set up, and a National Advisory Panel, made up of representatives from each of the State Universities, has been established to advise on all matters relating to the Dictionary. Working Parties have been formed in each State under the direction of the National Advisory member. Professor C. M. H. Clark and Mr. M. H. Ellis have accepted the joint editorship of Volumes I and II. These cover the periods 1788-1825 and 1825-50. Arrangements with a publisher are being negotiated and it is estimated that the first two volumes will reach the press by 1962.

Work in Progress.

Professor Hancock: as reported in 1958.
Mr. Fitzhardinge: as reported in 1958.
Dr. Gollan: as reported in 1958.
Dr. Low: African and Indian history.
Mr. Bolton: as reported in 1958.

Seminars and Lectures.

(1) The seminar on wool continued to meet throughout the year, having its final meeting in November. Arising from the seminar, two volumes of papers are being prepared. One will contain papers on political and economic aspects of the industry, the other on scientific aspects. It is planned to get these volumes to press in April, 1960.

(2) A work-in-progress seminar was held for scholars during first and third terms.
Other Activities.

Professor Hancock gave half a dozen lectures in the University of Sydney.

Mr. Fitzhardinge addressed the Royal Australian Historical Society and conducted the course in Ancient History at the Canberra University College.

A new and important development during the year was the foundation of a "consortium" of historians, with a membership drawn from various departments both of the University and Canberra University College. The aim of the consortium is to promote co-operation between historians irrespective of jurisdictional barriers. An experiment in joint lectures was begun in third term and will be continued next year.

Publications.


Gollan, R. A.—“Arbitration and the sliding scale in the N.S.W. coal industry in the eighteen-seventies.” The Journal of Industrial Relations, I, No. 1.


Martin, A. W. (Scholar, 1952–54), and Wardle, P. (Research Assistant, 1954–58).—Members of the Legislative Assembly of New South Wales, 1856–1901: Biographical Notes. Canberra: The Australian National University. (Social Science Monograph, No. 16.)

Robertson, J.—“The conscription controversy in Western Australia.” University Studies in Western Australian History, October, 1959.


DEPARTMENT OF LAW.

Staff.

Professor (on leave) . . . . . . . . . . . . G. Sawer, S.M., B.A., LL.M., of the Victorian Bar.

Senior Fellow (acting Head of the Depart- ment) S. J. Stoljar, LL.B., LL.M., Ph.D., of Gray’s Inn, Barrister-at-Law.

Mr. (now Professor) Ross Anderson of the University of Queensland came to the Department as a Visiting Fellow from February to December, 1959.

Professor Sawer went on his second study leave in January, 1959, and returned in January, 1960. He made a short visit to the United Kingdom where he gave lectures at the University of London and at a vacation school for Colonial Office administrators in the University of Cambridge, and spent the rest of the year as a visiting professor at the Max Plank Institute for Public Law and International Law at Heidelberg in West Germany. There he worked mainly on questions of comparative constitutional law, with special reference to the federal Realms of the British Commonwealth and to West Germany itself (where the system is federal); he also assisted with the collection, annotation and translation of British Commonwealth materials for a forthcoming work, on the declarations of war and peace in the Second World War, being prepared by the Institute.

Students and Teaching Activities.

Mr. A. Harari and Mr. D. K. Singh, the two research scholars in law continued their work for the Ph.D.; the former, supervised by Dr. Stoljar, continued his work in the field of the law of torts; the latter, supervised by Professor Anderson, pursued his comparative examination of problems of excess of power and breach of prohibitions under federal constitutions.
Research Programme.

Dr. Stoljar continued his research in the law of agency contract and legal theory. His book on agency has nearly been completed and should be published in 1960.

Professor Anderson carried on his research in administrative law in preparation for a book on administrative powers.

Other Activities.

During the year Dr. Stoljar and Professor Anderson attended the annual conference of the Australian Universities Law Schools in Sydney in August, where Professor Anderson acted as convenor for a committee on law schools' standards.

Publications.


Sawer, G.—"Town planning by Judges" (1959), 45 Journal of the Town Planning Institute, 109-12.


"Rabbits, the Law and the Constitution." Rabbit Problem in Australia: Conference convened by C.S.I.R.O. and held at Melbourne 11th-12th September, 1958, 52-69.


Stoljar, S. J.—"Doctrine of failure of consideration" (1959), 75 Law Quarterly Review, 53-76.


"Ascriptive and prescriptive responsibility" (1959), 68 Mind, 350-60.


Department of Political Science and of International Relations.

Staff.

Professor ... ... ... ... L. C. Webb, M.A.
Reader in Public Administration ... R. S. Parker, M.B.E., M.Ec.
Reader in International Relations ... Lord Lindsay of Birker, M.A.
Senior Fellow ... ... ... A. L. Burns, M.A.
Research Fellows ... ... ... J. A. Modelski, B.Sc. (Econ.), Ph.D.
Research Assistants ... ... ... Mrs. R. Brissenden, M.A.

In 1958 and 1959 the Department of Political Science and the Department of International Relations were combined as a temporary arrangement. As from the end of 1959, the members of the combined Department whose work is in the international relations field have been transferred to the Research School of Pacific Studies as the Department of International Relations. The Department of Political Science will, however, continue to be interested in some aspects of international relations.

Staff Changes.

In September, 1959, Lord Lindsay of Birker resigned to take up an appointment in the American University, Washington, D.C., as Professor of Far Eastern Studies, Chairman of the Department of Far Eastern Studies and Professor in the School of International Service.

Mr. R. G. Boyd took up his appointment as Research Fellow in February.

Students.

Mr. E. E. Crichton, B.Com., an officer of the Commonwealth Public Service Board, took up a Public Service Fellowship in the Department on 19th March, 1959, his research project for the year being: "Arbitration in the Public Service". Mr. Crichton has had considerable practical experience of this subject in the course of his work, and has published a number of papers on it in the Australian journal, Public Administration. At the end of the year he had completed drafts of several chapters of a monograph embodying the results of his research and developing certain proposals for reform.

† Visiting Fellow.
Mr. R. P. Deane, B.Ec., Public Service Fellow (see 1958 Report), completed his research during his term at the University, and wrote a report entitled “The establishment of the Department of Trade: a case-study in administrative reorganization”, which is being prepared for publication.

Mr. B. D. Graham, M.A., was awarded his doctorate for a thesis on the Australian Country Party and is at present studying at the Institute of Higher Political Studies in Paris on a travelling scholarship awarded by the Australian National University. He is completing a work on post-war French politics.


Mr. R. M. Martin, M.A., was awarded a doctorate for his thesis on relations between trade unions and the State in Australia. An award of a Rockefeller Fellowship enabled him to continue his trade union studies at Nuffield College, Oxford. In 1960 he will take up a lectureship in the Department of Government in the University of Sydney.

Mr. A. C. Palfreeman (Lic. es Sc. Politiques) submitted a thesis for the degree of Ph.D., “Australia’s Policy on Non-European Immigration—A Study of Purpose, Procedure and Implications”, in May, 1959, having completed the tenure of his scholarship in March. He has accepted appointment as Lecturer in Political Science at the University of New South Wales.

Mr. J. D. Playford, B.A., a research scholar enrolled for the Ph.D. degree, took up his scholarship in July. He is making a study of the Australian Communist Party.

Mr. V. Subramaniam, M.A., B.Sc., completed his scholarship and was awarded the Ph.D. degree for his thesis on “Promotion in the Commonwealth Public Service”. He accepted an appointment as Temporary Lecturer in Political Science at the University of Queensland, and later presented two papers on classification and promotion in the Australian public services to the November Conference of Australian Regional Groups of the Royal Institute of Public Administration. Unable, owing to immigration restrictions, to take up a permanent appointment offered by the University of Queensland, he accepted a Senior Simon Fellowship in the Department of Government at the Victoria University of Manchester, and will take up duty there in 1960. Mr. Subramaniam has been a valued student and colleague, and has made considerable contributions to research in public administration, during his four years in Australia.

Mr. Mao-Tsai Wu, LL.B., has continued his research for the M.A. degree on the topic: “Administrative Relations Between Federal, State and Local Governments in the Southern Tablelands Regions of New South Wales”.

Research Activities.

Professor Webb, assisted by Mrs. Heathcote, has been engaged on a study of aspects of the development of television in Australia.

Mr. Parker has begun work on a critical study of administrative theory in the context of Australian political and public service practices.

A group under the leadership of Dr. J. A. Models and Professor L. C. Webb prepared for publication the manuscript of a book on the South-East Asia Treaty Organization, presenting SEATO from within as it appears to its members, and from without in the perspective of the Asian Great Powers. Contributors were Mrs. R. Brissenden, Dr. Warren Hogan, a graduate of this University now at the University College, Newcastle, Mr. Gavin Boyd, Dr. J. A. Models and Professor L. C. Webb. Gathering material for this book Mrs. R. Brissenden (then Miss Rosemary Groves) travelled in India, Ceylon, Pakistan and Burma from January to April, 1959.

Mr. Boyd conducted researches subsidiary to his contributions to the SEATO book on Chinese Communist foreign policy and on the Protocol States of the South-East Asian area.

Dr. Models has complemented his work for the SEATO project with theoretical analysis of the behaviour of states in international systems and sub-systems. He has developed the conception of the filling of roles by Powers in various world political situations—a parallel approach to others being made at present in political science and sociology.

Mr. Burns has continued his studies of the relationship between the new weapons technology and the structure of the world political system. He has written specialist monographs on current strategic problems and on political issues such as the nth country problem and disarmament. His graphical analysis of the arms race develops certain techniques employed by economists at this University.

Lord Lindsay pursued his studies of Communist Chinese and Formosan foreign policies and internal politics. He has also analysed negotiations and bargaining situations characteristic of the Cold War and the campaign for peaceful co-existence.

Dr. Rawson has worked during the year on a study of the 1958 Federal election.
In July Professor Webb delivered three lectures on Church and State in Australia at the Theodore Fink Memorial Seminar in the University of Melbourne. The lectures will shortly be published. In August he delivered his inaugural lecture in the Australian National University under the title Politics and Polity. During the year Professor Webb served on the Research Advisory Committee set up by the Australian Broadcasting Control Board.

Mr. Parker read a paper on "Values in Public Administration" to Section G of the 1959 meeting of A.N.Z.A.A.S. in Perth. He remained in Perth for three weeks, lecturing in the Department of Economics of Western Australia, and leading staff seminars in that Department and in the Department of History. He continued his lecturing work for the Bursars' Administrative Staff College, Sydney, and for conferences of Commonwealth and State administrative officers in Canberra. As organizer of study groups for the Australian Capital Territory Group of the Royal Institute of Public Administration, Mr. Parker took an active part in a study of the administration of import licensing as a regulation of trade, and is helping to prepare the resulting report with a view to publication.

During most of 1959 the two groups in the Department of Political Science and of International Relations with their Research Assistants and Secretaries co-operated closely in Political as well as International studies. The International group has a regional focus overlapping with that of Departments in the School of Pacific Studies; but its theoretical concepts and analytic techniques have much in common with those of the Political Scientists. A foundation was laid for future co-operation between the two Departments, which are now to be located in different Schools.

Mr. Burns in February of this year concluded his six months' research with the Center of International Studies, Princeton University. He participated in the Princeton Conference on NATO Strategy, visited centers of international research at Cornell, Washington, Harvard and M.I.T., lectured at and collaborated in research with members of the staff of the Institute of War and Peace Studies at Columbia University, lectured to the cadets of West Point Military Academy and attended briefing conferences on civil defense, United States security and weapons technology. In April and May he lectured in Advanced International Studies at the Political Science Department, University of Chicago having travelled in the preceding interval on a grant from Carnegie Corporation. In April he attended at Northwestern University a four-day conference of researchers and teachers in International Relations, On his return journey to Australia he revisited the RAND Corporation, Los Angeles, the International Departments at Berkeley and San Francisco and the Center for Advanced Study in the Behavioral Sciences at Stanford in California. In September he lectured to the Departments of Politics and of History in the University of Melbourne.

Dr. Modelski left in October, 1959, to take up the position of Visiting Assistant Professor in the Department of Political Science at the University of Chicago. He will teach there until June of next year and from August to December of 1960 will be a Research Associate at the Center of International Studies, Princeton University. He is to lecture at Sarah Lawrence College and to read a paper to the annual conference of the Association of Asian Studies in New York.

Dr. Moreton Kaplan of the Department of Political Science, University of Chicago, was a guest of the School of Social Sciences at this University for a fortnight in November. He conducted a seminar in Bargaining Theory and Strategic Analysis under the auspices of the joint Department of Political Science and International Relations.

Professor Russell H. Fifield of the Department of Political Science at the University of Michigan, spent a week with this Department in the course of his travels on a project concerning South-East Asian politics for the Council of Foreign Relations. He participated in the seminars and discussions of the SEATO Group.

In January Dr. Rawson delivered a paper to the Australian Institute of Political Science's Summer School on Trade Unions and in March took part in a Seminar on the Australian National Income and its Distribution, organized by the Australian Council of Salaried and Professional Associations, and was co-author of a paper arising out of the Seminar. In November he gave a paper on the use of sample surveys in electoral studies in a Seminar conducted by the Department of Demography. He spent the third term as a visiting lecturer in the Department of History and Political Science at the University of Queensland.

Publications.


"Disarmament or the balance of terror?" (review article). *World Politics*, XII, No. 1, October, 1959, pp. 132-45.


Parker, R. S.—"The impact of the changing role of government and public authorities." *Tomorrow’s Executives*. Melbourne.


**DEPARTMENT OF SOCIAL PHILOSOPHY.**

*Staff.*


Professor of Philosophy . . . J. A. Passmore, M.A.

Senior Fellow . . . J. C. Harsanyi, M.A., Ph.D., Dr.Phil. (joined staff January, 1959).

Research Fellows . . . R. R. Brown, B.A., Ph.D.

H. O. Puppe, Dr. jur.

*Students and Teaching Activities.*

Six students were at work for the Ph.D. Mr. N. S. Thornton’s thesis on individuality and the State is nearing completion; Mr. Heron’s thesis on the theory of meaning, with special reference to Locke, is well under way; Mr. D. W. Dockrill has completed a series of studies in preparation for a thesis on nineteenth-century agnosticism; Mr. K. G. Pont, who enrolled in March, has been examining the work of Brentano and Meinong in preparation for a critical study of Russell; Mr. C. S. Ross, who also enrolled in March, has been studying Russell and Frege as a preliminary to his work on contemporary philosophy; Mr. N. C. Bhattacharryya, who enrolled in November, is reading Dewey in preparation for work on the philosophy of education.

During the year Dr. Brown gave a course of lectures at Canberra University College on "Logic", which was attended by two scholars from the Department; two of them also took courses in German at the College, and one studied Greek at St. Mark’s. Dr. Brown also met students at regular intervals to discuss with them a number of recent trends in philosophy. Professor Passmore gave a course of lectures on Wittgenstein throughout the year, and several lectures on Popper’s *Logic of Scientific Discovery*.

The scholars in the department formed their own philosophical society, to which they read papers. They were also able to engage in discussions with Associate Professor Douglas Gasking and Mr. David Armstrong of the University of Melbourne. Dr. Harsanyi led a series of seminars on "The Theory of Games" in the Department of Statistics.

*Research Programme.*

Professor Partridge continued his work on political and social theory in London and at Duke University, United States of America, where he was Visiting Professor for the Autumn semester. Professor Passmore completed a number of papers on the history of ideas, prepared a second edition of his *Hundred
Years of Philosophy and began work on a book on "Philosophical Reasoning". Dr. Harsanyi completed a number of papers on methodological problems and on the theory of games, and has now embarked upon his book on the latter topic for Stanford University Press. Dr. Brown completed additional sections of his book on the logic of social inquiry; Dr. Pappe completed papers on the philosophy of law and on the development of J. S. Mill's social ideas.

Other Activities.

Dr. Brown visited the University of Melbourne for a week; there he met senior students and addressed the Melbourne Branch of the Australasian Association of Philosophy on "Intention—Explanation". Professor Passmore delivered three lectures to senior science students in the University of Sydney on Bacon, Harvey and Descartes; took seminars at the University of Adelaide, and spoke to the Adelaide Philosophical Association on "Philosophy and the History of Philosophy". He also addressed the annual congress of the Australasian Association of Philosophy on "Infinite Regresses".

Publications.

Bradley, R. D.*—"Must the future be what it is going to be?" Mind, LXVIII, 193–208.


"History, the individual and inevitability." Philosophical Review, LXVIII, 93–102.


DEPARTMENT OF STATISTICS.

Staff.

Professor .. .. .. .. P. A. P. Moran, M.A., D.Sc.
Reader .. .. .. .. J. E. Moyal, Dipl. de l'Inst. de Stat. (Paris)

During the year Dr. G. S. Watson resigned on being appointed Associate Professor in the University of Toronto. Mr. G. O'Mahony completed his year as a Public Service Fellow in October and returned to the Bureau of Meteorology. Mr. S. R. Adke joined the department as a scholar.

A fortnightly seminar was held throughout the year. Courses of lectures were given on point processes (Mr. Moyal), Information theory (Mr. Moyal), probability theory (Professor Moran), and on statistical methods in medical research (Professor Moran).

Research Programme.

A. Random Processes (Mr. Moyal, Mr. Heathcote and Mr. Adke).—Mr. Moyal has completed a paper on "Incomplete discontinuous Markov processes" and a long original monograph on "The Stochastic theory of populations, point processes and counting processes". The latter is to be published by the University of California Press. He is now working on the asymptotic theory of multiplicative processes, and on the completeness of axiomatic systems in mathematical logic. He is also revising for publication as a book the article he published on stochastic processes in the Journal of the Royal Statistical Society for 1949. In collaboration with Mr. C. R. Heathcote he has prepared a paper on "Random walks in continuous time and the theory of queues" which is being published in Biometrika. Joint work on single server queues with arbitrary arrival and service distributions is proceeding. Mr. Heathcote has completed and published a paper on preemptive queues and is making further extensions

* Work completed while a scholar at A.N.U. † Not a member of Australian National University Staff.
of this theory using Erlang arrival and waiting time distributions. He is also working on the economics of queueing. Mr. Adke, in collaboration with Mr. Moyal, has been studying birth and death processes in which the individuals are undergoing geographical diffusion.

B. Meteorological problems (Mr. O'Mahony).—A preliminary investigation on the relationship between sea-temperatures and rainfall on the East coast of Australia was made. Work was also done on rainfall-runoff relationships.

C. Mathematical Genetics (Professor Moran and Mr. Watterson).—Mr. Watterson succeeded in proving that the Fokker-Planck diffusion equation has a unique solution which is a good approximation to the probability distribution of gene frequency in cases where the random process is itself only approximately Markovian. This enables a wide variety of new problems to be tackled rigorously.

In conjunction with Professor F. V. Atkinson of the C.U.C. a mathematical inequality was proved which shows that the mean fitness of a population increases from generation to generation.

Professor Moran wrote a paper on the theory of polyploidy and continued work on the calculation of the probabilities of survival of new mutants under various conditions. He also completed a book on mathematical genetics which is in course of publication by Springer.

Other Activities.

Mr. J. E. Moyal gave lectures at the Universities of Western Australia, Adelaide and New South Wales.

At the invitation of the United States National Research Council Professor Moran attended the Big Meadows Conference on Weather Modification in Virginia and afterwards spent a month at Princeton University giving lectures there. He also gave lectures at Columbia University and the University of California at Berkeley.

Publications.


BOOK.


“Non-random mating and its effect on the rate of approach to homozygosity.” Ann. of Human Genetics, XXIII (1959), 204–220.

THE RESEARCH SCHOOL OF PACIFIC STUDIES.

DEAN'S REMARKS.

The Dean was absent from Canberra or on sick leave for about four months of the year. During most of this period Professor Barnes was Acting-Dean; Professor Spate served as Acting-Dean when Professor Barnes was also away from Canberra.

Early in the year Council accepted a request from the Government of Western Samoa that the Dean should act as its constitutional adviser during the Territory's transition to independence. Professor Davidson paid brief visits to Samoa in this connexion in February and September and a longer visit during March and April. These duties will involve further visits during 1960. Professor Spate completed his study of the problems of economic and social adjustment facing the Fijian people which he had undertaken at the request of the Government of Fiji; he returned to Canberra in April. Professor Barnes represented the University at the Fourth South Pacific Conference at Rabaul in April.

This section of the annual report for 1958 discussed the various matters dealt with in the plan for the development of the School prepared at the request of Council. By far the most important action, in line with these proposals, has been the appointment of Sir John Crawford, C.B.E., M.Ec., as Director of the School and Professor of Economics. Since 1950 Sir John has been Secretary to the Department of Trade (formerly the Department of Trade and Commerce). He will spend the latter part of 1960 abroad visiting centres where work is being undertaken on the economics of under-developed areas and will assume duty in Canberra early in 1961.

During its study of the School's future development, the Faculty Board reached the conclusion that the appointment of a Director could be of major benefit provided a scholar with appropriate experience and personal qualities was available. But it did not regard such an appointment as essential. The Director-elect was bound, therefore, to face the careful and critical scrutiny of the School. It is a tribute wholly to Sir John Crawford's personal qualities that his assumption of office in 1961 is eagerly looked forward to. Already he has given considerable time and thought to the School's affairs; and those who have worked with him in this regard have gained a warm regard and deep respect for him. There is complete confidence that the School will enjoy a vigorous and invigorating future under his leadership.

Following Sir John Crawford's appointment, the initial steps have been taken towards building up the Department of Economics. Other developments agreed to by Council in 1958 have also been proceeded with; appointments to the Readership in Bio-geography and the Fellowship in Archaeology should be made early in the new year. Further consideration has been given to the New Guinea Research Unit and steps are in train to bring it into active existence.

The temporary transfer of the group working in International Relations to the Research School of Social Sciences was terminated on 31st December. From 1st January 1960 it will again constitute a Department of International Relations in the Research School of Pacific Studies.

During the year there were 40 students enrolled in the departments of the School (including some for part of the year only). Two former students received the Ph.D. degree in May. Three have been recommended for the award of the degree.

DEPARTMENT OF ANTHROPOLOGY AND SOCIOLOGY.

Staff.

Professor .. .. .. .. J. A. Barnes, D.S.C., M.A., D.Phil.
Readers .. .. .. .. W. E. H. Stanner, M.A., Ph.D. (Comparative Social Institutions).
Senior Fellow .. .. .. .. S. A. Wurm, Ph.D. (Linguistics).
Research Fellows .. .. .. .. Paula Brown, M.A., Ph.D.
A. L. Epstein, L.L.B, Ph.D.
Marie O. Reay, M.A., Ph.D. (from 15th October).
Research Assistant .. .. .. .. Marika H. van de Graaff, Cand. (from 14th December)

Dr. Marie Reay assumed her Research Fellowship in October. Dr. Reay gained her M.A. in 1947 at the University of Sydney and her Ph.D. in this University in 1958. She served as Research Assistant in the Department from February 1959 until taking up her Research Fellowship.

Professor M. A. Jaspan of Padjadjaran State University Bandung, was appointed to a Research Fellowship in October, but has not yet taken up his appointment.

Dr. Wurm returned from New Guinea in January. Dr. Stanner returned from the Northern Territory in December. In September, Dr. Epstein proceeded to Rabaul and Dr. Brown to Chimbu in the New Guinea Highlands. Dr. Reay left for the Northern Territory in November. Professor Barnes spent eight weeks touring New Guinea in April–June, and visited the Kimberleys in August.
Students and Teaching Activities.

During the year there were twenty students enrolled in the Department, of whom eleven were at the university for all or part of the year pursuing a course of study leading to the Ph.D. degree. Seven students were completing their theses for the degree elsewhere after leaving the University. One Fulbright student was enrolled as not proceeding to a degree here. The award of a Ph.D. to Mr. T. N. Madan was recommended in December. One student was under examination at the end of the year.

A former Scholar, Mr. D. A. Sivertsen, was awarded a research grant by the Norwegian Council for Research in the Humanities. Work on several Ph.D. theses continued during the year and several are now nearing completion.

Seminars on work in progress were held throughout the year. Papers on one or more topics were read by: Mr. Appell (social systems as energy systems; problems of Dusan organization); Dr. Brown (Chimbu distributions after a death); Mr. Hiatt (Liverpool River society; disputes, subsections and kinship); Mr. Peranio (Bisaya partition and inheritance; marriage and divorce; household and kinship); Mr. Verma (Mailu society); Dr. Wurm (aims and methods of modern linguistics). Several books and articles were discussed: Village on the border by Frankenburg (Mr. Appell); Social stratification in Polynesia by Sahlins (Dr. Freeman); Non-unilineal descent groups by Davenport (Dr. Freeman); Kapauka Papuans and their law by Pospisil (Mr. Ploeg); Enkele aspecten van de Mimika-cultuur by Pouwer (Dr. de Martinoir). Mr. Eckersley of the Department of Far-Eastern History read a paper on the place of the eldest son in Japanese society.

A series of discussions on fieldwork methods and techniques was held during the third term, led by Professor Barnes and Dr. Freeman.

Professor Barnes read a paper "Samples and universes in social anthropology" in a seminar organized by the Department of Demography, Research School of Social Sciences.

Mr. Hiatt gave two lectures at the Australian School of Pacific Administration, Mosman, and read a paper to the Anthropological Society of New South Wales.

Dr. Epstein addressed the Canberra Sociological Society, and Dr. Freeman read a paper on "Social anthropology as a form of nomothetic enquiry" to the Canberra branch of the Australasian Association of Philosophers. Dr. Wurm addressed the New Guinea Society. Professor Barnes acted as President of Section F at the A.N.A.A.S. Congress in Perth in August. Dr. Brown and Dr. Wurm read papers at the Congress, and Professor Barnes addressed a meeting of the Anthropological Society of Western Australia. In October he gave a lecture in Brisbane in connexion with the opening of the Ethnographic Museum of the University of Queensland.

Research Programme.

Professor Barnes spent eight weeks in Australian and Dutch New Guinea during April to June, assessing the research possibilities of various localities. In August he visited Port Hedland and the Kimberleys for the same purpose.

Dr. Stanner returned from Port Keats in December. The preliminary results of his research will appear as a series of articles in Oceania, the first to appear in December, 1959.

Dr. Freeman is working on his account of the Iban of Sarawak. He has jointly edited, with Professor W. R. Geddes of the University of Sydney, a symposium entitled Anthropology in the South Seas: Essays Presented to H. D. Skinner, which was published in November.

Dr. Wurm has been engaged in writing a manual for use in the field by missionaries, administrators and anthropologists, for recording languages in New Guinea. He has also been preparing for publication the first results of the linguistic survey of the Highlands of Australian New Guinea which he completed at the beginning of the year. He made a reconnaissance of parts of Northern Australia in August.

Dr. Brown was engaged in preparing for publication the results of her previous research in the Chimbu Sub-district, New Guinea. Later in the year she returned to New Guinea to continue her work in the field, in collaboration with Dr. Brookfield, Department of Geography. The Chimbu area studied by Dr. Brown and Dr. Brookfield may be suitable for a long-term study of social change involving intermittent field research in the same locality for some twenty years.

Dr. Epstein spent part of the year writing up material on African urban life at Ndola, Northern Rhodesia. Later he proceeded to Rabaul to begin a study of social conditions in the town, with special reference to the indigenous population. This field study forms part of an enquiry into urban conditions in the Pacific which was suggested at a meeting of the Research Council of the South Pacific Commission in 1958. Dr. Epstein is working in collaboration with his wife, Dr. T. S. Epstein of the Department of Economics, Research School of Pacific Studies, who is investigating cocoa-growing among the Tolai living near Rabaul.

Dr. Reay spent part of the year preparing for publication the material on kinship and local organization on Manam Island collected by the late Miss Camilla Wedgwood in 1933. Her book on the Kuma people of the Wahgi Valley, New Guinea Highlands, was published during the year.
November she went to the Northern Territory to begin an enquiry into the secular and ceremonial status of aboriginal women in various selected aboriginal groups. She is beginning her work at Borroloola, and has plans to visit later Areyonga and Melville Island. Her work is being supported in part by a grant from the Board for Anthropological Research at the University of Adelaide.

Mr. M. R. Allen returned at the end of the year from Aoba, New Hebrides, where he has been carrying out an enquiry into political and economic life. This enquiry is being undertaken in association with the United Kingdom Colonial Social Science Research Council.

In September Mr. Appell proceeded to North Borneo to carry out field research among the Dusun at Kudat.

Mr. Beckett has spent a year in the Torres Straits Islands where he is investigating the working of Native Councils and economic enterprises. He is expected to return to Canberra early in February, 1960.

Mr. Hiatt returned to Canberra in June from the Liverpool River district of Arnhem Land, Northern Territory. Mr. Hiatt is carrying out research on processes of social control in an aboriginal settlement recently established by the Administration. He has also investigated the traditional forms of local organization in the area. He will be returning to the area in March, 1960. Some results of his enquiries have already been published.

Mr. Peranio completed his field enquiries among the Bisaya of Sarawak and is now engaged in preparing his report.

Four Scholars arrived late in the year and are at present preparing to go into the field. Mr. Ploeg will probably go to Netherlands New Guinea to investigate indigenous systems of social control. Mr. Verma is beginning a study of social change and economic development among a selected community in south-eastern Papua. Dr. de Martinoir is planning an investigation of the social organization and culture of the peoples of the Upper Rejang, Sarawak. Mr. Singarimbun expects to work among the Karo Batak of Sumatra.

Mr. D. C. Laycock is carrying out field work in the Sepik District of New Guinea. He is investigating the distribution and structure of indigenous languages in this region. Mr. Laycock is the first Scholar in the Department to work in linguistics.

Mr. P. L. Newman of the University of Washington, a Fulbright Scholar, is attached to the Department but is not proceeding to a degree in the University. He is carrying out field work on indigenous systems of religious belief in the Central Highlands of New Guinea.

Other Activities.

Professor Barnes attended the Fourth South Pacific Conference in Rabaul in April–May as an observer.

A meeting of the Australian Branch of the Association of Social Anthropologists of the British Commonwealth was held in the Department in March. Drs. Freeman and Epstein read papers.

During the year, visitors to the Department have included Dr. Jean Guiart of the Ecole Pratique des Hautes Études, Paris; Dr. C. Hooykaas of the School of Oriental and African Studies, University of London; Mr. T. G. H. Strehlow, University of Adelaide; Mr. R. N. H. Bulmer of the University of Auckland; Dr. F.-J. Micha of the University of Bonn; and Mr. Anthony Forge of the University of London.

Professor Barnes was awarded the Rivers Memorial Medal for 1959 by the Royal Anthropological Institute of Great Britain and Ireland.

Publications.


Epstein, A. L.—“Linguistic innovation and culture on the Copperbelt, Northern Rhodesia.” *Southwestern Journal of Anthropology*, XV, 235–53.


* Member of Department of Geography. † Based on research carried out while a member of A.N.U. ‡ Not a member of A.N.U. staff.


“On aboriginal religion. 1: The lineaments of sacrifice.” *Oceania*, XXX.


**DEPARTMENT OF FAR EASTERN HISTORY.**

**Staff.**

Professor . . . . . C. P. FitzGerald.

Senior Research Fellows . . . G. Mulder, Drs.

T. W. Eckersley, B.A.

Research Fellows . . . . N. Barnard, B.A. Ph.D.

E. S. Crawcour, M.A., Ph.D.


In May this year Dr. Noel Barnard returned from Japan where he had been collecting source material for his research into bronze inscriptions of early Chinese civilization. Dr. E. S. Crawcour left in July for Japan, where he will spend a year at Tokyo University following up his research into the economic history of Japan in the seventeenth century.

**Students and Teaching Activities.**

Student numbers remained at four throughout the year, a new scholar, Mr. R. H. P. Mason, having arrived in December of last year. Mr. Mason is working on “The First General Election Held in Japan in 1890, and Selected Debates in the First Session of the Imperial Diet, 1890–1891”. Mr. A. Fraser returned in mid-November from Japan, where he collected material for his thesis on “The Meiji Bureaucracy”. Mr. I. de Rachewiltz finished his scholarship at the end of August, and has obtained from next year a post as Lecturer in Oriental Civilization at the Canberra University College. Mr. J. D. Frodsham will shortly complete his thesis on “A Biography of Hsieh Ling-yun (385–433 A.D.)”, and next year will take up a post at the University of Sydney as Lecturer in Oriental Studies.

In January, Professor C. P. FitzGerald attended the Summer School of the Victorian Council of Adult Education and delivered four lectures. In July he went to Bathurst, and there gave two lectures at the Teachers’ Training College.

**Research Programme.**

Dr. Mulder.—Good progress has been made in preparing the typescript for the first volume of “The Imperial Relatives by Marriage of the Former Han”.

Dr. Crawcour.—Dr. Crawcour, who is at present in Japan, is engaged in research on the economic history of Japan in the seventeenth century, with special reference to commercial development.

Professor FitzGerald.—Work was started on research into the origin of the use of chairs in China, and the general development of related Chinese furniture.

* Based on research carried out while a member of Australian National University.
Other Activities.

Dr. G. Mulder gave a lecture for the Oriental Society of Australia in Sydney in June on "Empresses and Concubines of the Former Han Dynasty", and subsequently wrote an article on the same topic for insertion in the Newsletter of that Society. He also acted as Assessor for the Intermediate and Leaving Certificates examinations in Chinese, New South Wales.

On the 10th November Dr. Barnard also gave a lecture for the Oriental Society of Australia in Sydney on "Early Chinese History in the Light of Recent Archaeological Discoveries".

Mr. Eckersley and Mr. Frodsham attended the A.N.Z.A.A.S. Conference in Perth in August, Mr. Eckersley reading a paper on "Some Aspects of Japanese Politics", and Mr. Frodsham on "Feudalism in Mediaeval China".

Publications.


"Some remarks on the authenticity of a western Chou style inscribed bronze." *Monumenta Serica*, XVIII.

"New approaches and research methods in Chin Shih Hsueh." *Memoirs of the Toyobunka Kenkyujo*, Tokyo University, XIX.

English Index and Summary (pp. i-vii, 1-25) in: "Tate sites: A study of settlement sites in the north-eastern regions of Japan." *The Institute for Oriental Culture (Toyobunka Kenkyujo)*, the University of Tokyo. Editors: Egami Namia, Sekino Takeshi, Sakurai Kiyohiko.

FitzGerald, C. P.—"The decline of the Manchu Dynasty." Chapter in the *Cambridge Modern History* (new edition), Vol. XI.

Frodsham, J. D.—"Origins of Chinese nature poetry." *Asia Major*.

DEPARTMENT OF GEOGRAPHY.

Staff.

Professor ... ... ... O. H. K. Spate, M.A., Ph.D.
Reader in Geomorphology ... J. N. Jennings, M.A.
Reader in Social Geography ... H. C. Brookfield, B.A., Ph.D.
Research Fellow ... ... ... G. J. R. Linge, B.Sc. (Econ.), Ph.D. (from 6th March)
Visiting Fellow ... ... ... H. H. B. Valentin, D. Phil. (to March).
Visiting Fellow ... ... ... M. M. Sweeting, M.A., Ph.D. (to August).

The long-heralded Readership in Biogeography was advertised during the year and produced an unexpectedly good field, from which the choice was not too easy; an appointment will be made shortly. One, if not both, of the vacant Research Fellowships will be filled in 1960.

The increasing pressure of "outside" work—i.e. requests for cartographical assistance from other Departments—has led to the appointment of a third cartographer, Mr. Erwin Feeken. A good standard in published maps is a material, if modest, enhancement of the prestige of a University, since well designed and executed maps "catch the eye"; and the Department is always glad to give all possible assistance in this respect.

During Professor Spate’s absence in Fiji (until April 10th) Mr. Jennings and Dr. Brookfield shared the charge of Departmental affairs.

Students.

During the year Mr. F. H. Bauer and Mr. Eric Bird completed their theses on Kangaroo Island and the Gippsland Lakes respectively. Miss Diana Howlett took up a scholarship for work on indigenous and European development in the Central Highlands of New Guinea; Mr. Roger Frazer spent some time in Fiji, during part of which he was acting as research assistant to Professor Spate in his survey of Fijian economic problems. Mr. R. H. T. Smith’s study of commodity flow continues to receive the active co-operation of the New South Wales State Railways Department.
Staff Research Activities.

Professor Spate concluded his officially sponsored study in Fiji, which has been published in English as an official paper and (in a specially prepared version) in Fijian. Dr. Brookfield spent some months in New Guinea, including Dutch New Guinea. He is working on the human geography of the Chimbu area in collaboration with Dr. Paula Brown (Anthropology).

In January, Mr. Jennings and Dr. Sweeting were engaged in field work in the Mole Creek area in northern Tasmania; this fitted appropriately into the second conference of the Australian Speleological Federation held in that state. From late April till early August they carried out a study of the hitherto geomorphologically little-known Limestone Ranges of the Fitzroy Basin (Kimberleys, West Australia), which provide a very remarkable combination of features, scarcely if at all noticed in the literature. These studies are likely to prove of significance to the vexed question of climatic differentiation in karst morphology, and some preliminary remarks which Dr. Sweeting was able to make on the basis of this comparative work were received with considerable interest at the meeting of the International Geographical Union’s Karst Commission, held at Vienna in October. In connexion with the Kimberley work, thanks are due to Dr. N. Fisher, Chief Geologist, Bureau of Mineral Resources, for the loan of air photographs.

Dr. Linge has begun work on a study of the causes, effects, and problems of industrial decentralization in southeastern Australia. He has also accepted an invitation to prepare a report assessing likely trends in the employment structure of the Australian Capital Territory which may have general application to Australian towns. A book on manufacturing in Auckland is being prepared for publication in New Zealand.

Other Activities.

During the year a National Committee for Geography was formed with a view to securing Australia’s belated adhesion to the International Geographical Union: the sponsorship of the Australian Academy of Science is gratefully acknowledged by the Convenor, Professor Spate, who has also served as a member of the I.G.U.’s Commission on the Humid Tropics.

Early in the year a two-day geomorphology seminar was held in the Department, organized by Mr. Jennings in conjunction with Mr. J. Mabbutt of C.S.I.R.O. Sixteen papers ranging widely over the field of Australian geomorphology were read and discussed; there were over 30 participants, mainly from Canberra (A.N.U., C.U.C., C.S.I.R.O., and B.M.R.) but with a welcome sprinkling of representatives from State Universities. This appears to be the first conference devoted to geomorphology in Australia’s history.

On his return journey to Berlin, Dr. Valentin was invited to the Second Coastal Geography Conference (Baton Rouge, Louisiana, U.S.A.) and read a paper based on his work in the Cape York Peninsula.

The Department has had an unusual crop of overseas visitors: Professor Frank Debenham, doyen of the Cambridge school of geography, and Professor David Linton, long time of Sheffield and now of Birmingham, both names of much repute in the British geographical world; Professor Hans Boesch of Zurich, Secretary-General of the International Geographical Union; from Moscow Professors Ivan Sedov of the Lomonosov University and Vladimir Kort of the Institute of Oceanology; and Dr. Ulrich Schweinfurth of the University of Bonn.

Publications.


“ The forest industries of New Guinea.” Geography, XLIII, iii, 210–12.


* Department of Anthropology.


"Integration . . . in the southern Murray Basin" (Part II), *ibid.*

Scott, P.—"Location and frontage in city retail areas." *The Valuer*, XV (1958), 194-200.*

"The Australian CBD." *Econ. Geog.*, XXXV, iv, 290-314 (20 figures).*

Smith, R. H. T.—"The Chicago Union Stockyards—a brief glance at current operations." *Review of Marketing and Agricultural Economics*, XXVII.


*Na Kawa i Taulkei: na veika reverevea vakailovo me baleti ira kei na veika me caka kina.* Government of Fiji, Suva; pp. iv and 130 (Fijian translation of rewritten version of the above).


Valentin, H.—"Geomorphological reconnaissance of the north-west coast of Cape York Peninsula." *Second Coastal Geography Conference* (Coastal Studies Institute, Louisiana State University), 213-32..

**DEPARTMENT OF PACIFIC HISTORY.**

**Staff.**

Professor . . . . . J. W. Davidson, M.A., Ph.D.

Senior Fellow . . . . . H. E. Maude, O.B.E., M.A. (from 10th July, 1959; formerly Senior Research Fellow).


Research Fellow . . . . M. C. Groves, B.A., Ph.D. (to 7th April, 1959).

Research Fellow . . . . Ethel Drus, M.A.

Research Assistant . . . . Honore Forster, B.A.

Mr. H. E. Maude, Senior Research Fellow, was appointed Senior Fellow in July; and Dr. F. J. West, a former Research Fellow, rejoined the Department as Senior Research Fellow from the Victoria Government of Wellington, where he was Senior Lecturer in the Department of History. Dr. J. S. Bastin relinquished his appointment as Fellow during May, to take up the post of Professor of History at the University of Malaya in Kuala Lumpur; while Dr. M. C. Groves, Research Fellow, left early in the year to become Senior Lecturer in the Department of Anthropology at the University of Auckland.

**Students and Teaching Activities.**

Nine Ph.D. students were attached to the Department for the whole, or part, of the period under review. Of these, four were enrolled during the year: Mr. A. M. Healy, who is studying Local Government in Papua; Mr. W. R. Roff, the Federal Council of Malaya, 1909-1942; Mr. Chiang Hai Ding, Currency Reforms in the Straits Settlements, 1867-1914; and Mr. C. Jack-Hinton, the History of Political Development on Malaita. The others being engaged in preliminary planning and documentary studies at Canberra.

Both the second year students, Mr. R. G. Crocombe and Mr. I. G. Fairbairn, were absent on field work for most of the year, the former in the Cook Islands on research into land tenure problems, and the latter in Western Samoa studying the recent economic development of the territory. Mr. K. Penny and Mrs. M. Roe were engaged in completing the writing of their theses for submission during 1960, and Miss E. Sadka rejoined as a student in December for the same purpose.

Mr. W. N. Gunson submitted his thesis on "Evangelical Missionaries in the South Seas, 1797-1860", and was recommended for the award of the Ph.D. degree.

* Work done while a member of the Department.
During the third term a series of Seminars was conducted by staff members and scholars on their research, in progress or completed, papers being contributed on Papua, New Guinea, Fiji, Samoa and Tahiti. In addition, Professor Davidson conducted two seminars on the Preparation for Independence in Western Samoa, and Professor Spate and Mr. R. Frazer, of the Department of Geography, gave papers on Fijian Administration at the Village Level.

Research Programme.

The Department of Pacific History is concerned with the study of historical situations involving contact between Western and non-Western cultures, with a particular emphasis on contacts of a “colonial” type in which Europeans have occupied positions of political and economic dominance. This field of research presents one particularly important problem of method. The major part of the documentary evidence consists of records made by Europeans and framed in terms of Western thought. The Department is engaged in devising and testing means to supplement the study of such documentary material in order to reach a fuller understanding of the social processes involved than is possible by conventional historical technique alone. This work makes its relations with other branches of the social sciences as close as those with other fields of history.

Since all historical research involves the study of specific situations, the geographical limitations imposed on the Department in its title—Pacific History—does not restrict the breadth of its theoretical preoccupations. On the contrary, it gives an added coherence and compactness to the body of factual knowledge which is subjected to theoretically-directed analysis. The danger of an undesirable narrowing of perception is guarded against both by the variety of situations available for study within the Pacific area and by the previous experience in other fields possessed by all members of the Department.

Miss Drus was engaged from March to September in completing her research in the Fiji and Western Pacific High Commission Archives at Suva on material relating to her study of “Government and Governed in Fiji, 1874-1910”.

Other members of the Department continued work in Canberra on a number of projects: Professor Davidson has given special attention to problems connected with the impact of government on Pacific Islands communities; Mr. Maude has concentrated on the early history of the Central and Eastern Pacific; and Dr. West on his study of Government Control in the Central Highlands of Papua and New Guinea, and an Administrative Biography of Sir Hubert Murray.

Progress has been made in completing the Department’s microfilm library of historical theses relating to the Pacific, which have now been catalogued. At the same time efforts were continued to locate and have copied all important documentary series on the area, with particular reference to Consular Post Records not hitherto available in Australia. Two important collections of personal records deposited with the Department for study were the Sir Arthur Grimble Papers on the Gilbert Islands, covering the years 1918-1930, and the J. T. Arundell Papers on the Central Pacific guano industry from the 1860’s to 1900.

Other Activities.

Professor Davidson paid two visits to Apia during the year, at the request of the Government of Western Samoa, to advise on the constitutional implications of independence. In this connexion he was called on, in particular, to act as Constitutional Adviser to the Samoan Working Committee on Self-Government. Dr. West has been engaged in preparing, on behalf of S.E.A.T.O., a series of studies on Political Advancement in three Dependent Territories in the South Pacific: Fiji, American Samoa and Tahiti. Professor Davidson lectured during the year at the Canberra University College.

Publications.

Bastin, J. A.—“Five water colour drawings of Penang and Malacca.” *Journal of the Malayan Branch of the Royal Asiatic Society*, XXXI, i.

Crocombe, R. G.—“The Cook Islands.” *Post-Primary School Bulletin*, XII, i, 1-36.


Maude, H. E.—“Tahitian interlude. The migration of the Pitcairn Islanders to the Motherland in 1831.” *Journal of the Polynesian Society*, LXVIII, ii, 115-40.


*Not a member of Australian National University staff.*


**Theses.**

During the year the following thesis was submitted and deposited in the Library after examination for the degree shown:

W. N. Gunson, for Ph.D.—"Evangelical Missionaries in the South Seas, 1797–1860."
THE LIBRARY.

1. Accessions.

<table>
<thead>
<tr>
<th></th>
<th>In Library at 31st December, 1958</th>
<th>Added During 1959</th>
<th>In library at 31st December, 1959.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Books and pamphlets in Western Languages.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Books</td>
<td>114,653</td>
<td>7,928</td>
<td>122,581</td>
</tr>
<tr>
<td>Pamphlets</td>
<td>7,185</td>
<td>40</td>
<td>7,615</td>
</tr>
<tr>
<td>Less items written off 1959</td>
<td></td>
<td>4</td>
<td>122,577</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7,611</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>130,188</td>
</tr>
<tr>
<td>(b) Books in Oriental Languages.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Books</td>
<td>24,011</td>
<td>287</td>
<td>24,298</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>154,486</td>
</tr>
</tbody>
</table>

Note.—The figures given do not include those of the library of the Mt. Stromlo observatory for which accurate records of the contents have not been made.


- Diderot, D.—Encyclopédie, 35 V.
- Encyclopaedia Canadiana, 10 V.
- Hinrichs, J. C.—Fünfjahrs-Katalog, 13 V.
- Deutsches Büchnerverzeichnis, 28 V.
- Journal of pharmacology and experimental therapeutics, V. 55-94.
- Annals of mathematics, Ser. 2. V. 1-29.
- California law review, V. 8-45.
- La revue du Pacifique, 23 V.
- Die Zukunft, V. 33-86.
- Deutscher Geographentag. Verhandlungen, 23 V.


One thousand and ninety-five items were presented to the library during the year. Through its embassy in Canberra the Government of France made a gift of 21 V. of the works of French classical authors and a set of the encyclopaedia "Larousse du XXe siecle". The Commonwealth Department of Defence made available 26 V. of the important Geographical handbook series issued by the Naval Intelligence Division of the Admiralty.

4. Losses.

Four books and four pamphlets which had been missing for two successive stock-takings were written off. It is pleasing to note that, in spite of almost complete open access and heavy use of the library, loss of material is almost negligible, a total of only 66 items being unaccounted for since the library commenced operations in 1948.


During the year there were rises in the subscription price of some individual serial titles the most notable being an increase from $83.00 to $150.00 for the subscription to Chemical Abstracts. However, the increased overall costs of serials purchased by the library in 1959 was not significant. This was probably due in some measure to the fact that there was no considerable buying of back sets of serials. The amount of the library grant spent on books was practically equivalent to that spent on serials.

6. Enquiries and Loans.

The demands for service continue to increase and the time may not be far distant before the library will be compelled to have a permanent reference section. At present this work is done by officers of the cataloguing section working in rotation.

Excluding unbound serials, 13,200 items were borrowed from the library during the year, an increase of 2,000 items over 1958. 1,239 items were borrowed from external sources, an increase of 217 over the previous year.
7. **Association of the A.N.U. and C.U.C.**

Towards the end of the year the Prime Minister intimated that the Government had decided that the Canberra University College should be associated with the Australian National University with one governing body. This decision will bear directly on the libraries of the two institutions and it will be necessary to find answers to such questions as the future administration of the library, library finance, physical division of book resources, the future of the Oriental collections, buildings, &c.

8. **Permanent Library Building.**

It is confidently expected that by the end of February, 1960, the architect will present full working drawings and quantities in a form that will enable the university to call tenders without delay. Previous reports have stressed the urgency of a permanent building to house the university's book collection and it is hoped that commencement of building operations will not be delayed by the decision that the C.U.C. be associated with the A.N.U.

9. **Staff.**

Once again the staff position has not been easy and a number of vacancies remain to be filled. During the year there were five resignations, one of which was to take up another appointment within the university and two of which were due to marriage. These two included a most efficient orders officer and the librarian in charge of the Oriental collection who had the special linguistic qualifications necessary for this position. Approval was given for the creation of a new position of Senior Assistant in charge of preparations and an appointment was made.
UNIVERSITY HOUSE.

I. GOVERNING BODY.

At the end of the year the composition of the Governing Body was as follows:—

Master—Professor A. D. Trendall.
Fellows—

Retiring 15th August, 1960—
Professor J. A. Passmore (Deputy Master).
Dr. R. R. Brown (Bursar).
Dr. W. H. Elliott.
Dr. D. S. Robertson.

Professor Passmore resigned on 31st December, 1959, and will be replaced by Dr. F. J. West for the rest of his term of office.

Retiring 15th August, 1961—
Professor C. P. FitzGerald (Deputy Master from 1st January, 1960).
Professor J. A. Barnes.
Dr. A. M. Sargeson (Steward).
Mr. E. Irving.

The terms of office of Professor B. J. Bok, Dr. J. D. Freeman, Dr. Rose M. Eccles and Mr. E. Irving expired on 15th August.

The Master returned on 8th March from his long vacation trip during which he visited England, Denmark, Poland, Germany, France, Switzerland and Italy. During this period he was mainly engaged in continuing his researches on South Italian pottery, but he also carried out various negotiations on behalf of the University. In July, he was appointed to the Australian Universities Commission and has since visited all the universities of Australia.

Professor F. E. A. Towndrow, Dean of the Faculty of Architecture in the University of New South Wales, spent one term as Visiting Fellow. He is preparing a volume on the Theory of Architectural Design.

II. MEMBERS AND RESIDENTS.

The number of members is now about 400; the average number of permanent residents has been between 110 and 120. During the year most of the members of the Canberra University College resident in the House moved out to accommodation of their own so that residents are now almost entirely members of the A.N.U.

During the year rates for all types of rooms were increased by 5 per cent. to meet the cost of a rise in the basic wage.

On many occasions during the year the House was completely full and the addition of 25 new rooms in the eastern annex extension will help considerably to ease the pressure next year.

III. VISITORS.

The flow of academic and other distinguished visitors continues at a high level and most are accommodated for varying periods at University House. They included: Professor T. Willard Berry, Duke University; Professor J. S. Boyce, Yale; Professor H. Bondi, King's College, London; Mr. S. H. Gordon Box of the B.B.C.; the Hon. Lionel Brett; Sir Lindor Brown, Royal Society; Sir Sydney Caine, London School of Economics; Mr. C. W. Collins, Christchurch, New Zealand; Professor F. Dainton, Leeds; Mr. K. H. Darja of the University of Delhi; Mr. M. Dowuona of the University College of Ghana; Professor R. Firth, University of London; Professor R. Fifield, Michigan, Dr. Karl Frank of the National Institute of Health, Bethesda, Maryland; Sir Ronald Fisher, Cambridge; Dean E. Griswold, Harvard Law School; Dr. A. L. Goodhart, Oxford; Professor A. L. Hales of the University of the Witwatersrand; Dame Florence Hancock; Professor Vincent Harlow, Oxford; Sir Charles Hercus, Otago; Dr. C. Hooykaas, London; Mr. K. Ivanov, Moscow University; Sir Harold Jeffreys, Cambridge; Professor D. H. Lehmer, Berkeley; Professor Victor LaMer, Columbia; Professor E. G. T. Liddell, Oxford; Professor D. L. Linton, Birmingham; Professor J. S. Lyou of Seoul National University; Professor B. N. Olsen, North Caroline State College; Dr. George Paik, Yuse University, Korea; Professor C. F. Powell, Bristol; Sir Raymond Priestley, Manchester; Professor T. Ropp, Duke University; Professor S. A. Riesenfeld, California; Professor L. Samuels, Utah; Professor Marshall H. Stone, Chicago; Dr. R. E. Scantlebury of the National Institute of Health, Bethesda, Maryland; Dr. V. K. R. V. Rao, Delhi; Dr. M. Sweeting, Oxford; Professor M. Stoker, Glasgow; Dr. A. H. Siddiqui, Karachi; Dr. G. Templeman, Birmingham; Dr. Peggy Volkox, London; Professor R. E. Watters, British Columbia; Professor T. B. L. Webster and Mrs. A. M. Webster, London; Dr. L. I. Sedov of the University of Moscow.

In addition Sir Alexander Carr-Saunders, Sir Donald MacDougall and Dr. Walter Baade, Visiting Professors at the Australian National University, resided in the House for about six months, as did Professors T. M. Cherry and J. A. LaNauze of the University of Melbourne, who spent a considerable portion of their sabbatical leave in residence here.
On the 26th March, we were honoured by a visit from H.R.H. Princess Alice, Countess of Athlone, and on the 21st April by H.E. the Governor of New South Wales, Lieut.-General Sir Eric Woodward.

4. BUILDINGS AND GROUNDS.

Work was commenced on the extension to the eastern annexe and is expected to be completed by June, 1960. The 25 rooms in the extension will enable the House to provide accommodation once again for conferences as it has not been able to do for the past two years owing to the high average number of permanent residents. The new Meetings Room should be much more satisfactory in design and acoustics than the old one which has been converted into three bedrooms.

The approach to the main entrance has been redesigned so as to prevent cars and lorries from driving too close to the front steps and causing them damage.

It is planned to replace the present electric stove in the kitchen with an oil-burning installation which should not only prove less costly to run and to maintain, but also provide a more efficient service.

5. HOUSE LIBRARY AND RECORD COLLECTION.

New committees were formed under the chairmanship of Professor C. P. FitzGerald with responsibility for the University House Library and Record Collection. Out of a yearly grant of £100 and £50 respectively, new books and records are being added to the collections and the numbers borrowed are steadily rising. Both collections have benefited greatly by the donations from members and visitors to the House. Particular mention must be made of the collection of foreign language books given by the German and French Ambassadors, and a further collection of British publications by the British Council.

6. GIFTS AND DONATIONS.

Professor P. A. Moran presented the House with a fine attic red-figured cup of the Segment class, dating to the later sixth century B.C. It is particularly well preserved and represents horsemen and spectators. The piece was published by the Master together with the other vases in the Fellows' Room in a short descriptive article in the University News. Sir Donald MacDougall presented the House with a silver candlestick.

7. FUNCTIONS AND ACTIVITIES.

Commencement Dinners were held as usual to mark the beginning of the academic terms. The Master spoke briefly about his travels after the first term Dinner; Sir William Holford after the second on the planning of capital cities, and Sir Donald MacDougall after the third made some interesting observations on Nuffield College, of which he is the Senior Bursar. A formal dance was held on the 6th November, and was attended by some 200 members and friends.

Lunch-time and after-dinner talks continue to attract many members. Topics dealt with this year included Aztec Civilization, Contemporary Fiji, A Day in Peking, Planning for cultural activities in Canberra, Exploring the Galaxies and the Wall-Paintings of Boscoreale. The Morrison Lecture was given in October by Dr. C. N. Spinks of the United States Embassy on the Khmer Temple at Prah Vihar.

The facilities of the Hall have been made available to the Chamber Music Society as in previous years, and five concerts were held, all extremely well attended.

8. PUBLICATIONS.

Trendall, A. D.—


“Fliacici Vasi,” article in Enciclopedia dell' Arte Antica, III.
### UNIVERSITY STATISTICS.

**No. 1.—Staff.**

**Year 1959.**

#### (a) Teaching and Research—

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>1. Professors</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>2. Readers</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>3. Senior Fellows and Fellows</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>4. Senior Research Fellows and Research Fellows</td>
<td>39</td>
<td>12</td>
</tr>
<tr>
<td>5. Research and Departmental Assistants</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>

**Total** | 124 | 30 | 154 | 1 | 9 | 10 |

#### (b) Library (including departmental sections)—

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>Engaged in Professional Work</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Other Assistants</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total** | 7 | 13 | 20 | | | |

#### (c) Central Administration—

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>Chief Administrative Officers</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Senior Administrative Assistants</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Clerks, Typists, Telephonists</td>
<td>29</td>
<td>52</td>
</tr>
<tr>
<td>Porters, Messengers, &amp;c.</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Total** | 44 | 54 | 98 | | | |

#### (d) Departmental Clerks and Typists

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>Engagement</td>
<td>18</td>
<td>65</td>
</tr>
</tbody>
</table>

#### (e) Maintenance—

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>Cleaning</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Gardening</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Upkeep of buildings</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

**Total** | 66 | 3 | 69 | 9 | 9 |

#### (f) Laboratories—

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>Adult Assistants</td>
<td>182</td>
<td>33</td>
</tr>
<tr>
<td>Junior Assistants</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

**Total** | 186 | 45 | 231 | 8 | 8 |

#### Summary—

<table>
<thead>
<tr>
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<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males.</td>
<td>Females.</td>
</tr>
<tr>
<td>(a) Teaching and Research</td>
<td>124</td>
<td>30</td>
</tr>
<tr>
<td>(b) Library</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>(c) Central Administration</td>
<td>44</td>
<td>54</td>
</tr>
<tr>
<td>(d) Departmental Clerks and Typists</td>
<td>18</td>
<td>65</td>
</tr>
<tr>
<td>(e) Maintenance</td>
<td>66</td>
<td>3</td>
</tr>
<tr>
<td>(f) Laboratories</td>
<td>186</td>
<td>45</td>
</tr>
</tbody>
</table>

**Total** | 445 | 210 | 655 | 1 | 26 | 27 |
### No. 2.—Details of Teaching and Research Staff.

#### Year 1959.

<table>
<thead>
<tr>
<th>Department</th>
<th>Professors</th>
<th>Readers</th>
<th>Senior Fellows and Fellows</th>
<th>Senior Research Fellows and Research Fellows</th>
<th>Research and Departmental Assistants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males/Females</td>
<td>Males/Females</td>
<td>Males/Females</td>
<td>Males/Females</td>
<td>Males/Females</td>
</tr>
<tr>
<td>John Curtin School of Medical Research—</td>
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<td></td>
</tr>
<tr>
<td>Biochemistry</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Biochemistry</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Chemistry</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Microbiology</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Experimental Pathology</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Physiology</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Animal Breeding Establishment</td>
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<td></td>
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<tr>
<td>Biological Inorganic Chemistry</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Research School of Physical Sciences—</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Particle Physics</td>
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<td>7</td>
<td>3</td>
<td></td>
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</tr>
<tr>
<td>Nuclear Physics</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
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<tr>
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<td>1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Radiochemistry</td>
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<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Astronomy</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Research School of Social Sciences—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Law</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Political Science and International Relations</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Demography</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Statistics</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Philosophy</td>
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<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Research School of Pacific Studies—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Anthropology and Sociology</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pacific History</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Geography</td>
<td>1</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Far Eastern History</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>19</td>
<td>40</td>
<td>2</td>
<td>39</td>
</tr>
</tbody>
</table>

### No. 3.—Special Research Workers.

#### Year 1959.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Working in Australia</td>
<td>Abroad</td>
<td>Working in Australia</td>
</tr>
<tr>
<td>Students and others (not being members of the staff as in Table 1 (a)) engaged in research—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidized by—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Commonwealth Government</td>
<td>...</td>
<td>...</td>
<td>5</td>
</tr>
<tr>
<td>2. State Government</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>3. Other Sources</td>
<td>...</td>
<td>...</td>
<td>4</td>
</tr>
<tr>
<td>Unsubsidized</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>...</td>
<td>...</td>
<td>9</td>
</tr>
</tbody>
</table>

N.B.—This return is Supplementary to that showing Teaching and Research Staff—Form Nos. 1 and 2.
### No. 4.—Students: Full-Course and Part-Course.

<table>
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<tr>
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NO. 6A.—AGE DISTRIBUTION OF MALE STUDENTS ENROLLED—(NEW STUDENTS ONLY).

Age as at 1st March, 1959.

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F.1804/60.—6
### No. 6.—Age Distribution of Female Students Enrolled—(New Students Only).
*Age as at 1st March, 1959.*

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### No. 8.—Home Residence Distribution of All Students Enrolled.

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F.1804/60.—7
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**Current Assets**

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<th>£</th>
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<tbody>
<tr>
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<td>Held in Imprests</td>
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<td>Advances against Expenses</td>
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<td>Advances, Department of Interior and Department of Works</td>
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<td><strong>Fixed Assets</strong></td>
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#### Fixed Assets

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<td>Research Equipment and Furniture—</td>
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<td>Research Schools and Library</td>
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<td>Administration and General Services</td>
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<td>University House (v.)—Buildings</td>
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<td>Equipment and Other Assets (Net)</td>
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<td><strong>Total Library</strong></td>
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<td><strong>Capital Accumulation (ii.)</strong></td>
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<tr>
<td>Restricted Funds (vi.)</td>
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<td><strong>Total Trust and Agency Funds (vii.)</strong></td>
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</table>

The above statement of assets and liabilities has been examined and is in agreement with the books. In my opinion it exhibits a true and fair view of the affairs of The Australian National University as at 31st December, 1959.

(Signed) H. C. NEWMAN,

*Auditor-General for the Commonwealth.*

8th June, 1960.

(Signed) L. G. MELVILLE,

*Vice-Chancellor.*

(Signed) J. RYAN,

*Accountant.*
# THE AUSTRALIAN NATIONAL UNIVERSITY.

## Capital Accumulation Account.

**For the Year Ended 31st December, 1959.**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Balance, 1st January, 1959</strong></td>
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<td>Commonwealth Grant for Capital Works and Services</td>
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<td>Assets Purchased from Restricted Funds</td>
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<td><strong>Total Add</strong></td>
<td>884,353</td>
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<tr>
<td><strong>Balance, 31st December, 1959, as contra to assets in Statement of Assets and Liabilities (i.)</strong></td>
<td>8,522,377</td>
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</table>

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Less—</strong></td>
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<td>Loss on Adjustment of Asset Values</td>
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<td>Loss on Sale of Houses to Members of Staff</td>
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<td><strong>Total Less</strong></td>
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**Balance, 31st December, 1959, as contra to assets in Statement of Assets and Liabilities (i.)** | 8,522,377 |       |

**Income—**

<table>
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<tbody>
<tr>
<td>Commonwealth Grant for Running Expenses</td>
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<td>Rentals Received</td>
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<td>Students and Examination Fees Received</td>
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<td>Sundry Income</td>
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**Expenditure—**

<table>
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<tbody>
<tr>
<td>The Research Schools [See analysis attached—(iv.)—]</td>
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<tr>
<td>The John Curtin School of Medical Research</td>
<td>379,354</td>
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<td>The Research School of Physical Sciences</td>
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<td>The Research School of Social Sciences</td>
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<td>The Research School of Pacific Studies</td>
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<td><strong>Total Expenditure—The Research Schools</strong></td>
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<td>90,504</td>
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<td>The Library—</td>
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<td>Pay-roll Tax</td>
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<td>Provision for Superannuation</td>
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<td>Salaries and Wages</td>
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<td><strong>Total Expenditure—Administration</strong></td>
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<td>Miscellaneous—</td>
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<td>Ceremonial Functions and Expenses</td>
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<tr>
<td>Subscriptions, Donations and Grants</td>
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<td>Bad Debts written off</td>
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<td>University Calendar and Public Relations Material</td>
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<td>Private Audit Expenses</td>
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<td>Legal Expenses</td>
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<td>Art Fund Subsidy</td>
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<td>Subvention for Facilities Provided by University House for General University Purposes</td>
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<td><strong>Total Expenditure—Miscellaneous</strong></td>
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<td>Maintenance and General Services—</td>
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<td>Repairs and Maintenance—Residential Buildings</td>
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<td>Hall of Residence—</td>
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<td><strong>Total Expenditure</strong></td>
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**Transferred to Capital Accumulation Account (ii.)**                       | 151,235 |
### ATTACHMENT TO INCOME AND EXPENDITURE STATEMENT (iii.)—31ST DECEMBER, 1959.

<table>
<thead>
<tr>
<th>Department and Unit</th>
<th>Salaries and Honoraria</th>
<th>Pay-roll Tax.</th>
<th>Provision for Superannuation</th>
<th>Field Research and Travelling Expenses</th>
<th>Administrative and Service Expenses</th>
<th>Total</th>
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<tbody>
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<td><strong>John Curtin School of Medical Research</strong></td>
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<td>280,053</td>
<td>7,426</td>
<td>32,080</td>
<td>10,449</td>
<td>44,296</td>
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<td></td>
<td>4,317</td>
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<tr>
<td><strong>Total</strong></td>
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<td>1,841</td>
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<td><strong>Subtotal</strong></td>
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<td>18,042</td>
<td>71,742</td>
<td>25,869</td>
<td>148,179</td>
</tr>
</tbody>
</table>
**THE AUSTRALIAN NATIONAL UNIVERSITY.**

**University House.**

**Operating Statement for the Year Ended 31st December, 1959.**

### Income—

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff Received—Residents</td>
<td>54,026</td>
</tr>
<tr>
<td>Income for Casual Meals and Catering</td>
<td>9,627</td>
</tr>
<tr>
<td>Membership Fees</td>
<td>1,856</td>
</tr>
<tr>
<td>Reimbursement of Board—House Staff</td>
<td>2,236</td>
</tr>
<tr>
<td>Subvention from University for Facilities Provided for University Purposes</td>
<td>5,000</td>
</tr>
<tr>
<td>Beverage Sales—Net Proceeds</td>
<td>2,187</td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td><strong>74,932</strong></td>
</tr>
</tbody>
</table>

### Expenditure—

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Foodstuffs</td>
<td>21,658</td>
<td></td>
</tr>
<tr>
<td>Fuel, Light and Power</td>
<td>9,791</td>
<td></td>
</tr>
<tr>
<td>Cleaning, Laundry and Sundry Materials</td>
<td>3,095</td>
<td></td>
</tr>
<tr>
<td>Domestic Staff Wages and Gratuities to Staff</td>
<td>29,433</td>
<td></td>
</tr>
<tr>
<td>Losses, Breakages and Replacements</td>
<td>982</td>
<td></td>
</tr>
<tr>
<td>Local Transport, Freight and Supply Expenses</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td><strong>65,076</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Administrative Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative Salaries</td>
<td>4,764</td>
<td></td>
</tr>
<tr>
<td>Pay-roll Tax</td>
<td>837</td>
<td></td>
</tr>
<tr>
<td>Workmen’s Compensation</td>
<td>295</td>
<td></td>
</tr>
<tr>
<td>Provision for Superannuation</td>
<td>447</td>
<td></td>
</tr>
<tr>
<td>Advertising and Appointment Expenses</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Posts, Telegrams and Telephone</td>
<td>319</td>
<td></td>
</tr>
<tr>
<td>Stationery, Printing and Office Expenses</td>
<td>284</td>
<td></td>
</tr>
<tr>
<td>Newspapers and Periodicals</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>Master’s and Fellow’s Entertainment Expenses</td>
<td>1,051</td>
<td></td>
</tr>
<tr>
<td><strong>Total Administrative Expenses</strong></td>
<td><strong>8,149</strong></td>
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</tr>
<tr>
<td><strong>Property Maintenance and Service Expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rates and General Services</td>
<td>377</td>
<td></td>
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<tr>
<td>Building Maintenance</td>
<td>973</td>
<td></td>
</tr>
<tr>
<td>Sundry Repairs</td>
<td>1,609</td>
<td></td>
</tr>
<tr>
<td><strong>Total Property Maintenance and Service Expenses</strong></td>
<td><strong>2,959</strong></td>
<td></td>
</tr>
<tr>
<td>Net Operating Loss Transferred to University Statement of Income and Expenditure (iii.)</td>
<td>1,252</td>
<td></td>
</tr>
<tr>
<td>Estimated Depreciation on Assets Transferred to University Statement of Income and Expenditure (iii.)</td>
<td>8,456</td>
<td></td>
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<tr>
<td><strong>Total Net Operating Loss</strong></td>
<td><strong>9,708</strong></td>
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</tr>
</tbody>
</table>

### Statement of Assets and Liabilities as at 31st December, 1959.

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundry Debtors</td>
<td>4,280</td>
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<tr>
<td>Stock on Hand (including Glassware, &amp;c.)</td>
<td>8,026</td>
</tr>
<tr>
<td>Works of Art and Record Library</td>
<td>1,398</td>
</tr>
<tr>
<td>Furniture and Equipment</td>
<td>137,886</td>
</tr>
<tr>
<td>Less Estimated Depreciation to Date</td>
<td>49,853</td>
</tr>
<tr>
<td><strong>Total Assets</strong></td>
<td><strong>101,737</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundry Creditors</td>
<td>3,020</td>
</tr>
<tr>
<td>Included in University’s Statement of Assets and Liabilities (i.)</td>
<td>98,717</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Subsidies and Donations Received During 1959</th>
<th>Funds Disbursed or Transferred During 1959</th>
<th>Net Amounts Transferred to Capital of Funds</th>
<th>Fund Balances 1st January, 1959</th>
<th>Fund Balances 31st December, 1959</th>
</tr>
</thead>
<tbody>
<tr>
<td>The John Curtin School of Medical Research Reserve</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>The Research School of Physical Sciences Reserve</td>
<td>780</td>
<td>832 Cr. 52</td>
<td>4,220</td>
<td>1,840</td>
<td>1,840</td>
</tr>
<tr>
<td>The Research School of Social Sciences Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Research School of Pacific Studies Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The University Art Reserve</td>
<td>200</td>
<td>191</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
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<tr>
<td>The University Film Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The University Publications Reserve</td>
<td>2,348</td>
<td>4,260 Cr. 1,912</td>
<td>9,851</td>
<td>7,939</td>
<td></td>
</tr>
<tr>
<td>Mount Stromlo Observatory Reserve for Accumulated Furlough</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>C.S.I.R.O. Grant for Sheep and Wool Research</td>
<td>7,617</td>
<td>7,617</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayer-Pharma Grant for Research in Medical Chemistry</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>C.S.I.R.O. Grant for Biological Inorganic Chemistry Section</td>
<td>3,423</td>
<td>3,642 Cr. 219</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rockefeller Grant for Research in Microbiology</td>
<td>1,045</td>
<td>1,045</td>
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<td></td>
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<tr>
<td>National Health and Medical Research Council Grant</td>
<td>1,174</td>
<td>1,174</td>
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<td></td>
<td></td>
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<tr>
<td>C.S.I.R.O. Grant for Tropical and Semi-Desert Sheep Research</td>
<td>1,625</td>
<td>400</td>
<td>1,225</td>
<td></td>
<td>1,225</td>
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<tr>
<td>Rural Credits Development Fund Grant for Tropical Sheep Research</td>
<td>2,830</td>
<td>2,830</td>
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<td>2,830</td>
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<tr>
<td>Commonwealth Government Grant for Accelerator Project</td>
<td>11,250</td>
<td>10,682</td>
<td>568</td>
<td>1,940</td>
<td>2,508</td>
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<tr>
<td>U.S.A. Office of Naval Research Grant, Mount Stromlo Observatory</td>
<td>4,243</td>
<td>5,077 Cr. 834</td>
<td></td>
<td></td>
<td>Dr. 834</td>
</tr>
<tr>
<td>Metropolitan Water, Sewerage and Drainage Board and Snowy Mountains Hydro-Electric Authority Grant for Geophysics</td>
<td>1,500</td>
<td>1,025</td>
<td>475</td>
<td></td>
<td></td>
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<tr>
<td>Nuffield Foundation Grant for Research in Demography</td>
<td></td>
<td>2,296 Cr. 2,296</td>
<td></td>
<td></td>
<td>936</td>
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<tr>
<td>Department of Immigration Grant for Research into British Migration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant in Aid—W. M. Hughes Biography</td>
<td>4,498</td>
<td>1,836 Cr. 2,662</td>
<td>2,784</td>
<td>5,446</td>
<td></td>
</tr>
<tr>
<td>Social Science Research Council Grant for Research in Economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian Banks Grant for Visiting Professor in Economics</td>
<td>3,500</td>
<td>1,925 Cr. 1,238</td>
<td>2,855</td>
<td>2,855</td>
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</tr>
<tr>
<td>National Development Grant—Department of Geography</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lady Islaas Donation for Books</td>
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<td></td>
<td></td>
<td></td>
<td>4</td>
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<tr>
<td>C.S.I.R.O. Grant—Department of Geography</td>
<td>250</td>
<td>250</td>
<td></td>
<td></td>
<td>250</td>
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<tr>
<td>Grant for New Guinea Research Unit</td>
<td>7,000</td>
<td>7,000</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>E. M. Symon Bequest—Department of Anthropology</td>
<td>752</td>
<td>752</td>
<td></td>
<td></td>
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<tr>
<td>Grant for Journal of Pacific History</td>
<td>268</td>
<td>268</td>
<td></td>
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<tr>
<td>General Motors Holden Ltd. Grant for Scholarships</td>
<td>4,300</td>
<td>4,349 Cr. 49</td>
<td>2,019</td>
<td>1,970</td>
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<tr>
<td>Australian Atomic Energy Commission Grant for Scholarships</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fund for Publication—Campanian and Lucanian Pottery</td>
<td>542</td>
<td>542</td>
<td></td>
<td></td>
<td>542</td>
</tr>
<tr>
<td>Commonwealth Government Grant for Post-Graduate Scholarships</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Assurance Commission</td>
<td>5,400</td>
<td>5,400</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Vice-Chancellor's Discretionary Fund</td>
<td>95</td>
<td>411 Cr. 316</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonwealth Trading Bank of Australia—Interest Bearing Deposit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61,293</td>
</tr>
</tbody>
</table>

|                                                                 | £                                             | £                                          | £                                          | £                              | £                                 |
| Common Bank and Deposit                                                   | 65,810                                        | 58,045                                     | 7,765                                      | 53,528                         | 61,293                            |
THE AUSTRALIAN NATIONAL UNIVERSITY.

STATEMENT OF TRUST AND AGENCY FUNDS FOR THE YEAR ENDED 31ST DECEMBER, 1959.

<table>
<thead>
<tr>
<th>Subsidies, Donations and Subscriptions</th>
<th>Interest and Capital Appreciation</th>
<th>Total</th>
<th>Transferred to Reserve</th>
<th>Fund Balance 1st January, 1959</th>
<th>Fund Balance 31st December, 1959</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Funds—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonwealth Superannuation and P.vident Account Fund</td>
<td>53,631</td>
<td>£11,747</td>
<td>£65,378</td>
<td>£721</td>
<td>£64,657</td>
</tr>
<tr>
<td>The Australian National University Supplementary Superannuation Benefits Fund</td>
<td>4,224</td>
<td>992</td>
<td>5,216</td>
<td>..</td>
<td>5,216</td>
</tr>
<tr>
<td>The Australian National University Superannuation Scheme—</td>
<td></td>
<td></td>
<td></td>
<td>792</td>
<td>792</td>
</tr>
<tr>
<td>Member's Fund No. 1</td>
<td></td>
<td></td>
<td></td>
<td>209</td>
<td>209</td>
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<tr>
<td>Member's Fund No. 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Funds—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Lord Rutherford Memorial Trust Fund</td>
<td></td>
<td>186</td>
<td>186</td>
<td>235</td>
<td>Cr. 49</td>
</tr>
<tr>
<td>Morrison Oration Trust Fund</td>
<td></td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>580</td>
</tr>
<tr>
<td>Sir Littleton Groom Memorial Scholarship Trust Fund</td>
<td></td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>810</td>
</tr>
<tr>
<td>Norwegian-Australian Cultural Trust Fund</td>
<td></td>
<td>114</td>
<td>114</td>
<td>100</td>
<td>14</td>
</tr>
<tr>
<td>Danish-Australian Cultural Trust Fund</td>
<td></td>
<td>104</td>
<td>104</td>
<td>113</td>
<td>Cr. 9</td>
</tr>
<tr>
<td>Swedish-Australian Cultural Trust Fund</td>
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<td>81</td>
<td>81</td>
<td>122</td>
<td>Cr. 41</td>
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<tr>
<td>Agency Funds—</td>
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</tr>
<tr>
<td>The Salomé Memorial Fund</td>
<td></td>
<td>150</td>
<td>151</td>
<td>130</td>
<td>21</td>
</tr>
<tr>
<td>Mount Stromlo Observatory Fund</td>
<td></td>
<td>1,928</td>
<td>232</td>
<td>2,160</td>
<td>2,160</td>
</tr>
<tr>
<td>The Vice-Chancellor's Discretionary Fund</td>
<td></td>
<td>4,050</td>
<td>50</td>
<td>4,100</td>
<td>4,100</td>
</tr>
<tr>
<td>The Research School of Physical Sciences</td>
<td></td>
<td>48</td>
<td>5</td>
<td>53</td>
<td>84</td>
</tr>
<tr>
<td>Faculty Fund</td>
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<td>22</td>
<td>22</td>
<td>6</td>
<td>16</td>
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<tr>
<td>The Department of Biochemistry Fund</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>The Research School of Social Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty Fund</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>The Research School of Pacific Studies</td>
<td></td>
<td>28</td>
<td>28</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Faculty Fund</td>
<td></td>
<td>11,251</td>
<td>33</td>
<td>11,251</td>
<td>4,822</td>
</tr>
<tr>
<td>The John Curtin School of Medical Research Contingencies Fund</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fund for Return Fares—Special Deposit</td>
<td></td>
<td>33</td>
<td>33</td>
<td>534</td>
<td>Cr. 501</td>
</tr>
<tr>
<td></td>
<td>75,541</td>
<td>14,393</td>
<td>89,934</td>
<td>6,867</td>
<td>83,067</td>
</tr>
</tbody>
</table>

Investments—

Commonwealth Superannuation and Provident Account Fund | £277,480 | £270,401 |
The Australian National University Supplementary Superannuation Benefits Fund | £23,550 | £23,516 |
The Australian National University Superannuation Scheme—
  Member's Fund No. 1 | £14,600 | £13,774 |
  Member's Fund No. 2 | £200 | £191 |
The Lord Rutherford Memorial Trust Fund | £7,000 | £6,610 |
Morrison Oration Trust Fund | £580 | £580 |
Sir Littleton Groom Memorial Scholarship Trust Fund | £850 | £848 |
Norwegian-Australian Cultural Trust Fund | £2,200 | £2,135 |
Danish-Australian Cultural Trust Fund | £2,200 | £2,146 |
Swedish-Australian Cultural Trust Fund | £1,600 | £1,564 |
Mount Stromlo Observatory Fund | £6,410 | £6,283 |
The Vice-Chancellor's Discretionary Fund | £2,100 | £1,989 |

338,770

The Vice-Chancellor's Discretionary Fund—Loans | £248 |
Cash in Bank—Commonwealth Savings Bank of Australia—Account No. S.979 | £11,990 |

342,275