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THE AUSTRALIAN NATIONAL UNIVERSITY

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1960  
REPORT

COMMONWEALTH OF AUSTRALIA

REPORT OF THE COUNCIL  
OF  
THE AUSTRALIAN NATIONAL UNIVERSITY

FOR THE YEAR ENDING 31st DECEMBER, 1960

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1961

# THE AUSTRALIAN NATIONAL UNIVERSITY.

## REPORT OF THE COUNCIL FOR THE PERIOD 1st JANUARY, 1960 TO 31st DECEMBER, 1960.

To His Excellency General Sir Dallas Brooks, K.C.B., K.C.M.G., K.C.V.O., D.S.O., K.St.J.,  
Administrator of the Government of 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, 1960, to 31st December, 1960, furnished in compliance with Section 33 of the Australian National University Act 1946-1960.

### THE COUNCIL.

The Council met eleven times during the year in January, February, March, April, May, July, August, September, 30th September (being the first meeting of the reconstituted Council on the association of the Canberra University College with the University) and November. Dr. H. C. Coombs, Pro-Chancellor, presided over the meetings of Council except in January when the Chancellor was present.

The terms of office of Mr. W. D. McDonald, Sir Frank Richardson, Mr. G. Coleman and Mr. D. B. Heron expired on 30th June, 1960. The Prime Minister approved the extension of the terms of office as members of Council of Mr. W. D. McDonald and Sir Frank Richardson until 30th September, 1960. Under an amendment of the Elections (Members of the Council) Rules approved by Council at its meeting on 11th March, 1960, the terms of office of Mr. G. Coleman and Mr. D. B. Heron was extended to 31st December, 1960 or immediately before the prescribed date on which the Australian National University Act 1960 came into operation.

Elections took place and appointments were made in accordance with the provisions of Part II, Section 7, of the Australian National University Act 1960, and the following Councillors took office as from 30th September, 1960:—

(a) Elected by the Senate—

- \*Keith Alexander Laught, LL.B. (Adel.)
- \*Dorothy Margaret Tangney, B.A., Dip.Ed. (W.A.).

(b) Elected by the House of Representatives—

- \*†Kim Edward Beazley, B.A. (W.A.).
- ‡Leslie Harry Ernest Bury, M.A. (Cantab.), A.A.S.A., A.B.I.A.

(c) Appointed by the Governor-General—

- \*Norman Lethbridge Cowper, C.B.E., B.A., LL.B. (Syd.).
- §John Qualtrough Ewens, C.B.E., LL.B. (Adel.).
- Edmund John Buchanan Foxcroft, M.A. (Melb.).
- Sir Kenneth Fraser, C.B.E., C.St.J., M.B., Ch.M., M.S. (Syd.), F.R.A.C.S.
- \*Herbert John Goodes, C.B.E., B.A. (W.A.)
- Brian William Hone, B.A. (Adel.), M.A. (Oxon.).
- Stephen Lackey Kessell, M.B.E., M.Sc. (Adel.), Dip. Forestry (Oxon.).
- Alexander George Mitchell, Ph.D., M.A. (Syd.).
- \*Warren d'Arcy McDonald, C.B.E.
- \*Sir Frank Richardson.
- §Arthur Thomas Shakespeare.
- Frederick William George White, C.B.E., M.Sc., Ph.D. (Cantab.).

(d) Members ex-officio—

Chancellor .. .. .	*The Right Honourable Viscount Bruce of Melbourne, P.C., C.H., M.C., B.A. (Cantab.), Hon. LL.D. (Syd., Melb., Cantab. and A.N.U.), Hon. D.C.L. (Oxon.), F.R.S.
Pro-Chancellor .. .. .	*Herbert Cole Coombs, M.A. (W.A.), Ph.D. (Lond.), Hon. LL.D. (Melb.), Hon. D.Litt. (W.A.).
Vice-Chancellor .. .. .	Leonard George Holden Huxley, M.A., D.Phil. (Oxon.), Ph.D. (Adel.), F. Inst. P., F.A.A.

\* Member of the old Council prior to reconstitution.

† The House of Representatives on 8th September extended his term of office to the 1st day of the sitting of the 24th Parliament.

‡ The House of Representatives on 8th September elected Mr. Bury to fill the vacancy caused by the resignation of Mr. P. E. Joske and to continue as a member of Council until the 1st day of the sitting of the 24th Parliament.

§ Formerly member of Council of Canberra University College.

- Deputy Vice-Chancellor .. \*Arthur Dale Trendall, C.M.G., K.C.S.G., M.A. (Cantab.), Litt.D. (N.Z.), Hon. Litt.D. (Melb.), Hon. D.Litt. (Adel.), F.S.A.
- Principal of the School .. \*†Herbert Burton, B.A. (Q'ld.), M.A. (Oxon. and Melb.).
- Deputy Chairman of the Board of the Institute \*Arnold Hughes Ennor, D.Sc. (Melb.), F.A.A.
- (e) Chosen by Heads of the Research Schools in the Institute (two members)—  
\*Sir Mark Oliphant, K.B.E., B.Sc. (Adel.), M.A., Ph.D. (Cantab.), Hon. LL.D. (St. Andrews), Hon. D.Sc. (Melb., Toronto, Belf., Birm. and N.S.W.), F. Inst. P., F.R.S.N.Z., F.A.A., F.R.S.  
Percy Herbert Partridge, M.A. (Syd.).
- (f) Chosen by the Deans of Faculties in the School (two members)—  
Burgess Don Cameron, M.Ec. (Syd.), Ph.D. (Cantab.).  
James Desmond Smyth, M.A., Sc.D. (Dub.)
- (g) Elected by the Professors in the Institute (one member)—  
Trevor Winchester Swan, B. Ec. (Syd.).
- (h) Elected by the Professors in the School (one member)—  
†Leslie Finlay Crisp, M.A. (Oxon. and Adel.).
- (i) Elected by the non-professorial staff of the Institute (one member)—  
\*Robin Allenby Gollan, M.A. (Syd.), Ph.D. (Lond.).
- (j) Elected by the non-professorial staff of the School (one member)—  
†Douglas William Smith, B.Com., LL.B. (Melb.).
- (k) Elected by the Research Students (one member)—  
Ian Alexander Hamilton Turner, LL.B., B.A. (Melb.).
- (l) Elected by the Undergraduate Students (one member)—  
John Laurence Carroll, B.Com., B.Sc. (Melb.).
- (m) Elected by Convocation—  
William Macmahon Ball, M.A. (Melb.).  
†Harold George Raggatt, C.B.E., D.Sc. (Syd.), F.A.A.  
\*Sir Roland Wilson, C.B.E., B.Com. (Tas.), D.Phil., Dip. Econ. and Pol. Sc. (Oxon.), Ph.D. (Chicago).  
\*Roy Douglas Wright, D.Sc., M.B., M.S. (Melb.), F.R.A.C.S., F.R.A.C.P.
- (n) Co-opted Members (not exceeding two in number)—  
To be appointed.

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

Percy Ernest Joske, on 10th June, 1960.

## THE DEVELOPMENTS OF 1960 IN SUMMARY.

### GENERAL DEVELOPMENTS.

Following the Australian National University Act 1960, which came into operation on 30th September, the principal functions of the Canberra University College were taken over by, and the staff of the Canberra University College became staff of, the Australian National University. The first meeting of a reconstituted Council was held on that day. The University now includes the Institute of Advanced Studies and the School of General Studies—the former comprising the four Research Schools which previously made up the Australian National University, the latter being solely responsible for undergraduate teaching. Doctoral degrees will be the general responsibility of the Institute, and Masters' degrees the concern of the School, but both degrees may be taken in either part of the University.

*The new School of General Studies was part of the University for only three months of the year under review. In these circumstances only brief references have been made to the work of the School of General Studies in this report and all of them are contained in the first part, "The Developments of 1960 in Summary". A report on the work of the Canberra University College for the period 1st January to 29th September, 1960, is contained in a separate document.*

The Chancellor, Viscount Bruce of Melbourne, visited the University in January.

Council, at its meeting on 9th September, accepted the resignation of Sir Leslie Melville as Vice-Chancellor as from 29th September. Council resolved to place on record its great regret at Sir Leslie's resignation and its appreciation of the distinguished service which he had given to the University in the seven years during which he had held the office of Vice-Chancellor. As Vice-Chancellor he had never spared himself, and the University's loss in his resignation was universally recognized. Sir Leslie took with him the good wishes of the Council as he entered on his new work as Chairman of the Tariff Board.

\* Member of the old Council prior to its reconstitution.  
† Formerly member of Council of Canberra University College.

Council, consequent on Sir Leslie's decision to retire, appointed Professor L. G. H. Huxley to succeed him.

Their Excellencies the late Viscount Dunrossil and Lady Dunrossil honoured the University with a visit on Monday, 21st March. Their Excellencies also visited Mount Stromlo Observatory in February.

The Rt. Hon. The Prime Minister visited Mount Stromlo in April.

Mr. A. L. G. McDonald retired from the post of University Librarian as from 10th March. Mr. McDonald was appointed Librarian in May, 1948, and to him fell the task of creating a University Library from its very beginnings. The first books acquired by the Library were 500 volumes presented by the University of Melbourne and the collection in the Institute now comprises 154,000 volumes, of which 24,000 volumes are in the Oriental Collection. The Council, in recognition of the great pioneering work carried out by Mr. McDonald, has appointed him Librarian Emeritus.

Mr. J. J. Graneek, Librarian of the Queen's University, Belfast, Northern Ireland, has been appointed University Librarian in succession to Mr. McDonald.

Professor Sir Keith Hancock informed the Council that he wished to resign from the Directorship of the Research School of Social Sciences on his return from study leave. Sir Keith will continue to serve the University as Professor of History in the Research School of Social Sciences.

Council approved the establishment of a Chair of Mathematics within the Research School of Physical Sciences, and Dr. B. H. Neumann, F.R.S., at present Reader in Mathematics at the University of Manchester, has been appointed to the Chair and as Head of the Department. Dr. Neumann will not be taking up his appointment till the middle of 1962.

It has also been decided to establish an Electron and Ion Diffusion Unit within the Research School of Physical Sciences under the direction of the Vice-Chancellor. The Unit will be staffed by a small group which has worked under Professor Huxley for some years at the University of Adelaide.

The Research School of Social Sciences is to develop work in the fields of Sociology and the History of Ideas.

With the appointment of Professor Sir John Crawford, Director of the Research School of Pacific Studies, to the Chair of Economics, a new Department corresponding to that in the Research School of Social Sciences has been established in the Research School of Pacific Studies.

Council has approved the creation of Personal Professorships as a means to recognize outstanding performance in research. Such recognition will only be given in special cases and on rare occasions; it will usually only be given to persons already on the University staff, though appointment by invitation to others is not precluded. As implied by the title, such a Professorship is personal to the holder and the post will not be filled again on the resignation or retirement of the holder. A Personal Professor will not therefore be referred to as holding a Chair.

#### SITE AND BUILDINGS.

A contract for the permanent Library building was let in April. Construction is expected to finish in the latter part of 1962. An additional Wing of 25 rooms at University House was completed. The building to house the 12 MeV tandem electrostatic generator for the Department of Nuclear Physics was erected by the staff of the Research School of Physical Sciences and was ready in good time to house the apparatus which arrived from the United States of America in October.

The first permanent building of the School of General Studies, housing six of the departments of the Arts Faculty, was completed in 1960, officially opened on 14th September, by the late Governor-General and named the Haydon-Allen Building in honour of the first full-time lecturers in Arts at the former Canberra University College, Professor J. F. M. Haydon and Dr. L. H. Allen.

Consequent upon association of the College with the University, the Council of the University invited the Site Consultant to prepare a revised master plan to guide the effective use of the combined sites. Discussions have taken place with the National Capital Development Commission towards the provision of adequate land for the University and the determination of site boundaries so that a lease can be secured to incorporate the areas which had been under Ministerial promise to the College.

Work continued on the Physics building and the first Hall of Residence for the School of General Studies. These projects, which have been under the direction of the National Capital Development Commission, will be ready for occupation early in 1961. The Commission has also undertaken the detailed planning of the proposed Chemistry building which should be started early in 1961.

A capital works programme for the triennium 1961-63 has been prepared and submitted to the Australian Universities Commission at its request and in the light of the recommendations for this University contained in its Report of October, 1960.

#### DEGREES AWARDED.

The degree of Doctor of Philosophy was conferred on: Mr. G. B. Barlin (Medical Chemistry); Mr. R. D. Barry (Microbiology); Mr. F. H. Bauer (Geography); Mr. E. C. F. Bird (Geography); Mr. R. D. Bradley (Social Philosophy); Mr. E. K. Carter (Geophysics); Mr. C. Forster (Economics—Social Sciences); Mr. D. S. Gemmel (Nuclear Physics); Mr. E. W. Godbole (Radiochemistry); Mr. W. N.

Gunson (Pacific History); Mr. D. S. Kemsley (Geophysics); Mr. T. N. Madan (Anthropology and Sociology); Mr. J. Rutherford (Geography); Mr. K. Schell (Microbiology); Mr. T. L. Suttor (History); Mr. H. Y. T'ien (Demography); Mr. J. M. Tregenza (History); Mr. K. R. Walker (Geophysics); Mr. B. P. Walpole (Geophysics); Mr. R. K. Wilson (Geography).

At the annual examinations in November, 1960, 34 students of what is now the School of General Studies qualified for Bachelors' degrees. Of these, 31 students fulfilled the requirements for degrees of the University of Melbourne with which the College was associated until September, 1960. These degrees will be conferred in 1961.

Four students are eligible for Bachelors' degrees of the Australian National University, but the degrees will not be conferred until 1962.

#### ENROLMENTS.

Forty-nine new research students enrolled with the Institute of Advanced Studies in 1960 and the total number enrolled at the end of the year was 147. Of the new research students 23 were Australians, 6 were from the United Kingdom, 6 from the United States, 5 from New Zealand, 2 each from Canada, India and Japan and 1 each from Sweden, Germany and Fiji.

On 30th September, 1960, 900 students were enrolled in the School of General Studies and of these 229 were full-time students. Students enrolled with the School of General Studies for higher degree courses numbered 47, for bachelors' degree courses 688, undergraduate diploma courses 8, miscellaneous courses 116. Details are included as an appendix.

#### STAFF APPOINTMENTS.

Senior appointments and promotions were—

##### *Institute of Advanced Studies—*

Professor S. Fazekas de St. Groth, Professor in Virology.  
 Professor F. P. Dwyer, Professor in Inorganic Chemistry.  
 (Both appointed from 9th December, 1960.)  
 Dr. D. Walker, Reader in Geography,  
 Mr. A. L. Burns, Reader in International Relations,  
 Dr. A. E. Ringwood, Senior Fellow in Geophysics,  
 Dr. W. Buscombe, Senior Fellow in Astronomy,  
 Dr. S. V. Boyden, Senior Fellow in Experimental Pathology.  
 Dr. A. R. Hall, Senior Fellow in Economics (Social Sciences),  
 Dr. C. A. Price, Senior Fellow in Demography,  
 Dr. Norma McArthur, Senior Fellow in Demography,  
 Dr. R. A. Gollan, Senior Fellow in History,  
 Dr. D. D. Perrin, Senior Fellow in Medical Chemistry,  
 Dr. C. A. Mims, Fellow in Microbiology,  
 Dr. G. Mulder, Senior Fellow in Far Eastern History,  
 Mr. E. Irving, Senior Fellow in Geophysics,  
 Dr. G. A. Joplin, Senior Fellow in Geophysics,  
 Dr. J. H. Carver, Senior Fellow in Nuclear Physics,  
 Dr. F. C. Barker, Senior Fellow in Theoretical Physics,  
 Dr. D. S. Robertson, Senior Fellow in Particle Physics,  
 Dr. P. B. Treacy, Senior Fellow in Nuclear Physics,  
 Dr. J. M. Gani, Senior Fellow in Statistics,  
 Mr. J. B. Waugh, Fellow (Electronics Engineer).

##### *School of General Studies—*

Dr. A. Brown, Reader in Applied Mathematics at the University of Melbourne, to the Chair of Mathematics on the resignation of Professor F. V. Atkinson.  
 Dr. H. A. J. Ford, Reader in Law in the University of Melbourne, to the Robert Garran Chair of Law, on the resignation of Professor J. G. Fleming.  
 Mr. J. E. Richardson, Chief Assistant in the Commonwealth Attorney-General's Department, Canberra, to the new Chair of Public Law.  
 Dr. G. S. L. Tucker, Reader in Economic History at the University of Melbourne, to the Chair of Economic History formerly occupied by Professor H. Burton who will continue as Principal of the School and a Professor of Economic History.  
 Dr. R. Van der Borgh, Senior Lecturer in Mathematics in the University of Natal, to the new post of Associate Professor in Mathematics.  
 Mr. W. P. Packard, Senior Lecturer in Geography at the University of Canterbury, to the new position of Warden of the Hall of Residence.  
 Dr. J. H. Bradbury, Senior Research Officer, C.S.I.R.O., to a new senior lectureship in Chemistry.  
 Dr. L. J. Hume, Acting Assistant Director of the Bureau of Agricultural Economics, Canberra, to a new post of Senior Lecturer in Political Science.  
 Mr. K. L. McKay, Lecturer in Classics, University of Canterbury to a new senior lectureship in Classics.

- Dr. A. J. Mortlock, Senior Scientific Officer at Harwell, to a new senior lectureship in Physics.  
 Dr. D. M. Paton, Senior Lecturer in Botany at the University of Tasmania, to a new post of Senior Lecturer in Botany.  
 Mr. Soebardi, Senior Lecturer in Islamology at the University of Padjadjaran, Bandung, to a new senior lectureship in Indonesian.

Promotions made during 1960 were—

- Mr. O. H. B. van der Sprenkel, Senior Lecturer in Oriental Civilization, to Associate Professor from 1st January, 1960.  
 Dr. T. H. R. Rigby, Senior Lecturer in Russian, to Associate Professor from January, 1961.  
 Dr. K. V. Sinclair, Lecturer in French, to Senior Lecturer from January, 1961.

#### SENIOR STAFF RESIGNATIONS.

*Institute of Advanced Studies.*—There were no resignations among the senior academic staff but the Librarian, Mr. A. L. G. McDonald, resigned owing to ill health. Six Research Fellows left the University at the end of their appointment: Dr. Salter and Dr. Howes joined the Commonwealth Public Service, Dr. Wright won a University Travelling Scholarship, Dr. Burley became a Lecturer in the Faculty of Commerce and Social Science at the University of Birmingham, and Miss Drus is now a Lecturer in History in the University of Hull. Mrs. Wright left the University to get married.

#### *School of General Studies*—

- Professor F. V. Atkinson, Professor in Mathematics, to an appointment as Professor in Department of Mathematics, University of Toronto.  
 Professor J. G. Fleming, Robert Garran Professor of Law, to a professorship in Law at the University of California, Berkeley.  
 Mr. G. Hughes, resigned from Lectureship in German, January, 1960, in order to accept position with Union Repertory Theatre in Melbourne.  
 Miss Helga Gaertner, Temporary Lecturer in German (appointed February), resigned in June, 1960 on her marriage.

#### STUDY LEAVE.

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

#### *Institute of Advanced Studies*—

- Professor Sir Keith Hancock, Director, Research School of Social Sciences,  
 Professor Sir Mark Oliphant, Director, Research School of Physical Sciences,  
 Professor Sir John Eccles, Professor of Physiology,  
 Professor A. Albert, Professor of Medical Chemistry,  
 Professor W. D. Borrie, Professor of Demography,  
 Professor K. J. Le Couteur, Professor of Theoretical Physics,  
 Professor J. W. Davidson, Acting Director, Research School of Pacific Studies,  
 Professor J. A. Passmore, Professor of Philosophy,  
 Professor O. H. K. Spate, Professor of Geography,  
 Professor P. A. Moran, Professor of Statistics,  
 Dr. G. B. Mackaness, Reader in Experimental Pathology,  
 Mr. R. S. Parker, Reader in Political Science,  
 Dr. M. S. Paterson, Reader in Geophysics,  
 Mr. J. W. Blamey, Senior Research Engineer (Senior Fellow) in Particle Physics,  
 Dr. S. J. Stoljar, Senior Fellow in Law.  
 Mr. W. K. Whitten, Veterinary Officer,  
 Dr. H. J. Cairns, Senior Fellow in Microbiology.  
 Dr. F. C. Barker, Fellow in Theoretical Physics.

#### *School of General Studies*—

- Professor H. W. Arndt, Professor of Economics.  
 Professor K. E. M. Baier, Professor of Philosophy.  
 Professor E. J. Hannan, Professor of Statistics.  
 Associate Professor K. C. Masterman, Head of the Department of Classics.  
 Dr. S. Encel, Senior Lecturer in Political Science.  
 Dr. K. V. Sinclair, Lecturer in French.

#### JOHN CURTIN SCHOOL OF MEDICAL RESEARCH.

In the Department of Biochemistry the research programme has continued along lines which have been developed over the last few years. Of fundamental interest has been the extension of the work connected with the finding of D-serine in animal tissue, kinetic studies of enzymes which fall into the group of phosphoryltransferases, amino-acid metabolism, protein synthesis and folic acid metabolism. A number of new and interesting enzymes have been discovered and the importance of a new pathway for glycine and threonine catabolism has been confirmed. The acquisition of excellent technical facilities

for work with tritium and the counting of low activity radio-carbon samples has been of great value in all these fields. Much of the work has been done with bacteria and lower animals and its extension, in the future, to the higher animals will be awaited with interest.

The Biological Inorganic Chemistry Unit has completed, in conjunction with the Departments of Physiology and Bacteriology of the University of Melbourne, detailed screening tests on a number of anti-bacterial metal complexes. Clinical trials on four selected complexes are in progress in three Melbourne hospitals.

The Department of Experimental Pathology has continued investigations in two general fields of research, the transport and metabolism of lipids and immunology. The work on lipids is related to the aetiology of atherosclerosis and of liver disease, to the formation of milk in the lactating mammary gland and to ruminant digestion. Studies in immunology include the antibacterial defence mechanisms in diseases in which immunity does not appear to depend upon serum antibodies, and the mechanisms concerned in cellular discrimination between indigenous and foreign matter.

Much of the work of the Department of Medical Chemistry revolved around outstanding problems in the chemistry of biologically-active heterocyclic substances. These problems were tackled by electrochemistry, by spectroscopy, and by synthesis and led to useful discoveries in the pteridine, pyrimidine, quinazoline and pyridine series. Studies of the binding constants of biologically important metals have led to results of interest to biochemists.

Investigations in the Department of Microbiology on myxomatosis, which have been an important part of the work of the department for the last decade, have now been concluded. Studies of genetic interaction between pox-viruses have given conclusive evidence of recombination, and a novel sort of reactivation of heat-killed virus is being investigated.

Fluorescent antibody staining and autoradiography are two techniques which have been usefully applied to studies in the pathogenesis of poxvirus infections, both at the cellular level and in intact animals.

Experiments with influenza virus and specific immune serum have led to the formulation of a new method of expressing the neutralizing potency of antisera, which promises to have wide practical applications.

Chemical and Biological studies of salivary gland mucoprotein, which is an inhibitor of influenza virus haemagglutination have led to a detailed definition of the relations between the chemical structure and biological function of this mucoprotein.

The Department of Physical Biochemistry has grown in staff (Professor Ogston, Drs. Armstrong and Preston, Mr. Davies, Miss Atkinson) and in equipment in the course of the year. The main lines of research have been in the physical biochemistry of proteins and of substances related to connective tissue. There has been theoretical and experimental collaboration with members of several other departments. A course of lectures on the physical biochemistry of proteins was given.

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.
- (v) The transmission mechanism at the neuro-muscular junction.
- (vi) Synaptic excitatory and inhibitory transmitters in the central nervous system.
- (vii) Biophysics of muscular contraction.
- (viii) The effect of temperature changes on the hormonal control of water and salt metabolism.
- (ix) The action of metabolic poisons on the electrical activity of the heart.
- (x) The hormonal secretion from adrenal glands.

#### RESEARCH SCHOOL OF PHYSICAL SCIENCES.

In the Department of Astronomy the major event of 1960 was the completion of the first stage of the Coudé Spectrograph and the photographing of the spectrum of Canopus with this instrument attached to the 74-in. reflector. Good progress is being made with the site-testing programme for a Field Station for Mount Stromlo Observatory and much good work has been done already at the Mount Bingar Field Station near Griffith, New South Wales. Results of significance in relation to the problems of star birth and evolution have come from colour-magnitude studies of stars in the Magellanic Clouds and studies bearing on the spiral structure of the Milky Way System have been continued. Spectrographic studies have led to the discovery of several stars of unusual chemical composition. Comparative studies of gaseous nebulae in the Milky Way System and the Magellanic Clouds have shown that the composition of the interstellar gas in the Milky Way System and that in the Magellanic Clouds are very similar. New instrumentation of the National Time Service has been placed into regular operational use, and the I.B.M. 610 Computer is assisting the Observatory's Staff significantly in the reduction and analysis of great masses of observational data.

Towards the end of 1959 the former Department of Radiochemistry was absorbed into the Department of Geophysics in order to make a greatly intensified attack on the problem of measuring the ages of Australian rocks. A Reynolds type mass-spectrometer has been purchased for potassium-argon dating and a survey of stratigraphically well-dated rocks by this method is already almost complete. It is hoped to begin dating by the Rubidium-Strontium method shortly. An Australia-wide survey of rock ages will be made in collaboration with the Bureau of Mineral Resources. In connection with this work the activities of the Department in Geochemistry have been greatly expanded. Work on petrology, meteorites, heat flow, palaeomagnetism, seismology, deformation of rocks and minerals at high pressures and the study of phase equilibria at high pressures continues.

By the end of the year the major components of the tandem accelerator in the Department of Nuclear Physics were erected. The first beam is expected from the machine by Easter, 1961. In the research field a minute trace of the man-made element Californium-252 was used to establish the first examples of spontaneous ternary and quaternary fission.

In the Department of Particle Physics work has been concentrated on the completion and testing of the homopolar generator, following the troubles experienced with the bearings at the end of 1959. Various modifications were introduced and testing continued. Many hours of satisfactory running were obtained but failure in the small guide bearing caused testing to be temporarily held up. Modifications to the small guide bearing have now been made and the assembly prior to the carrying out of the electrical tests is now proceeding.

In the field of plasma physics into which research was begun in 1959, the year has been largely one of construction and assembly with experimental work restricted to initial tests and measurements.

The Department of Theoretical Physics has continued work on theoretical aspects of nuclear physics and high temperature plasmas and commenced some work on related problems of astrophysics. An agreement has been entered into with I.B.M. (Australia) to rent an I.B.M. 1620 Computer from August 1961.

#### RESEARCH SCHOOL OF SOCIAL SCIENCES.

As in previous years, the Department of Demography devoted a considerable part of its attention to further studies of immigration, including studies both of an historical and contemporary character.

The two other major interests of the Department were the structure of the Australian population and investigations of population trends in the Pacific Islands and South East Asia.

One book was published, a second reached the proof stage and a third manuscript for a major book was completed.

The Department of Economics' central interest is in processes of economic growth and fluctuation. Research work is carried on within three sections of the Department. In economic statistics work continued on problems of social accounting, economic forecasting and population analysis. Research in economics continued in the theory of international trade and theoretical and statistical analysis of consumer demand; theoretical models of capital accumulation and economic growth; the Australian capital market and industrial trends; studies of productivity, investment and the work force; and studies of technical change in Australian agriculture. 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 work of the History Department in Australian and British Commonwealth History has continued on the lines reported in the last two years.

Work on the Australian Dictionary of Biography has moved forward. A National Committee, representing the State universities was set up. The Melbourne University Press has been appointed to publish the Dictionary. Separate editorship of the first two volumes have been agreed upon; Mr. M. H. Ellis will edit Volume I., 1788-1825; Professor C. M. H. Clark Volume II., 1826-1850. Provisional editors, reflecting State interests, have commenced work on the period 1851-1890.

The work of the Department of Law has continued on the lines reported last year, namely the study of the constitutional and legislative history of the Commonwealth. Some special work was done, arising out of the papers of the late Mr. Justice Kriewaldt, on judgments and statistical studies relating to the absorption of the Northern Territory aboriginal community into the legal system of the white man. Members of the Department were concerned with the study of the law of agency and with the scope of the trade and commerce power in the Australian and United States Constitutions. The Department was expanded by the appointment of a research assistant, and steps were taken to appoint an additional senior fellow and a research fellow, as a result of which appointments to these positions are likely to be made in 1961.

The Political Science Department continued its work on elections and political parties and on the political aspects of trade unionism. In public administration the main concentration was on public corporations and the historical development of the Australian Public Service.

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. Advice on statistical analysis was given to other departments.

## RESEARCH SCHOOL OF PACIFIC STUDIES.

Field work in Social Anthropology and Sociology continued in Sumatra, Sarawak, North Borneo, West New Guinea, the Territory of Papua and New Guinea, and in the New Hebrides, as well as in the Torres Strait Islands and among aborigines and part-aborigines in the Northern Territory and Victoria. Linguistic research was carried out in Queensland.

The Department of Economics has been in process of formation during the year. The Department is primarily concerned with the problems of economic growth in the underdeveloped countries of South East Asia and the Pacific, and with economic relations between Australia and the countries of that region. Research is being undertaken into development problems in New Britain, the Malaya-Borneo region, Australian Trade Relations, and the special problems of development in multi-racial societies. With the arrival of additional staff in 1961, the scope and range of research is expected to be widened, and particular attention will be paid to the territories of New Guinea and Papua.

The Department of Far Eastern History, in which the study of the history of China has by now become firmly established, has taken an important step towards the development of Japanese historical research along similar lines through the appointment of two new staff members, who between them are able to contribute to our knowledge of the development of Japanese cultural and social institutions from the Tokugawa period until the present day.

The interests of the Department of Geography are about equally divided regionally between the Australian continent, from the tropical north to Tasmania, and the Pacific Islands, especially New Guinea but ranging east as far as Fiji and Samoa. Within these areas, most of the research has lain in the fields of social and economic geography but the Department is also concerned with problems of political and historical geography. On the side of physical geography attention has been devoted mainly to geomorphological studies within Australia, but a start has been made on field work in New Guinea, and the recent appointment of a Reader in Biogeography initiates what it is hoped will be a major and unusual development. The growing map collections in the Department is always available to students of other disciplines in the University and it is also the policy of the Department to render cartographic assistance to the greatest extent possible.

The international relations group in the former combined Department of Political Science and International Relations transferred at the beginning of 1960 from the School of Social Sciences to that of Pacific Studies. Mr. A. L. Burns was Acting Head. The Department has published studies in South East Asian international politics, in the foreign relations of Communist China, India, Japan, Malaya and Australia, in weapons technology, arms control and the theory and methodology of international relations. A file of more than a dozen English-language Asian newspapers is being catalogued.

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.

## THE SCHOOL OF GENERAL STUDIES.

*Faculty of Arts.*

*General Remarks.*—Association of the Canberra University College with the Australian National University this year left the constitution and membership of the Faculty practically unchanged, and the same is true of its powers and functions as defined in the Faculties Statute of the new University. Professor Hope was re-elected Dean and Dr. R. F. Brissenden continued as Sub-Dean. Faculty decided not to avail itself for the time being of the right conferred by the Statute to nominate persons to the number of three other than those specified as members of the Faculty. A good deal of the business of Faculty during the year was occupied by the revision of rules, the preparation of new courses and syllabuses in preparation for the separation from Melbourne, and by discussion of problems raising questions of precedent and procedure. As a result of this the Faculty is now established on sound working lines though there are still a number of problems to be considered and resolved. Great thanks are due to the members of the administrative staff who helped to make this possible. The Haydon-Allen Building, named to commemorate the service of Dr. L. H. Allen and Mr. J. F. M. Haydon in the Canberra University College, was opened by His Excellency the late Governor-General of the Commonwealth in September and provided accommodation for the departments of Classics, English, History, Modern Languages and Philosophy, with temporary quarters for the Department of Mathematics.

*Staff and Teaching.*—Full-time staff of the nine departments of the Faculty in 1960 was 55 and part-time staff, including tutors, was 13 giving a total of 68. Taking into account that the nine departments include fourteen separate disciplines (Classics 2, Modern Languages 3, and Oriental Studies 3) this given an average of less than five teachers for each discipline and, excluding part-time teachers, research assistants and demonstrators (18), of less than four full-time teachers for each discipline. This is clearly inadequate to maintain proper university standards of teaching and research for full pass courses, honours courses now in most cases extending to third or fourth years, in addition to the supervision of post-graduate students for masters' and doctors' degrees. Faculty is in particular need of specialist staff for the building up of the strong honours schools on which its standing as a university must depend.

The period following amalgamation witnessed a move for departments with matching departments in the Institute of Advanced Studies to make informal arrangements for co-operation in the field of post-graduate teaching and supervision. This is an excellent trend but it raises a problem for those departments, notably English, Modern Languages and Psychology, who lack this advantage of being able to call on the resources of advanced specialists and research scholars in their fields, and there is a special need to provide more specialist teachers in these departments.

*Enrolments.*—Student enrolments showed a sharp increase in 1960 and considerably exceeded predictions, and this increase is expected to continue. There has been a general rise in the quality of students as well. This is all to the good as experience shows that an honours school does not function satisfactorily unless groups are above a size which no department of the Arts Faculty has yet reached.

The figures supplied by the heads of departments in their individual reports suggest that there is a quite undue 'wastage', particularly in first year, of students who enrol and fail to complete the year.

A survey by Mr. Rose of the distribution of enrolments by subjects has showed that the removal of the restrictions on the free choice of subjects for an Arts degree, imposed by the University of Melbourne, and of the requirements that all students should take a language and a science, has not resulted in narrowness or imbalance of course structure as some feared when the restrictions were removed. That this is so is due largely to the student advisers who take care to discourage the average students from courses too narrowly confined to one range of disciplines, but encourage the student to think about his choice of subjects and to be responsible for his own choice. At the same time the new system allows students to concentrate on a narrower field where special circumstances make this advisable.

The larger time required for student advising in Arts, the rise in the number of enrolments and the large numbers of changes in courses required at the end of the first year under the open choice system, has proved a severe strain on the time and stamina of the Sub-Dean. In future it is proposed to appoint an assistant for this work over the enrolment period and, if possible, one who would take on the work of Sub-Dean in a subsequent year.

The Library is well-enough equipped for the present pass courses, but very inadequate, particularly in the humanities, in books and material for honours and research work. This is an urgent problem at the moment as honours schools begin to be built up. A capital grant for the building up of Arts research material is needed. It is as fully justified as the capital grants for equipment which in Science faculties are taken as a matter of course. Without it honours schools will deteriorate, advanced scholarship become impossible, and good staff become harder to recruit.

#### *Faculty of Economics.*

The staff of the Department of Economics was increased with the arrival in August of Dr. G. M. Neutze and Dr. K. Sloane. The work of the Department has increased rapidly with the provision (from 1961) of a four-year honours course, the extension of duplication of lectures for day students to cover the complete economics major and the rapid growth in student numbers. Enrolments in the first two years of the economics major rose from 65 in 1957 to 276 in 1960. In August the Department organized a seminar on "Teaching and Research in Industrial Relations" which was attended by lecturers from seven universities. Professor Arndt continued his research on aspects of the Australian capital market and Professor Cameron was engaged on inter-industry analysis. Mr. Rose continued research on Australia's population geography, Dr. Hieser was engaged in work on economic dynamics and the steel industry, Mr. Head was working in the field of public finance. On Professor Arndt's departure for Geneva on sabbatical leave the Department was greatly assisted by Professor Swan (of the Institute of Advanced Studies) in delivering lectures and examining.

In the Department of Statistics Professor Hannan returned from study leave in June. Enrolments rose sharply to 114 in the first year of the statistics sub-major. Professor Hannan was engaged in research on the general theory of canonical correlation and on various aspects of time series and seasonal variation. Dr. Leser continued his work on demand functions and on methods of trend construction. Professor Hannan participated in a seminar in August conducted by the Commonwealth Bureau of Meteorology.

In the Department of Economic History student numbers were temporarily held down in 1960 by re-arrangement of courses consequent on separation from the University of Melbourne. Dr. Forster was engaged in research on industrial growth in Australia.

#### *Faculty of Law.*

The Faculty of Law was concerned with the teaching and examining in a wide range of subjects for fifty-eight students. The new four-year course for the degree of Bachelor of Laws of the Australian National University came into operation. Arrangements have been made with the Council of Legal Education in Victoria whereby a Bachelor of Laws of the Australian National University can be admitted to practise in Victoria on the same terms as a Bachelor of Laws of the University of Melbourne. These arrangements preserve the professional outlet which was available to Melbourne graduates who studied in the former Canberra University College. It is hoped that admission rights in respect of New South Wales will be obtained and steps have been taken to seek these rights.

The full-time teachers of the Faculty were also engaged in research on a number of legal topics. Professor Ford began a study of the law of succession in Australia and continued a study of Australian taxation law. Mr. Tarlo began preparation of a textbook on the law of real property in collaboration with two law teachers of the University of Melbourne, and also began a study of the law of restitution in Australia. Dr. Biggs revised the manuscript for a book on annulment of marriage and investigated the question of establishment of family courts in Australia.

#### *Faculty of Science.*

The Science Faculty has passed through a turbulent year dealing successively with problems brought on by increased student numbers, budget restrictions and shortage of accommodation. The number of student enrolments for first and second year Science courses far exceeded the most optimistic predictions made last year and at one stage it appeared that it would be impossible to present third year classes in 1961. There was also a strong possibility that student enrolments for first and second year Science would have to be restricted.

Acceptance in principle by the Commonwealth Government of the Report of the Australian Universities Commission led to the provision of additional financial support for the development of the Faculty. The problem of acquiring additional space for the rapidly expanding student numbers has taxed the ingenuity and patience of the staff and the administration to the full. Accommodation problems have been accentuated by the delay in the completion of the Physics building which is also to house temporarily the Departments of Geology and Psychology.

Although the Department of Physics will be able to occupy part of the building in time for commencement of the 1961 academic year, the space to be occupied by the Departments of Geology and Psychology will not now be completed until the second term of 1961. Additional space will also be required for the Department of Mathematics which is temporarily housed in the Haydon-Allen Building. Regarding the other Science buildings, tenders are shortly to be called for the Department of Chemistry and the Departments of Geology and Zoology are in the design stage. All these buildings are included in the recommendations of the Universities Commission for the 1961-63 triennium.

In 1961, the Department of Chemistry will occupy the areas vacated by the Physics Department and later those vacated by the Geology Department. Additional temporary accommodation for the Department of Zoology will also be provided by the erection of a wooden hut adjacent to the present building and by the use of areas vacated by the United States Educational Foundation. The Faculty is grateful to the various sections of the University, particularly to the Maintenance Section, for assistance in overcoming some of the urgent accommodation problems which arose in 1960 and but for which it would have been necessary to impose quotas of enrolment in first year science units.

A number of new staff appointments have been made as mentioned earlier in this report. It is worthwhile noting that in attracting staff to the University, two questions dominate those raised by prospective candidates—(a) provision of research facilities; (b) housing for their families. Appointments of staff of calibre in the future will depend very much to what extent these problems can be adequately solved by the University.

In all Departments, staff and post-graduate research has proceeded actively and although delays in the arrival of equipment and acute shortage of space have inevitably held up some developments, a substantial number of research programmes is now in progress in all Departments. The number of post-graduate workers is expected to increase substantially in 1961.

#### *Department of Adult Education.*

In 1960 the adult education programme was expanded to include seventeen courses in Canberra with a total enrolment of 381, and three courses in the Southern Tablelands region, two of which were held at Queanbeyan and one at Cooma. The regional enrolments were 40. There were courses in languages (French, German, Italian, Dutch, Philosophical Greek), nuclear physics, sociology, international affairs, child development, music and drama. Professor B. J. Bok delivered a very successful extension lecture at Cooma to an audience of 194, and Professor Asa Briggs (who is President of the Workers' Educational Association in Great Britain) visited W.E.A. groups at Cooma and Island Bend. There is now sufficient interest in adult education in Canberra and the surrounding regions to warrant a continuing expansion of the adult education programme.

#### FINANCIAL.

Statements of Accounts of the University for 1960 form the final section of this report.

This year the statements of accounts are in two parts—

- (a) for the University other than the School of General Studies, for the year ended 31st December 1960, and
- (b) for the School of General Studies, formerly the Canberra University College, from 30th September, 1960, to 31st December, 1960.

The Australian Universities Commission in its report of October, 1960, recommended the following grants for the University in the triennium 1961-63:—

					£m.
Grant for Recurrent Expenses—1961	..	..	..	..	2.800
					3.100
					3.350
					<hr/> 9.250
Grants for Building Projects—1961-63	..	..	..	..	3.902
Furnishings—1961-63	..	..	..	..	.187
Capital Equipment—1961-63	..	..	..	..	1.067
					<hr/> 14.406

Special Purpose Grants and Bequests to the University during 1960 were as follows:—

Donor.	Purpose.	Amount.
Rockefeller Foundation .. .. .	Expenses in connexion with Rockefeller Foundation Fellowship Holders	£A. 1,112
United States of America National Institute of Health	Research in Microbiology .. .. .	1,847
United States of America Office of Naval Research	Research in Microbiology .. .. .	221
National Health and Medical Research Council ..	Research in Astronomy .. .. .	834
C.S.I.R.O. .. .. .	Research in Microbiology and Biological Inorganic Chemistry	2,970
Wool Research Committee .. .. .	Research in Biological Inorganic Chemistry ..	3,223
	Sheep and Wool Research—	
	Department of Microbiology .. .. .	2,759
	Department of Physiology .. .. .	3,875
Rural Credits Development Fund of the Reserve Bank of Australia	Department of Physiology .. .. .	2,980
Metropolitan Water Board and Snowy Mountains Hydro-Electric Authority	Seismic Research in Geophysics .. .. .	2,000
Department of Immigration .. .. .	Research into British Migration .. .. .	730
Goldsbrough-Mort & Co. Ltd. .. .. .	History of the Wool Industry .. .. .	250
Anonymous .. .. .	Australian Dictionary of Biography .. .. .	1,500
The Hunter Douglas Foundation .. .. .	Research by the Research School of Pacific Studies ..	1,500
Broken Hill Pty. Ltd. .. .. .	National Income Research Project .. .. .	200
British Solomon Island Protectorate .. .. .	Census Analysis .. .. .	300
General Motors—Holden's Ltd. .. .. .	Scholarships .. .. .	6,000
Anonymous .. .. .	Vice-Chancellor's Discretionary Fund .. .. .	2,000
Anonymous .. .. .	Vice-Chancellor's Discretionary Fund .. .. .	500
Australian Institute of Nuclear Science .. .. .	Scholarships .. .. .	1,552
Commonwealth Office of Education .. .. .	Post-Graduate Scholarships .. .. .	9,050

Details of grants for research in the School of General Studies, received in 1960, are as follows:—

Donor.	Purpose.	Amount.
Commonwealth Bank of Australia .. .. .	For research in the Department of Economics ..	£A. 750
Social Sciences Research Council of Australia ..	For research in the Department of Psychology ..	150
National Capital Development Commission ..	For lake biology research by Departments of Botany and Zoology	400

#### VISITING RESEARCH WORKERS AND VISITORS.

A list of such visitors during 1960 is given overleaf.

#### STATISTICS.

The statistical tables furnished to the Commonwealth in respect of the University operative in 1960 are given on pages 86-91.

#### 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:—

- Dr. J. W. Cornforth, National Institute of Medical Research, London.  
 Professor J. Evenden, University of California.  
 Dr. G. E. Kron, Lick Observatory.  
 Dr. K. Kumar, Tata Institute, Bombay.  
 Dr. W. M. Deuchars, Atomic Weapons Research Establishment, England.  
 Dr. Tord Elvius, Uppsala University.  
 Dr. J. C. Burns, Victoria University of Wellington.  
 Professor Asa Briggs, University of Leeds.  
 Professor L. H. Aller, University of Michigan.  
 Miss Ann Savours, Scott Polar Institute, Cambridge.  
 Professor S. Bashkin, State University of Iowa.  
 Dr. C. Goodwin, Duke University.  
 Dr. N. F. Hush, University of Bristol.  
 Dr. C. Hartley Grattan, United States of America.  
 Professor D. Oliver, University of Harvard.  
 Dr. R. van der Borgh, University of Natal.  
 Dr. J. R. Williams, University of West Virginia.  
 Dr. C. C. B. Bull, Victoria University of Wellington.  
 Dr. Cherry Gertzel, University College of East Africa.  
 Associate Professor R. D. Russell, University of British Columbia.  
 Dr. P. Erdős, Haifa.  
 Professor H. M. Gluckman, University of Manchester.

## VISITORS.

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

- Their Excellencies The Late Governor-General and Viscountess Dunrossil.  
 His Excellency The Governor of Victoria and Lady Brooks.

Among other overseas visitors to the university were—

- The Hon. Sir David Smith, Chancellor of the University of New Zealand.  
 Professor Sir Alexander and Lady Todd, University of Cambridge.  
 Sir Lawrence Bragg, Royal Institution, London, and Lady Bragg.  
 Professor A. K. McIntyre, University of Otago.  
 Professor D. H. Wilkinson, University of Oxford.  
 Mr. L. B. Glick, University of Pennsylvania.  
 Mr. H. Fail, University of Durham, England.  
 Professor B. H. Beckhart, Columbia University, New York.  
 Professor M. M. Beckhart, Vassar College.  
 His Highness The Sultan of Pahang.  
 Sir Clough and Lady Thuraisingham, Malaya.  
 Professor W. R. Niblett, University of London.  
 Professor L. Rosenfeld, Copenhagen.  
 Professor R. H. Dalitz, University of Chicago.  
 Mr. Pillai, Commissioner of Prisons, Ceylon.  
 Lord and Lady Tweedsmuir.  
 Professor S. S. Spivack, Columbia University, New York.  
 Professor Theodore Sizer, Yale.  
 Dr. J. R. Killian, Chairman, M.I.T.  
 Mr. Cobbold, Governor of the Bank of England.  
 Mr. T. H. Carroll, Ford Foundation.  
 Mr. W. O. Broad, University of New Zealand.  
 Professor J. H. Franklin, Brooklyn College.  
 Dr. P. F. R. Venables, Principal, College of Technology, Birmingham.  
 Dr. Rankl, Guest Conductor, Elizabethan Theatre Trust, and Mrs. Rankl.  
 Dr. P. D. Shukla, New Delhi.  
 Professor H. A. Simon, Carnegie Institute of Technology, Pittsburgh.  
 Professor Bearman, Mount Wilson and Palomar Observatory.  
 Mr. H. Drake, Institute of Advanced Legal Studies, London.

## THE JOHN CURTIN SCHOOL OF MEDICAL RESEARCH.

## DEAN'S REMARKS.

A significant addition to the academic structure of the Institute of Advanced Studies was made by Council towards the close of the present year by the approval of Personal Professorships. Reference to these positions is made elsewhere in the Annual Report but it is extremely satisfying to note that two members of this School—Dr. F. P. Dwyer, Reader in Biological Inorganic Chemistry, and Dr. S. Fazekas de St. Groth, Reader in Virology—have been elected to the first two of these posts. The appointments will be taken up on 1st January, 1961.

As a result of a decision by the United States Public Health Service to extend its post-doctoral fellowship plan, a "limited number of fellowships to highly qualified scientists" has been awarded to research workers resident outside the U.S. Only four such fellowships have been awarded to Australians since this decision was made in 1958 and each of these has gone to a member of this School—awards in 1959 were made to Drs. Mackaness and Joklik from the Departments of Experimental Pathology and Microbiology, respectively. In 1960 Dr. Cairns of the Department of Microbiology and Dr. Morrison of the Department of Biochemistry were awarded similar fellowships.

In the previous report and under this heading mention was made of an animal breeding annexe which it was hoped may have been commenced during the current year. The amalgamation of the Australian National University with the Canberra University College, and the projected development of additional biological departments on the campus, indicated the desirability of some revision of the earlier plan to permit the supply of experimental animals to departments other than those in this School. The new design will allow of all necessary expansions for the future and capital moneys for this and a small radioactive isotopes laboratory have been approved by the Australian Universities Commission. It is likely that a start will be made on the first stage of the annexe in the forthcoming year.

## DEPARTMENT OF BIOCHEMISTRY.

*Staff.*

Professor	..	..	..	..	A. H. Ennor, D.Sc., F.A.A.
Senior Fellow	..	..	..	..	W. H. Elliott, M.A., Ph.D.
Fellows	..	..	..	..	R. L. Blakley, M.Sc., Ph.D.; J. F. Morrison, M.Sc., D.Phil.; H. Rosenberg, B.Sc., Ph.D.
Research Fellow	..	..	..	..	D. I. Magrath, M.Sc., Ph.D.
Head Technician	..	..	..	..	R. Adams.

*Student and Teaching Activities.*

There are ten students, all of whom propose proceeding to a Ph.D. degree: M. D. Doherty, B.Sc. (commenced 21st October, 1957), I. M. Beatty, B.Sc. (commenced 4th March, 1958) and T. J. Gaffney, M.B., B.S. (commenced 9th February, 1959), who are engaged on research into the biochemistry and chemistry of the substituted guanidines; B. McDougall, M.Sc. (commenced 3rd March, 1958) and B. V. Rama Sastri, B.Sc. (commenced 19th September, 1960), who are working on studies concerned with folic acid; 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; Sadako Sugai, M.Sc. (commenced 19th September, 1960), who is working on amino acid activation; Margaret Green, B.Sc. (commenced 19th October, 1960), who is working on amino acid metabolism, and W. J. O'Sullivan, B.Sc. (commenced 15th February, 1960), who is engaged in kinetic studies on metal activation of enzymes.

Miss A. M. Morgan, A.B., M.A., a Fulbright scholar, completed twelve months' work in the Department in July and left Australia to take up a position as lecturer at Smith College, Massachusetts, U.S.A.

V. Whittaker, M.B., B.S. (commenced 4th March, 1957) completed his thesis and took up a post-doctoral appointment in the Department of Biochemistry, University of California, Berkeley, in June.

Departmental seminars and regular meetings of the journal club have continued as in former years and have been arranged by the students.

*Research Programme.*

Reference has been made in the last two annual reports to the work concerned with lombricine, a compound of more than usual interest, not only because of its chemical structure, but also because of the fact that it contains serine as the D-enantiomorph. Work on this compound has continued—part has been concerned with its chemical synthesis and that of its N-phosphoryl derivative, and part

with the more biochemical aspects of both compounds. D-, L- and DL-lombricine have now been synthesized (Magrath, Beatty) by guanidination of the corresponding serine ethanolamine phosphodiester (SEP), which have also been prepared synthetically. The guanidination reaction proceeds with good yield of the product but the yield of SEP is lower. Alternative synthetic routes are being explored. N-phosphoryllombricine has been prepared (Magrath, Beatty, Ennor) by reacting N-phosphoryl-O-methylurea with D-SEP and has been shown to be identical with the product obtained by direct phosphorylation of lombricine with phosphoryl chloride. The synthetic product has not as yet been shown to be identical with the naturally occurring compound which has, at the time of writing, defied attempts at isolation as a pure compound. However, yields approaching 100 per cent. of that present in earthworm muscle have been obtained with a purity of over 95 per cent. (Ennor, Rosenberg). It is anticipated that the pure compound will soon be obtained.

The finding of D-serine in lombricine and SEP suggested that D-serine may be present in the free amino-acid pool in earthworm tissue. D-serine has been isolated (Ennor, Rosenberg) from the free amino-acid pool in amounts which suggest that 25 per cent. of the free serine is of the D-configuration. Extreme care has been taken to avoid racemization of L-serine during the isolation process and there can be no doubt that the D-isomer arises as a result of a biological reaction. It is, however, uncertain whether this reaction is a direct synthesis, a racemization involving L-serine, or a breakdown of D-SEP or lombricine. Experiments designed to determine this point are in progress (Ennor, Rosenberg).

Attempts to isolate and study the transamidinase enzyme responsible for the conversion of SEP to lombricine have failed because of the close similarity in properties between this enzyme and arginase, which is plentiful in earthworms. Lombricine phosphoryltransferase, the enzyme responsible for catalysing the reversible reaction between lombricine and adenosine-triphosphate, has been considerably purified and its properties are being studied (Gaffney).

Investigations concerned with the composition of earthworm ribonucleic acid have continued but at low priority because of pressure of other problems. Considerable amounts have now been accumulated and will be degraded to permit complete characterization of the constituent nucleosides (Magrath).

Considerable work has been done on the distribution of SEP in the animal world (Morgan, Rosenberg, Ennor). It is now clear that the two isomers exist; L-SEP appears to be confined exclusively to reptiles, amphibians, birds and fishes and though its function is at present unknown its distribution suggests that it may be of some evolutionary significance. D-SEP has been found only in the earthworm and while it may have some other function, it is certainly the precursor of lombricine.

Studies (Morrison, Doherty) involving N-phosphorylcreatine (PC) have been referred to in the previous report. The reactions involved have proved difficult to unravel but it is now clear that the claims by other workers with respect to the transfer of a phosphoryl group from 1,3-diphosphoglyceric acid to creatine to form PC in rabbit muscle extracts are incorrect. The reaction occurs only in the presence of adenine nucleotides, and is the result of a number of well established glycolytic reactions in addition to that catalysed by creatine phosphoryltransferase. The reaction also occurs in the presence of DPN or DPNH<sub>2</sub> and in this case is due to their non-enzymic conversion to, or contamination by, ADP-ribose, which is then enzymically converted to AMP. This latter compound is then converted to ADP or ATP in the presence of a phosphoryl group donor—the reaction is catalysed by crystalline preparations of myokinase plus creatine phosphoryltransferase which latter was found to be contaminated by ATP firmly bound to the protein. During the course of this work the presence of a hitherto unrecognized enzyme, ADP-ribose pyrophosphatase, has been established—its properties are being investigated.

Reference has previously been made to a theory (Ennor, Morrison) advanced to explain the role of divalent metal ions in the activation of enzymes which catalyse phosphoryl group transfer reactions. A general kinetic approach to the problem has now been made (Morrison, O'Sullivan). Essentially the problem was to determine the manner in which the enzyme-Mg-ADP complex may be formed from its three constituent parts. The stability constants were determined and a velocity equation was derived in terms of the relevant dissociation constants and concentrations of Mg<sup>2+</sup> and ADP<sup>3-</sup>. The kinetic data are consistent with the active complex being formed by all of the possible pathways. The magnitude of the values for the dissociation constants of the enzyme-ADP and enzyme-Mg complexes indicates that independent binding of Mg<sup>2+</sup> and ADP<sup>3-</sup> occurs, and that the presence of Mg<sup>2+</sup> on the enzyme surface has no marked effect on the binding of ADP<sup>3-</sup> and vice versa.

The work on aminoacetone metabolism has continued (Elliott, Green). A new soluble enzyme has been obtained from sonically disrupted *Staph. aureus* and this catalyses the conversion of threonine to aminoacetone. The enzyme appears to be widely distributed among micro-organisms. The reaction is completely specific for DPN. The system has a sharp pH optimum and has unusual properties particularly with respect to its cation requirement. The characteristics and distribution of the enzyme are being studied as part of the programme of work on glycine and threonine metabolism. Such work is designed to prove the existence in mammalian tissue of the metabolic cycle referred to earlier (1958, 1959) but before this can be done exploratory work on comparatively simple systems in which parts at least of the cycle are known to be operative is being carried out.

In continuance of the study of the synthesis of  $\alpha$ -amylase by *B. subtilis* (Elliott, Coleman) it has been found that formation of the enzyme is dependent on the presence of ferric ions in the medium. At the cell-free level, studies on amino-acid activation by different preparations of *B. subtilis* have been made.

A new method of measuring amino-acid activation has been evolved. This depends on the separation, on a carboxylic acid resin, of amino-acyl hydroxamates from all other hydroxamates and enables determination of the level of amino-acid activation irrespective of the level of endogenous substrates. A chromatographic procedure for separating amino-acid hydroxamates on paper offers the possibility of detecting the simultaneous activation of different amino-acids present together in a mixture. These experimental methods are now being applied to *B. subtilis* extracts in an investigation of cell-free protein synthesis.

Some additional advances have been made in the study of some of the reactions in which folic acid and its derivatives are involved. A new enzyme, dihydrofolic reductase from *Streptococcus faecalis* R, has been purified 400-fold (Blakley, McDougall) and has been found to be specific for the reduction of dihydrofolic acid and its conjugates by TPNH. This is the first enzyme of this type isolated from bacteria and its discovery sheds new light on the means by which bacteria convert folic acid to its biochemically active forms. The enzyme is inhibited very powerfully by the folic acid analogue, aminopterin—the inhibition develops over a period of 10 min. and becomes non-competitive. The enzyme is extremely stable to heat, for only 50 per cent. of the activity is lost after a 2 hr. exposure to 100° when mM glutathione is present. Its protein nature, however, is indicated by its destruction by trypsin, its inability to pass through a dialysis membrane and its susceptibility to urea and surface denaturation.

Progress has been made on the study of thymidylate synthetase, an enzyme of considerable importance not only because of its part in the cellular synthesis of nucleic acid, but because it is one of the few enzymes which synthesize methyl groups. The enzyme has been purified 100-fold from *Strep. faecalis* R and has been shown (Blakley, McDougall) to catalyse the reaction between deoxyuridylate and 5,10-methylenetetrahydrofolate to form thymidylate and dihydrofolate. This latter compound has been identified by spectrophotometric and enzymic methods and its formation forms the basis of a new and rapid spectrophotometric assay of the enzyme. The reaction described above is irreversible and is inhibited by thymidylate.

The understanding of the mechanism of this enzymic reaction has been furthered by several observations, e.g. it has been found that only one enzyme is involved and that no intermediate accumulates. Additional information was obtained from isotope studies. For this purpose tritiated TPNH has been prepared from tritiated glucose-6-phosphate and has been used to reduce dihydrofolate and thus to yield tetrahydrofolate-6-H<sup>3</sup>. It has been shown (Blakley, McDougall) that when the latter compound reacts with deoxyuridylate in the presence of purified thymidylate synthetase, thymidylate-methyl-H<sup>3</sup> is produced.

A survey of various tissues has indicated that yeast is a good source of methylenetetrahydrofolate reductase, an enzyme linking the formyl-activating and hydroxymethyl-activating functions of tetrahydrofolate (Blakley, Rama Sastri). Work has commenced on the purification of this enzyme.

#### Other Activities.

Dr. J. F. Morrison and Dr. H. Rosenberg visited the University of Queensland from 1st August to 5th August, and from 9th May to 19th May, respectively, to give courses to final-year and honours students in the Department of Biochemistry.

Professor A. H. Ennor was absent from the Department on study leave from 16th January to 20th June, during the bulk of which time he was a Visiting Professor in the University of California at La Jolla. Lectures and seminars were given in various centres of the United States, in Europe and in the Philippines. Professor Ennor was appointed Deputy Chairman of the Board of the Institute of Advanced Studies.

Professor Ennor, as President of the Australian Biochemical Society, presided at the Annual General Meeting of the Society, which was held in Canberra. All members of the Department presented scientific papers to the meeting.

#### Publications 1960.

Beatty, I. M. and Magrath, D. I.—

“The synthesis and properties of lombricine and related compounds.” *Aust. J. Sci.*, **22**, 413.

“The synthesis of D-, L- and DL-2-amino-2-carboxyethyl 2-guanidinoethyl hydrogen phosphate (lombricine) and the identity of the natural compound with the D isomer.” *J. Amer. Chem. Soc.*, **82**, 4983.

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

“The synthesis of N-phosphoryl-D- and L-lombricine.” *Nature*, **188**, 1026.

Blakley, R. L.—

“Crystalline dihydropteroylglutamic acid.” *Nature*, **188**, 231.

“Spectrophotometric studies on the combination of formaldehyde with tetrahydropteroylglutamic acid and other hydropteridines.” *Biochem. J.*, **74**, 71.

“A spectrophotometric study of the reaction catalysed by serine transhydroxymethylase.” *Biochem. J.*, **77**, 459.

Blakley, R. L. and McDougall, B. M.—

“The role of DPNH and tetrahydropteroylglutamate in the synthesis of thymidylic acid.” *Biochim. Biophys. Acta*, **39**, 176.

“Dihydrofolic reductase from *Streptococcus faecalis* extracts.” *Aust. J. Sci.*, **22**, 416.

- Coleman, G. and Elliott, W. H.—  
 “A method for studying amino acid activation in crude tissue extracts.” *Nature*, **188**, 64.  
 “Studies on  $\alpha$ -amylase synthesis by *Bacillus subtilis*.” *Aust. J. Sci.*, **22**, 420.
- Doherty, M. D. and Morrison, J. F.—  
 “The possible role of DPN in biological transphosphorylation reactions.” *Aust. J. Sci.*, **22**, 414.
- Elliott, W. H.—  
 “The estimation of aminoacetone and  $\delta$ -aminolaevulinic acid.” *Biochem. J.*, **74**, 90.  
 “Methylglyoxal formation from aminoacetone by ox plasma.” *Nature*, **185**, 467.  
 “Aminoacetone formation by *Staph. aureus*.” *Biochem. J.*, **74**, 478.  
 “Studies on the synthesis and metabolism of aminoacetone.” *Aust. J. Sci.*, **22**, 413.
- Ennor, A. H., Rosenberg, H., Magrath, D. I. and Beatty, I. M.—  
 “The occurrence of D-serine in lombricine and serine ethanolamine phosphodiester (SEP).” *Aust. J. Sci.*, **22**, 413.
- Ennor, A. H., Rosenberg, H., Rossiter, R. J.,\* Beatty, I. M. and Gaffney, T.—  
 “The isolation and characterization of D-serine ethanolamine phosphodiester from earthworms.” *Biochem. J.*, **75**, 179.
- Gaffney, T. J., Rossiter, R. J.,\* Rosenberg, H. and Ennor, A. H.—  
 “The *in vivo* incorporation of inorganic  $^{32}\text{P}$  into lombricine and serine ethanolamine phosphodiester of the earthworm.” *Biochim. Biophys. Acta*, **42**, 218.  
 “The *in vivo* synthesis of lombricine in the earthworm.” *Aust. J. Sci.*, **22**, 414.
- McDougall, B. M. and Blakley, R. L.—  
 “Methylation of deoxyuridylic acid by extracts of *Streptococcus faecalis* R.” *Aust. J. Sci.*, **22**, 417.  
 “Mechanism of the action of thymidylate synthetase.” *Nature*, **188**, 944.
- Morgan, A. M.† and Beatty, I. M.—  
 “The distribution of serine ethanolamine phosphodiester in animal tissues.” *Aust. J. Sci.*, **22**, 415.
- Rosenberg, H. and Ennor, A. H.—  
 “The occurrence of free D-serine in the earthworm.” *Nature*, **187**, 617.
- Rossiter, R. J.,\* Gaffney, T., Rosenberg, H. and Ennor, A. H.—  
 “Biosynthesis of lombricine.” *Nature*, **185**, 383.  
 “Lombricine and serine ethanolamine O-phosphodiester in the earthworm.” *Fed. Proc.*, **19**, 232.  
 “The *in vivo* formation of lombricine in the earthworm (*Megascolides cameroni*).” *Biochem. J.*, **76**, 603.
- Whittaker, V. K. and Blakley, R. L.—  
 “The biosynthesis of the methyl group of thymidylic acid by extracts of calf thymus gland.” *Aust. J. Sci.*, **22**, 416.

## DEPARTMENT OF EXPERIMENTAL PATHOLOGY.

*Staff.*

Professor .. .. .	F. C. Courtice, M.A., D.Phil., D.Sc., L.R.C.P., M.R.C.S., Hon. F.R.A.C.S., F.R.A.C.P., F.A.A.
Reader .. .. .	G. B. Mackaness, M.B., B.S., M.A., D.Phil., D.C.P.
Senior Fellows .. .. .	Bede Morris, B.V.Sc., D.Phil.; S. V. Boyden, Ph.D., M.R.C.V.S. (commenced 25th April).
Research Fellows .. .. .	A. K. Lascelles, M.V.Sc.; G. Woolley, M.Sc., Ph.D. (commenced 23rd May).
Department Assistant .. .. .	A. Schmidt, M.D. (commenced 1st December).
Head Technician .. .. .	J. Harding.

*Student and Teaching Activities.*

During the year there were two students proceeding to a Ph.D. degree: D. G. Garlick, B.Sc. (Med.), M.B., B.S. (commenced 2nd February), who is working on the exchange of lipids between the plasma and various tissues of the body, and T. J. Heath, B.V.Sc. (commenced 27th June), who is working on the absorption of lipids in the ruminant animal; R. J. Vaughan, M.B., B.S., arrived at the end of the year to work on the immune response.

Seminars have been held within the Department and also in conjunction with the Department of Microbiology.

\* Visiting Professor.

† Visiting Fulbright scholar.

*General.*

Professor Courtice spent two weeks in July as Visiting Professor to the Department of Physiology in the University of Western Australia. He also gave lectures in Sydney for the Postgraduate Committee in Medicine.

Dr. Mackaness was on study-leave at the Rockefeller Institute in New York until May. He attended a summer school in Electron Microscopy in Sydney in December.

Dr. Morris, Mr. Lascelles, Dr. Garlick and Professor Courtice participated in the Inaugural Meeting of the Australian Physiological Society in Sydney in May.

Professor Courtice was elected a Fellow of the Royal Australasian College of Physicians in May. He served as a member of the Medical Research Advisory Committee of the N.H.M.R.C., the Advisory Council of the Life Insurance Medical Research Fund of Australia and New Zealand, the Australian Natural Sciences Committee of U.N.E.S.C.O., the National Medical and Scientific Advisory Committee of the National Heart Foundation and the Board of Canberra Community Hospital.

*Research Programme.*

Research in the Department concerns two major fields of experimental pathology: immunology and the transport and metabolism of lipids. Several approaches are being made to various problems within these fields.

*Composition of blood lipids in hypercholesterolaemia (Courtice and Garlick).*

Investigations of the mechanisms concerned in the deposition of cholesterol in the arterial wall in experimental atherosclerosis in rabbits have been continued. The composition of the various lipoprotein complexes has been determined after their separation with the preparative ultracentrifuge at varying densities. The lipoproteins in the plasma of the hypercholesterolaemic rabbit were separated into three fractions, those of densities 1.063–1.200 ( $\alpha$ -lipoprotein), 1.019–1.063 ( $\beta$ -lipoprotein) and <1.019. The protein, phospholipid, free cholesterol, cholesterol ester and triglyceride in each fraction were determined. As the lipoproteins become less dense, the relative amount of protein and phospholipid which stabilize the cholesterol and triglyceride decreases.

Preliminary observations have been made with the electron microscope of the size of these lipoproteins. The lipoprotein of density 1.063–1,200 is fairly uniform in size and the smallest of the fractions; that of density 1.019–1.063 is larger and less uniform in size whereas the least dense fraction contains the largest and most variable sized complexes. Further studies are being made to determine the size and composition of these fractions not only in experimental hypercholesterolaemia but also in the plasma of humans with essential hypercholesterolaemia and similar disturbances in lipid metabolism.

*Permeability of capillaries to proteins and lipoproteins (Courtice and Garlick).*

The transfer of proteins and lipoproteins from the circulating plasma to the lymph in the leg of the normal and hypercholesterolaemic rabbit has been further investigated. The concentration of the proteins (albumin,  $\alpha$ -globulin,  $\beta$ -globulin and  $\gamma$ -globulin) and of the three lipoprotein fractions separated by ultracentrifugation have been determined in the plasma and in the lymph in these animals. These experiments show that even with the lipoproteins there is a gradient from plasma to lymph which was roughly parallel with the size of the molecule or complex. When the capillary wall is damaged by heat, there is a considerable increase of all fractions in the lymph, but the differential gradients of the various molecules remains. These experiments throw light on the mechanisms involved in the exchange of proteins and lipoproteins across the vascular endothelium and may help to elucidate the problems of deposition of cholesterol and other lipids in the arterial wall in atherosclerosis.

*Exchange of proteins and lipoproteins between plasma and lymph in the liver (Courtice and Woolley).*

Hepatic lymph was collected from normal and hypercholesterolaemic rabbits and the concentrations of the various protein and lipoprotein fractions determined. Although the levels of these substances were higher in lymph from the liver than from the leg, there was still a differential gradient which was approximately proportional to the size of the molecule. To ascertain whether all or practically all of these proteins and lipoproteins in the lymph are derived from the plasma and not the liver cells, the specific activities of labelled albumin and globulins in plasma and lymph have been determined. These experiments are still in progress, but so far show that the proteins in lymph are derived from the plasma. These experiments suggest that although there may be large gaps between the endothelial cells of the sinusoids through which the proteins and lipoproteins can freely diffuse, there must be smaller fenestrations through which the macromolecules are filtered by varying degrees of restricted diffusion.

*The role of liver in fat metabolism (Morris).*

In order to investigate the role which the liver plays in the intermediary metabolism of long-chain fatty acids, experiments have been continued using an isolated perfused liver system. The effect of variables such as the concentration of fatty acids in the perfusate, the pressure and the temperature of the perfusion fluid and the glycogen content of the liver have been studied and the rate of uptake and

oxidation of  $^{14}\text{C}$  labelled palmitic acid measured. The labelled fatty acid was added to the perfusate either as a soluble albumin-fatty acid complex or in the form of chylomicron triglyceride. Significant differences were found in the way in which the free fatty acids and the triglycerides were metabolized by the liver and this has suggested that the metabolic rate of long-chain fatty acids is related in some way to the physical form in which they are transported in the blood stream.

The lipids in the perfusate and in the liver were separated by silicic acid chromatography and this has shown extensive conversion of the labelled fatty acids to other substances. Both free fatty acids and triglycerides were taken up by the liver and then subsequently retransported in the perfusate. The extent to which these lipids were retransported was related to the liver's metabolic requirements. If the liver was devoid of glycogen, the fatty acids underwent rapid oxidation either to  $\text{CO}_2$  or ketone bodies and retransport was minimal. If the liver was replete with glycogen, extensive retransport of lipid occurred both as free fatty acid and as triglyceride.

Free fatty acids which were taken up by the liver were converted rapidly into triglycerides and phospholipids. The greatest amount of label was recovered as phosphatidyl-choline and it appeared that this substance represents an important intermediary in the oxidation of both free fatty acids and triglycerides.

#### Surgical techniques for the collection of lymph in unanaesthetized sheep (Lascelles and Morris).

In order to carry out studies on the part played by the lymphatic system in several aspects of the physiology of ruminant animals, it has been necessary to develop methods for the collection of lymph from conscious sheep over long periods of time. Surgical techniques have been worked out to enable lymph to be collected from the liver, intestines, mammary gland and thoracic duct for periods of time up to 2 months. These preparations are being used to study the absorption of fat in the sheep and the part played by the lymphatic system in the secretion of milk and its reabsorption from the mammary glands.

#### Lymph from the mammary gland of sheep (Lascelles and Morris).

Studies have been made on the flow and composition of lymph from the mammary gland of lactating and non-lactating ewes. It has been found that the mammary gland may contribute as much as 20-30 per cent. of the total thoracic duct lymph flow in the lactating ewe and up to 20 per cent. of the total thoracic duct lymphocyte output.

In general the mammary gland lymph has been found to resemble lymph obtained from other areas of the body such as the head and neck and limbs. There is, however, a much greater plasma-lymph gradient of free fatty acids and triglycerides in lymph obtained from lactating sheep than in lymph obtained from dry sheep. It is thought that this is due to the mobilization and uptake of depot and dietary fat by the mammary gland during the secretion of milk.

Measurements have been made to establish the size of the interstitial fluid pool in the lactating and dry mammary gland and it has been found that in the lactating gland the amount of interstitial fluid present was about 5-10 times the amount in the dry gland. The increase in the volume of interstitial fluid is accompanied by an increase in the vascularity of the gland and a higher fractional rate of transfer of fluid and protein through the pool.

During the drying-off process changes occur in the composition of lymph coming from the udder. This is due to absorption of milk proteins and lipids into the lymph. Milk proteins have been identified in the lymph by specific precipitation in agar using antisera prepared in rabbits injected with sheep milk. Quantitative studies have been carried out to assess the significance of the lymphatic pathway in the reabsorption of milk from the udder. For this purpose  $^{131}\text{I}$  serum albumin and  $^{131}\text{I}$  sheep casein have been prepared and injected through the teat canal into the udders of lactating ewes. The appearance of radioactive protein in the lymph draining from the udder and in the circulating blood has been followed during the time the secreted milk was being reabsorbed.

#### Peritoneal absorption (Lascelles and Morris).

The removal of unesterified fatty acids from the blood by various tissues is probably related in some way to the structure of the capillary endothelium. The peritoneal cavity is a modified tissue space which is lined by serosal cells which resemble vascular endothelium very closely. Experiments have been carried out to establish whether unesterified fatty acids and albumin were absorbed from the peritoneal cavity at the same rate and by the same mechanism. The results suggested that unesterified fatty acids exchanged rapidly in both directions across the peritoneal serous membrane. In the case of albumin, there was a unidirectional transfer of unlabelled protein into the peritoneal cavity. The net removal of both albumin and unesterified fatty acids occurred together with the absorption of fluid through the lymphatic system.

#### The digestion and absorption of long-chain fatty acids in sheep (Heath and Morris).

Some experiments have been completed on the absorption of long-chain fatty acids in sheep. In ruminant animals the dietary cellulose is converted by the microorganisms of the rumen into short-chain fatty acids such as acetic and propionic and these are absorbed from the gut. The diet of the young lamb, however, consists chiefly of milk which is rich in long-chain fatty acids and these are absorbed as such.

In order to establish whether adult sheep can digest and absorb long-chain fatty acids as efficiently as young lambs, it is necessary to introduce the fat-meal directly into the abomasum or the small intestine so as to prevent the fatty acids from being broken down by the microorganisms in the fore-stomachs. Sheep were prepared with fistulae in the abomasum and with the hepatic and intestinal lymphatic ducts catheterized. Experiments were carried out to follow the changes which occur on the lymph during the absorption of a fat-meal. It has been found that while fat is being absorbed, the flow of lymph from the intestines increases and there is significant rise in the concentration and output of free fatty acids, triglyceride, cholesterol and phospholipids in the lymph. No significant change occurs in the flow or lipid content of the hepatic lymph. Experiments are being carried out with  $^{14}\text{C}$  labelled fatty acids to measure the extent to which the long-chain fatty acids are absorbed via the intestinal lymph and to establish in which regions of the gut fat absorption takes place.

#### Cellular aspects of immunity (Mackness).

For the first half of the year this work was carried out while on study leave in the department of Dr. Rene Dubos at the Rockefeller Institute, New York. It was concerned with the cellular aspects of immunity against the staphylococcus. Since June the work in progress in Canberra has been designed to analyse the antibacterial defence mechanism in diseases in which immunity does not appear to depend upon serum antibodies. The organism chosen for this work is *Listeria monocytogenes*. Work to the present point has been devoted to the development of a suitable experimental system. By serial passage in mice an organism of enhanced virulence has been obtained and a method of measuring its growth characteristics in mouse macrophages has been devised. Enhancement of virulence during mouse passage was attended by an adaptation of the organism to growth within mouse macrophages. The adapted strain can now be used to study the effect of immunisation upon the interaction of the organism with the host's defence system both *in vivo* and in the tissue culture system which has been developed.

#### Cellular discrimination between indigenous and foreign matter (Boyden).

In all multicellular animals the major role in preventing colonization of the tissues by microorganisms is played by the wandering phagocytic cells, the main function of which is the uptake and digestion of all foreign cells (bacteria, protozoa, &c.). Obviously, for this system to function satisfactorily, the phagocytic cells must be able to distinguish between matter to be phagocytosed (i.e. foreign cells) and matter not to be phagocytosed (i.e. healthy cells of the host). Although the very existence of multicellular animals depends on this capacity of the phagocytic systems to discriminate between foreign and indigenous matter, the mechanism by which this is done is completely unknown.

A similar problem arises in connexion with the immune response (i.e. antibody production, &c.) which, in vertebrates, supplements the action of the phagocytic system in defence against infection. In general, antibodies are produced only against extraneous proteins and polysaccharides (e.g. of bacterial origin), and not against the host's own macromolecules. Thus the cells responsible for antibody production are also capable of distinguishing between foreign and indigenous matter; but again the mechanism by which they do so is unknown. However, for several reasons it seems likely that the mechanism by which this distinction is made is basically the same both in the immune response and in the phagocytic response.

When microorganisms gain access to the tissues the first action of the phagocytic cells is to move towards them, presumably in response to soluble substances liberated by the foreign cells. This phenomenon ("chemotaxis") has been selected as a starting point for a series of investigations which is planned on the general problem of the mechanism by which cells discriminate between foreign and indigenous matter. The almost complete lack of information on the nature of chemotactic stimuli in relation to phagocytes is due mainly to the fact that there has been no technique available by which soluble substances could be tested for chemotactic activity. The first step in our experiments has therefore been to develop a method by which this can be done. The method utilizes filter membranes of pore size such that the phagocytic cells under study can only pass from one side of the membrane to the other by actively squeezing themselves through. The cells are placed on one side of the membrane, and a solution of the substance to be tested on the other. If the test substance is active, the cells appear on the far side of the membrane: otherwise they remain on the side on which they were first placed.

Studies with this technique are so far only in the early stages. A few observations, however, have been made. Using rabbit phagocytic cells (polymorphonuclear leucocytes), it has been found that macromolecules from different biological sources differ greatly in their chemotactic activity. Preparations containing protein molecules structurally very different from rabbit proteins (e.g., bacterial proteins) have a strong chemotactic effect, whereas certain more closely related "foreign" proteins (e.g. human serum albumin) are only weakly chemotactic, if at all. However, mixtures of substances such as human serum albumin (which are not chemotactic, or only weakly so) with the serum of rabbits immunized against the protein in question are strongly chemotactic. Thus antibodies appear to assist the phagocytes in the detection of foreign molecules in cases where the latter differ to a relatively slight degree from the host's own proteins.

## Publications.

During the year the following papers by members of the staff were published:—

Boyden, S.V.—

“Antibody Production.” *Nature* (London) **185**, 724.

Boyden, S. V. and Sorkin, E.\*—

“The absorption of antigen by spleen cells previously treated with antiserum *in vitro*.”  
*Immunology*, **3**, 272.

Courtice, F. C.—

“Determination of protein fractions in small samples of plasma and of lymph in the rabbit.”  
*Aust. J. Exp. Biol. & Med. Sci.*, **38**, 395.

“The flow and composition of hepatic lymph in the normal and hypercholesterolaemic rabbit.” *Aust. J. Exp. Biol. & Med. Sci.*, **38**, 403.

“Mechanisms of lipid accumulation in atherogenesis.” *American Heart Journal*, **60**, 664.

French, J. E.,\* Florey, H. W.\* and Morris, B.—

“The absorption of particles by the lymphatics of the diaphragm.” *Quart. J. Exp. Physiol.*  
**45**, 88.

Lascelles, A. K. and Morris, B.—

“The absorption of unesterified fatty acids bound to albumin from the peritoneal cavity of the rat.” *Aust. J. Exp. Biol. & Med. Sci.*, **38**, 473.

Mackness, G. B.—

“The phagocytosis and inactivation of staphylococci by macrophages of normal rabbits.”  
*J. exp. Med.*, **112**, 35.

Morris, B.—

“The proteins and lipids of the plasma of some species of Australian fresh and salt water fishes.” *J. cell. & comp. Physiol.* **54**, 221.

“Some observations on the production of bile by the isolated perfused liver of the rat.”  
*Aust. J. Exp. Biol. & Med. Sci.*, **38**, 99.

## DEPARTMENT OF MEDICAL CHEMISTRY.

## Staff.

Professor .. .. .	A. Albert, Ph.D., D.Sc., F.R.I.C., F.A.A.
Senior Fellows .. .. .	D. J. Brown, M.Sc., Ph.D.; D. D. Perrin, Ph.D., F.R.I.C.
Senior Research Fellow .. .. .	E. Spinner, M.Sc., Ph.D.
Research Fellows .. .. .	W. L. F. Armarego, Ph.D. (from 4th January); G. B. Barlin, M.Sc., Ph.D. (from 2nd September); R. F. Evans, D.Phil. (from 22nd December, 1959); Joyce E. Fildes, M.Sc., Ph.D.
Hon. Research Fellows .. .. .	J. W. Cornforth, D.Phil., F.R.S.; Rita Cornforth, M.Sc., D.Phil. (from 1st September).
Head Technician .. .. .	J. S. Narper.

## Student and Teaching Activities.

There are five students proceeding to a Ph.D. degree: S. Matsuura, M.Sc. (commenced 17th March, 1958), who is completing his thesis on the reduction of hydroxypteridines; N. W. Jacobsen, M.Sc. (commenced 12th January, 1959), who is working on the methylation of aminopteridines and aminopyrimidines; J. C. B. White, M.Sc. (commenced 4th June, 1959), who is working on physico-chemical studies of substituted hydroxypyridines; C. J. Hawkins (commenced 19th March, 1960), who is working on the oxidation-reduction potentials of copper complexes; Y. Inoue, M.Sc. (commenced 14th April, 1960), who is working on reversible addition of water to the carbon-nitrogen double bond.

A course of instruction in the techniques of infra-red spectroscopy was given to members of the School by Dr. Spinner.

Seminars, arranged by Dr. E. Spinner, were held fortnightly in the Department.

## Research Activities.

As usual, much of the work of the Department revolved around outstanding problems in the chemistry of biologically-active heterocyclic substances.

A study of the ionization constants and spectra of the (unsubstituted) naphthyridines revealed none of the irregularities found in some other polyazanaphthalenes, notably quinazoline and pteridine, which accordingly must owe their unusual properties (e.g., covalent hydration) to the 1,3-configuration of nitrogen atoms (Albert).

\* Not a member of the Australian National University.

The reduction of the four isomeric monohydroxy-pteridines led to four dihydro- and two tetrahydro-derivatives. One of these (3,4-dihydro-2-hydroxypteridine) is hydrogenated in the pyrimidine ring, which is unprecedented (Albert and Matsuura).

The insertion of a methyl-group into the 7-position of 6-hydroxypteridine was found to exert a strong steric barrier to the covalent hydration of this substance across the 7,8-double bond. A number of Michael-additions (e.g., of acetone, and ethyl malonate) were made at this double bond (Albert and Reich).

A new method for micro-potentiometric titration was devised for determining the stability complexes of heavy metals. This method was applied to complexes of the anion of adenine (Albert and Serjeant).

The long-standing problem of how methyl groups apparently migrate from nuclear to extranuclear nitrogen atoms in heterocyclic compounds, has been decided experimentally in the pyrimidine series. Tracer studies with  $^{15}\text{N}$  have conclusively shown that ring-fission and re-cyclization are the essential steps in the re-arrangement and that migration does not occur (Brown).

Up to the present, all examples of the methylation of amino- and hydroxy-pteridines have given products that are methylated (on a ring-nitrogen atom) in the ring carrying the substituent. However, 2-amino-4-hydroxypteridine (which is the fundamental nucleus of almost all of the natural pteridines) has now been found to undergo transannular methylation on  $\text{N}^{(8)}$ . This phenomenon, which is quantitative, may be of particular interest in connexion with  $\text{N}^{(9)}$ -substitution in natural pteridines.

At the same time it has been found that, of the nine possible tautomeric forms of "2-amino-4-hydroxypteridine", a particular form, viz., 2-amino-3,4-dihydro-4-oxopteridine, strongly predominates in aqueous solution (Brown and Jacobsen).

The early promise of N-phenylsydnone and its derivatives as tumour inhibitors has not been confirmed in extensive tertiary screening at the Cancer Chemotherapy Center, Bethesda. Renewed interest is being taken in pyrimidines and aminopteridines, a number of which are being prepared in quantity for testing (Brown).

Methylation of 4-amino-6-hydroxypyrimidine has been proven to occur at  $\text{N}^{(4)}$ . A substance recently claimed by others to be the  $\text{N}^{(8)}$  isomer has been shown to have re-arranged to 4-hydroxy-6-methylaminopyrimidine. A variety of other N-methylated derivatives of 4,6-disubstituted pyrimidines has been made, and it is now possible to forecast the position of alkylation in such pyrimidines with some confidence (Brown and Harper).

Studies on the behaviour of metallic ions under physiological conditions were continued. Stability constants have been obtained for transition-metal complexes with *o*-aminophenols and with the N-oxides of adenine and adenosine. The hydrolysis of cupric ion in aqueous solution has been shown to take the form of a series of equilibria involving polynuclear copper-hydroxyl complex formation (Perrin).

A very sensitive freezing-point depression apparatus has been constructed in order to study the degree of aggregation of organic molecules in aqueous solution (Perrin).

A systematic investigation of the effect of complex-forming species on the oxidation-reduction potentials of cupric-cuprous systems has been commenced (Perrin and Hawkins).

A quantitative study is in progress dealing with the kinetics and equilibria involved in reversible water-addition to nitrogen-containing heterocyclic compounds. This type of reaction produces hysteresis effects during acid-base titrations. The work has been facilitated by the construction of a rapid-reaction apparatus for attachment to a recording spectrophotometer (Perrin and Inoue).

Samples of the Australian poison plant *Sarcostemma australe* ("caustic vine") have been examined with a view to finding a good source of the  $\text{C}^{21}$  sapogenin sarcostin. The hitherto unknown 3-methyl-5-isoxazolone has been prepared and its chemistry has been studied. (+)-Linalool from the oil of *Melaleuca viridiflora* provided a starting-point for synthesis of (-)-mevalonolactone. This lactone is of interest in connexion with the biosynthesis of cholesterol, and studies on hyperpiesia (J. W. and R. H. Cornforth).

The infrared and Raman spectra of 2-, 3- and 4-aminopyridine, 2-aminopyrimidine, and of several aminomethylpyridines have been compared with those of their hydrochlorides. In the cation of 3-aminopyridine the positive charge is borne by the ring nitrogen atom. In the other cations it resides principally on the exocyclic (amino) nitrogen atom giving an essentially amidinium type of cation (Spinner).

The infrared spectra of the hydrochlorides of formimino and acetimino methyl ether differ in important respects from that of the hydrochloride of acetamide; this confirms the earlier evidence that the latter is not the hydrochloride of acetimino alcohol (i.e., acetamide that has been protonated on the oxygen atom) (Spinner).

The infrared and Raman spectra of the hydrochlorides of N-methylformamide and N,N-dimethylformamide are in accord with the view that in these molecules, too, it is the nitrogen and not the oxygen atom that has been protonated (Spinner).

A number of substituted 2-hydroxypyridines have been found to exist predominantly in the lactam form. With two probable exceptions, their cations seem to be formed by protonation on the nitrogen atom. The Raman and infrared spectra of the cation of 2-methoxy-pyridine differ in important respects from those of the cation of 2-hydroxypyridine, confirming that the latter is not protonated at the oxygen atom (Spinner and White).

Further work on the cation of quinazoline (which is hydrated covalently and hence abnormal) has shown that any substituent in the 4-position, whether electron-donating or electron-withdrawing, causes the normal cation to predominate. In sufficiently strong sulphuric acid, the equilibrium between the abnormal and the normal cation favours the latter ion even for unsubstituted quinazoline. 3:4-Dihydroquinazoline and a number of related compounds have also been studied (Armarego and Spinner).

Attempts to synthesize 1,4-dihydroquinazoline always produced the 3-4-isomer. Hence these isomers exist in dynamic equilibrium with the latter preponderating. New and improved syntheses for quinazoline and phthalazine, suitable for their preparation in large amounts, have been worked out (Armarego).

The nature of the mercapto-group in heterocyclic rings containing two nitrogen atoms is being investigated. It has been found that tautomerism protonation usually favours the nitrogen atom that is nearer to the sulphur atom (Barlin).

A study of the reduction of pyrimidine has been commenced, to resolve anomalies in the literature. The ring-chain tautomerism of the products is undergoing investigation (Evans).

A method for the microdetermination of individual halogens by titrimetric methods has been worked out for use in conjunction with the rapid combustion procedure (Fildes).

#### *Other Activities.*

Professor Albert was the guest of the U.S. National Academy of Sciences at a Symposium on Biological Aspects of Metal Binding (held in Pennsylvania State University) in September. The International Union of Pure and Applied Chemistry held a Symposium on Natural Products in Melbourne, Canberra and Sydney in August. The visits and excursions during the Canberra period were arranged by this Department. The following papers were read at the meeting: "The 6-hydroxypteridines" (Albert), "The reduction of hydroxypteridines" (Albert and Matsuura), "Some N-methylated pyrimidines and purines" (Brown), "Methylation of aminopteridines" (Brown and Jacobsen), "Reversible addition of water to N-heterocycles" (Perrin and Inoue), "A spectroscopic study of water addition to the cation of quinazoline" (Spinner).

Pyrimidines, purines, and pteridines have been requisitioned from Dr. D. J. Brown for research activities by Professor F. Bergmann (The Hebrew University, Jerusalem), Dr. S. Gronowitz (University of Uppsala), Professor D. Ackermann (University of Würzburg), and colleagues within the John Curtin School.

High pressure hydrogenations have been performed for other Departments in the School and for the C.S.I.R.O. The large-scale Technical Laboratory has been made available to C.S.I.R.O. on several occasions.

During the year, 110 ionization constants of 82 organic substances were determined for research workers in this School and elsewhere.

Spectroscopic service work comprised 110 ultraviolet and 70 infrared spectra; 20 of the latter were for other Departments.

The demands made by the Medical School upon the services of the routine microanalytical laboratory were 26 per cent. greater than in 1959. A total of 1699 requests for microanalysis were dealt with. Of these only 59 per cent. originated within the Department.

#### *Publications.*

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

Adler, T. K., and Albert, A.—

"The azaindoles. Part I. Ionization constants and spectra." *J. Chem. Soc.*, p. 1794.

Albert, A.—

"*Selective Toxicity.*" Second, revised and enlarged, edition. Methuen, London. xii. + 234 pp., 4 plates.

"Ionization constants of heterocyclic substances. Part IV. The effect of a tautomerizable  $\alpha$ -substituent on the ionization of a second substituent." *J. Chem. Soc.*, p. 1020.

"The naphthyridines. Ionization constants and spectra." *J. Chem. Soc.*, p. 1790.

"Purine-8-carboxylic acid." *J. Chem. Soc.*, p. 4705.

Albert, A. and Reich, F.—

"Pteridine studies. Part XI. The decomposition of 2-hydroxypteridine by alkali." *J. Chem. Soc.*, p. 1370.

- Albert, A., and Serjeant, E. P.—  
 "Quantitative studies in the avidity of naturally-occurring substances for trace metals. 4. A potentiometric method for highly insoluble complexes, and its application to complexes of the adenine anion." *Biochem. J.*, **76**, 621.
- Albert, A., and Spinner, E.—  
 "The vibration spectra and structures of the hydroxypyridines and hydroxypyrimidines in aqueous solution." *J. Chem. Soc.*, p. 1221.
- Brown, D. J. (with Bergmann, F.,\* Kwietny, H.\*, and Levin, G.\*)—  
 "The action of mammalian xanthine oxidase on N-methylated purines." *J. Amer. Chem. Soc.*, **82**, 598.
- Brown, D. J., and Harrison, R. J.—  
 "Naphthimidazoles. Part III. 6,7,8,9-Tetrahydronaphth[1,2]imidazoles." *J. Chem. Soc.*, p. 1837.
- Brown, D. J., and Jacobsen, N. W.—  
 "The unique transannular methylation of 2-amino-4-hydroxypteridine." *Tetrahedron Letters*, No. 25, 17.  
 "Pteridine studies. Part XII. The methylation of 4-aminopteridine." *J. Chem. Soc.*, p. 1978.
- Perrin, D. D.—  
 "The hydrolysis of copper (II) ion." *J. Chem. Soc.*, p. 3189.  
 "Metal complexes with adenine-N<sub>(1)</sub>-oxide and adenosine-N<sub>(1)</sub>-oxide." *J. Amer. Chem. Soc.*, **82**, 5642.
- Perrin, D. D. (with Curtis, D.,† and Watkins, J. C.†)—  
 "The excitation of spinal neurones by the ionophoretic application of agents which chelate calcium." *J. Neurochem.*, **6**, 1.
- Perrin, D. D., and Inoue, Y.—  
 "Reversible water addition to some nitrogen heterocycles." *Proc. Chem. Soc.*, p. 342.
- Spinner, E.  
 "The vibration spectra and structures of the *hydrochlorides* of hydroxypyridines and hydroxypyrimidines." *J. Chem. Soc.*, p. 1226.  
 "The vibration spectra and structures of the *sodium salts* of hydroxypyridines and hydroxypyrimidines." *J. Chem. Soc.*, p. 1232.  
 "The infrared spectra of some N-heteroaromatic mercapto-compounds and of their N-methyl- and S-methyl-derivatives." *J. Chem. Soc.*, p. 1237.  
 "Restricted internal rotation in protonated amides." *J. Phys. Chem.*, **64**, 275.  
 "Intramolecular van der Waals-London cohesions and chemical reactivity. The transition state in the bimolecular nucleophilic displacement reaction of halide ion with alkyl halide." *Aust. J. Chem.*, **13**, 218.  
 "Bond-lengths and nuclear quadrupole coupling in vinyl halides." *J. Chem. Phys.*, **33**, 611.  
 "Infrared spectra of some N-heteroaromatic thiols and methylthiols." "Documentation of Molecular Spectroscopy." Butterworth, London. Cards 6211-6218.

## 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.
Professor in Virology .. .. .	S. Fazekas de St. Groth, M.D., Ch.B., Sc.M., F.A.A. (appointed 9th December, 1960).
Senior Fellow .. .. .	H. J. F. Cairns, M.A., M.D.
Fellows .. .. .	W. K. Joklik, M.Sc., D. Phil.; C. A. C. Mims, B.Sc., M.B., B.S.
Research Fellows .. .. .	I. D. Marshall, B.Ag.Sc., Ph.D. (on leave); D. W. Howes, M.Sc. (resigned 1st April, 1960); W. G. Laver, M.Sc., Ph.D.; Miss G. M. Woodroffe, M.Sc.; F. Lehmann-Grube, M.D. (appointed 24th May, 1960); D. A. Lowther, B.Sc., Ph.D. (appointed 19th July, 1960).
Honorary Fellow .. .. .	A. Gottschalk, M.D., D.Sc., F.R.A.C.I., F.R.I.C., F.A.A. (Senior Research Fellow of the National Health and Medical Research Council).
Honorary Research Fellows .. .. .	Mrs. R. Greenland, Ph.D. (U.S. Public Health Service Research Fellow); C. I. Davern, M.Sc.Agr., Ph.D.
Departmental Assistant .. .. .	R. C. Weir, B.Sc. (appointed 14th June, 1960).

\* Not a member of the Australian National University.

† Members of the Physiology Department of the John Curtin School of Medical Research.

*Students and Teaching Activities.*

Research Students	.. .. .	K. J. Lafferty, B.Sc. (commenced 4th March, 1957), J. Withell, B.Sc. (commenced 4th March, 1957), K. Schell, D.V.M. (commenced 4th February, 1957), R. D. Barry, B.V.Sc. (commenced 19th February, 1957), I. H. Holmes, B.Sc. (commenced 10th March, 1958), Miss P. Abel, M.Sc. (commenced 5th February, 1958), K. B. Easterbrook, B.Sc. (commenced 16th December, 1958), R. G. Webster, M.Sc. (commenced 25th February, 1959), W. H. Murphy, B.Sc. (commenced 24th August, 1959), J. A. Roberts, B.V.Sc. (commenced 1st January, 1960), J. B. Dawson, B.M., B.Ch. (commenced 13th January, 1960), M. F. Warburton (commenced 10th March, 1960).
Theses	.. .. .	The following research students were awarded the Ph.D. for theses with the titles indicated: R. D. Barry, "Multiplication of Influenza Virus"; K. J. Lafferty, "The Neutralization of Animal Viruses"; K. Schell, "The Innate Resistance of Mice to Mousepox".

*Research Programme.*

The activities of the Department continue to be concentrated on animal virology, utilizing the poxviruses and influenza virus for the study of a number of fundamental problems.

Epidemiological observations on myxomatosis in Australia have been brought to a close. Next year work is to commence on the epidemiology of the arthropod-borne encephalitides in the Australasian region.

The pathological effects of viruses on intact animals are being studied by extensive use of fluorescent antibody staining and autoradiographic labelling to localize the cells in which significant events occur.

More emphasis has recently been placed on biochemical and biophysical methods, and all four biochemical laboratories in the Department are now operating. The recent generous grant of £12,500 to the Department by the Wellcome Trust, for the purchase of an analytical ultracentrifuge, will allow further exploitation of biophysical methods of investigation.

*Epidemiology of myxomatosis in California (Marshall).*

Dr. Marshall, working in California with some support from the Wool Research Fund, has been able to isolate several Californian strains of the virus; these differ in several respects from South American strains. Transmission experiments with myxomatosis of *S. bachmani* caused by Californian and South American strains showed that the former was much more readily transmitted by mosquitoes.

*Genetics of poxviruses (Fenner, Greenland, Woodroffe).*

Recently it was reported that eighteen *u* mutants of rabbitpox virus could be arranged in four linkage groups by pairwise crossing experiments (Gemmell and Fenner). Calculation of recombination frequencies was impossible with rabbitpox and its *u* mutants because of variability in egg response and difficulties in the differentiation of plaques on cell monolayers. Nine independently isolated *u* mutants of cowpox virus were therefore investigated, as these gave more easily differentiated pocks on the egg membrane, and recognizably different plaques on chick embryo fibroblasts. However, extensive experiments by Miss Woodroffe and Dr. Greenland showed that in pairwise crosses the cowpox *u* mutants would not recombine to produce wild-type.

In studies of the reactivation of heat-inactivated poxviruses Miss Woodroffe had demonstrated that hybridization occurred between all members of the vaccinia-variola subgroup. Dr. Greenland utilized this approach and proceeded to carry out pairwise crosses of the cowpox *u* mutants and selected *u* mutants of rabbitpox, with positive results. These are now being systematically analysed in terms of the linkage groups of rabbitpox virus.

*The multiplication of vaccinia virus (Cairns, Davern, Easterbrook).*

Dr. Cairns has studied the initiation of infection by vaccinia virus using staining with fluorescein-coupled antibody to detect vaccinia protein and autoradiography to detect tritiated thymidine incorporation into its DNA. At the early stages of infection the synthesis of new virus material is localized in separate cytoplasmic foci, each of which arises from a single infecting vaccinia virus particle. In the course of infection at various multiplicities the proportion of cells initiated to produce virus increases. The probability of this event increases with multiplicity and, once it occurs, all the potentially infective particles carried by the cell initiate foci virtually simultaneously.

Using the method developed by Dr. Cairns, Dr. Davern has explored the effects of base analogues on the manufacture of vaccinia virus protein and nucleic acid. Using tritiated thymidine on 5-bromodeoxyuridine-blocked KB and HeLa cells, the cells were no longer able to synthesize DNA, even when returned to normal nutrient conditions. Even though they cannot replicate their own DNA, these cells are able to support the multiplication of vaccinia virus when they have been returned to normal nutrient conditions. Under the same conditions the production of infective virus was inhibited, but the focal development of vaccinia coat protein continued. All these foci retained the ability to incorporate tritiated thymidine, even as late as 8 hours after infection. Thus, unlike the host-cell DNA, the vaccinia DNA does not seem to be rendered impotent in the presence of 5-bromodeoxyuridine.

Using a suspended-cell system, Mr. Easterbrook found that the virus-inhibitory activity of 5-bromodeoxyuridine was initiation-dependent. However, 5-bromodeoxyuridine-blocked cells which would not produce infectious virus on simple reversal could be induced to do so by challenge with a second virus, which could be either live or heat-inactivated. In the latter case the heated virus was also reactivated.

In other studies on the effect of metabolic inhibitors on vaccinia virus multiplication, Mr. Easterbrook has found that sodium azide completely inhibits the formation of virus if added to cells immediately following absorption of virus. Removal of the inhibitor by dilution reveals no evidence of subsequent recovery of the infection process. The cells are capable however of supporting the multiplication of a second virus. Thus azide blocks an early stage in the sequence of infection, but this block may be overcome by the initiation of infection by a second virus which in some way rescues the sodium azide blocked virus.

#### Reactivation of poxviruses (Joklik, Holmes, Abel).

Treatment with heat or urea transforms poxvirus particles into entities which lack infectivity but which are still capable of absorbing to host cells. On superinfection with any other poxvirus, the virus inactivated with heat or urea commences replication (i.e. it is reactivated), without loss of genetic information. This is interpreted by supposing that heat or urea inactivates some part of the virus which carries no genetic material.

Dr. Joklik and Mr. Holmes have now found that not only are particles inactivated with heat or urea reactivated by superinfection with a related active virus, but also with virus which has been itself inactivated by nitrogen mustard. This reagent reacts preferentially with nucleic acid. The results indicate that in the particle inactivated with nitrogen mustard that part of the virus which has been inactivated by heat or urea is still functional and that damaged particles co-operate, one contributing the portion inactivated by nitrogen mustard (the genetic material), and the other the material necessary to enable replication to commence. In agreement with this hypothesis, virus inactivated with nitrogen mustard contributes no genetic material which can be detected in the progeny.

Dr. Joklik is engaged on the preparation of pure vaccinia virus labelled with radioactive tracers which should be of great assistance in exploring the mechanism of reactivation as well as in many other aspects of vaccinia virus multiplication.

Miss Abel has investigated three phenomena involving UV-irradiated virus: mutation, multiplicity reactivation and marker rescue (cross-reactivation). With vaccinia virus, as with bacterial viruses, the rate of mutation from  $u +$  to  $u$  pock type was increased by UV radiation in proportion to the dose of radiation delivered.

Experiments have shown that in very small host cells like chick embryo fibroblasts multiplicity reactivation can occur in cells infected multiply with single virus particles, whereas such inocula fail completely in large cells like KB or HeLa. In the latter cells, however, multiplicity reactivation can be demonstrated if the irradiated virus is introduced in clumps.

#### Mechanism of immune reactions involving viruses (Fazekas de St. Groth, Webster, Warburton, Lehmann-Grube).

*Evaluation of neutralization tests.* Further development of the statistico-kinetic model developed two years ago led Dr. Fazekas to propose a new unit of antibody action, the *neutralizing potency* or  $pN$ , a concept entirely analogous to the pH notation. The  $pN$  is independent of both the host system, the technique of assay and the virulence of the virus used.

*Equilibrium conditions of the virus-antibody system.* Dr. Fazekas and Mr. Webster have studied the quantitative aspects of neutralization process on influenza virus and their antibodies. This system allows work on both simple and crossed reactions, and by a combination of techniques impossible elsewhere. First they demonstrated that equilibrium between free antigen, free antibody and antigen-antibody complexes, holds even under extreme conditions. Thus, changing the concentration of any one reagent or of the volume of the system led to predictable shifts in the equilibrium, and the final state remained the same whether it was approached from one or the other side. Preliminary tests suggest that there is no gross heterogeneity in the system.

*Estimation of parameters.* It was possible to count the number of antigenic sites per virus particle, and the evidence implies a close-packed array of sub-units constituting the viral coat. Of these sites only a fraction is critical, i.e. instrumental in the neutralization process. Criticality seems to be a statistical and not a material property.

*In vitro tests in another host cell system.* Dr. Lehmann-Grube is seeking to standardize another host-cell system in which to analyse influenza virus-antibody interactions. Cultured cells derived from foetal swine lungs are highly sensitive to several strains of influenza A virus, whereas cells derived from adult swine lung are highly sensitive only to swine influenza virus. Techniques for growing cells from swine lungs are being standardized by Dr. Lehmann-Grube and Dr. Lowther, using collagenase for the liberation of the cells from the tissues.

*Development of immunochemical methods.* Equilibrium constants of infective antigens and antibody have never been determined, and to measure them Dr. Fazekas and his collaborators have had to design new techniques. Thus, by separating virus and antibody by special cellulose acetate membranes of 50 mu pore diameter the virus will be confined to its compartment but antibody can pass freely through the membrane. From the distribution of the latter the equilibrium constant can be determined directly, and since the technique can be used at all temperatures over which proteins are stable, it provides a general method for determining thermodynamic constants in such systems.

The number of antibody molecules is determined by "electrodieresis" and "electrosyneresis". These new methods are based on the fact that around pH 6 antibody is positively while virus is negatively charged. If electrophoresis is performed on a support that acts as molecular sieve, the free reagents will move in opposite directions whereas the antigen-antibody complex remains stationary. For such measurements Dr. Fazekas and Mr. Webster have developed an electrophoresis apparatus working on 0.001 cm.<sup>3</sup> samples and a staining technique capable of quantitatively estimating 10<sup>-13</sup> moles of  $\gamma$ -globulin.

*The immune response.* In the course of this work it became obvious that the quality of antibody depends to such a degree on the route and schedule of immunization that no general conclusions can be drawn from the study of a few sera only. To overcome this difficulty Mr. Webster and Mr. Warburton have established a serological library which already extends to over 3,000 sera. All homologous and most heterologous neutralization tests have been performed on these as well as the competitive *in vitro* tests. However, evaluation would be premature without the results of non-competitive tests, and a systematic application of the immunochemical methods just described.

#### Chemical structure of influenza virus components (Laver).

Dr. Laver is engaged in an investigation of structure and function in the influenza group of viruses. By a new method of purification, he has obtained pure LEE influenza virus, and has studied its protein moiety by means of N-terminal amino acid analysis. For this purpose a micro-modification of Edman's method, using highly radioactive <sup>35</sup>S-phenyl-isothiocyanate was developed.

Work is proceeding on the separation and characterization of the various biologically active components of the virus, namely the two antigens, the haemagglutinin and the enzyme neuraminidase, following disruption of the particle by deoxycholate.

#### Experimental pathology of viral infections (Mims, Roberts, Howes).

In spite of the fact that effective vaccines have already made paralytic poliomyelitis a less common disease, the way in which infection occurs and the virus spreads throughout the body is still very imperfectly understood. Dr. Mims and Mr. Howes have made an attempt to answer some of the outstanding problems and it seems likely that the throat is the initial site of infection in the cynomolgus monkey. Virus is present in the blood less than 24 hours later and is secreted in considerable amounts into the bile.

In experiments concerning the origin, fate and function of lymphocytes, using the autoradiographic technique, Dr. Mims has found that the thymus gland is the major source of lymphocytes in immature mice. More than half of the thymic lymphocytes have been indelibly radioactively labelled with tritiated thymidine, and a study of the fate of transfused labelled cells is in progress.

In collaboration with Dr. M. F. Day, of the Division of Entomology, C.S.I.R.O., Dr. Mims has analysed the growth of Murray Valley Encephalitis Virus in infected mosquitoes, using the fluorescent antibody technique. It has been found that the blood cells of the mosquito are infected and are probably of considerable importance in the spread of the virus through the body of the mosquito.

Mr. Roberts has been studying the early stages in the development of skin and lung lesions in mousepox. He has discovered that macrophages are often the first cells to be infected in primary lung and skin lesions while epithelial cells are only secondarily involved. The spread of virus in developing skin and lung lesions is also being studied.

#### Molecular structure of submaxillary gland mucoproteins active as influenza virus antihaemagglutinins (Gottschalk, Murphy, Thomas and Fazekas de St. Groth).

Dr. Gottschalk and his collaborators have continued their work on the chemical structure and physical properties of the virus haemagglutinin inhibitory mucoproteins. Quantitative measurements by Mr. Thomas and Dr. Gottschalk showed that the reduced viscosity of the ovine mucoprotein (OSM) at pH 6.1 decreased from 3.13 to 1.33 on enzymic removal of the terminal N-acetylneuraminic acid units. The viscosity of OSM also decreased from 3.50 to 2.50 between pH 4.3 and 1.8, that is, in the pH range of decreasing ionization of N-acetylneuraminic acid. The decrease in viscosity was found to be reversible on readjustment of the pH. These results indicate that the negative charge of the carboxyl

group of N-acetylneuraminic acid is responsible for the extended shape of the mucoprotein. On enzymic removal of the acid at pH 6.0 or on suppression of its ionization the molecule assumes a more compact shape.

Dr. Gottschalk and Dr. Fazekas have studied the susceptibility of OSM to digestion by trypsin. The activity of this enzyme is sterically hindered by the prosthetic groups. Removal by neuraminidase of the terminal neuraminic acid units increased by 45 per cent. the number of peptide bonds split by trypsin.

Mr. Murphy has successfully applied the lithium borohydride technique to bovine submaxillary mucoprotein (BSM). As in OSM, it was found that about 85 per cent. of the carbohydrate-prosthetic groups, identified earlier as sialyl (2 6) N-acetylgalactosamine, are linked in glycosidic-ester fashion to the free carboxyl groups of aspartic and glutamic acid residues of the protein moiety, while about 15 per cent. are present in an alkali-stable O-glycosidic linkage.

#### Complementary base pair orientation bias in human DNA (Davern).

KB or HeLa cells were permitted to undergo a single semi-conservative replication of their DNA where 5-bromouracil was incorporated instead of thymine. The density gradient analysis of this singly substituted 5-bromouracil DNA gave a bimodal density distribution. This was interpreted in terms of an overall bias in the orientation of the adenine-thymine couplets in the DNA molecules.

#### Financial Support.

The Wool Research Fund made a grant of £798 towards the cost of investigations into myxomatosis in California.

The Wellcome Trust made a grant of up to £E10,000 for the purchase of an analytical ultracentrifuge. This instrument is to be used in studies of molecular genetics.

#### Other Activities.

Dr. S. Fazekas de St. Groth was elected a Fellow of the Australian Academy of Science in April, 1960, and was appointed to a personal professorship in December.

Professor F. J. Fenner was awarded the Walter Burfitt Prize of the Royal Society of New South Wales.

#### Visits Abroad.

Dr. I. D. Marshall was abroad for the whole year on a U.S. Academy of Science Post-Doctoral Fellowship, which he has occupied in the Department of Epidemiology at the School of Public Health, University of California, Berkeley.

Dr. W. K. Joklik was on study leave at the Laboratory of Cell Biology, National Institutes of Health, Bethesda, Md., and returned to the Department on 22nd July, 1960.

Dr. H. J. F. Cairns went on study leave in May. He is spending the major part of his leave in the Department of Genetics, Carnegie Institute of Washington, Cold Spring Harbor, N.Y.

Dr. A. Gottschalk was in the United States of America and Europe from 14th May to 12th August. He spent six weeks at the University of Michigan, Ann Arbor, and later participated in an International Symposium on "Biochimie des Glucides" in Paris, France.

Professor F. J. Fenner visited India in December, as a Consultant in Medical Research, under Colombo Plan sponsorship.

#### Publications.

The following papers written by members of the Department were published during 1960:—

Barry, R. D.—

"Equilibrium sedimentation of influenza virus in caesium chloride density gradients." *Aust. J. Exp. Biol. & Med. Sci.*, **38**, 499.

Benge, W. P. J.—

"Staining autoradiographs at low temperature." *Stain Technology*, **35**, 106.

Cairns, H. J. F.—

"The initiation of vaccinia infection." *Virology*, **11**, 603.

Davern, C. I.—

"Bias in base-pair orientation in DNA." *Nature*, **188**, 208.

Fenner, F. and Woodroffe, G. M.—

"The reactivation of poxviruses. II. The range of reactivating viruses." *Virology*, **11**, 185.

Gemmell, A. and Fenner, F.—

"Genetic studies with mammalian poxviruses. III. White (*u*) mutants of rabbitpox virus." *Virology*, **11**, 219.

Gottschalk, A.—

"Sialic Acids: Their molecular structure and characteristic reactions." *Drug Research*, **10**, 355.

- "Neuraminidase." *The Enzymes*. 2nd ed. Academic Press, Inc. N.Y. Volume IV., p. 461.
- "The correlation between composition, structure, shape and function of a salivary mucoprotein." *Nature*, **186**, 949.
- Gottschalk, A. and Fazekas de St. Groth, S.—
- "On the relationship between the indicator profile and prosthetic group of mucoproteins inhibitory for influenza virus haemagglutinin." *J. Gen. Microb.* **22**, 690.
- "Studies on mucoproteins. III. The accessibility to trypsin of the susceptible bonds in ovine submaxillary gland mucoproteins." *Biochim. Biophys. Acta*, **43**, 513.
- Gottschalk, A. and Simmonds, D. H.—
- "Studies on mucoproteins. II. Analysis of the protein moiety of ovine submaxillary gland mucoprotein." *Biochim. Biophys. Acta*, **42**, 141.
- Gottschalk, A., Whitten, W. K. and Graham, E. R. B.—
- "Inactivation of follicle-stimulating hormone (FSH) by enzymic release of sialic acid." *Biochim. Biophys. Acta*, **38**, 183.
- Graham, E. R. B. and Gottschalk, A.—
- "Studies on mucoproteins. I. The structure of the prosthetic group of ovine submaxillary gland mucoprotein." *Biochim. Biophys. Acta*, **38**, 513.
- Joklik, W. K., Abel, P. and Holmes, I. H.—
- "Reactivation of poxviruses by a non-genetic mechanism." *Nature*, **186**, 992.
- Joklik, W. K. and Darnell, J. E. Jr.\*—
- "The fate of poliovirus adsorbed to HeLa cells." *Fed. Proc.* **19**, 403.
- Joklik, W. K., Holmes, I. H. and Briggs, M. J.—
- "The reactivation of poxviruses. III. Properties of reactivable particles." *Virology*, **11**, 202.
- Joklik, W. K., Woodroffe, G. M., Holmes, I. H. and Fenner, F.—
- "The reactivation of poxviruses. I. Demonstration of the phenomenon and technique of assay." *Virology*, **11**, 168.
- Marshall, I. D. and Fenner, F.—
- "Studies in the epidemiology of infectious myxomatosis of rabbits. VII. The virulence of strains of myxoma virus recovered from Australian wild rabbits between 1951 and 1959." *J. Hyg.*, **58**, 485.
- Marshall, I. D. and Regnery, D. C.\*—
- "Myxomatosis in a Californian brush rabbit (*Sylvilagus bachmani*)." *Nature* **188**, 73.
- Mims, C. A.—
- "Intracerebral injections and the growth of viruses in the mouse brain." *Brit. J. Exp. Path.* **41**, 52.
- "An analysis of the toxicity for mice of influenza virus. I. Intracerebral toxicity." *Brit. J. Exp. Path.*, **41**, 586.
- "An analysis of the toxicity for mice of influenza virus. II. Intravenous toxicity." *Brit. J. Exp. Path.*, **41**, 593.
- Schell, K.—
- "Studies of the innate resistance of mice to infection with mousepox. I. Resistance and antibody production." *Aust. J. Exp. Biol. & Med. Sci.*, **38**, 271.
- "Studies on the innate resistance of mice to infection with mousepox. II. Route of inoculation and resistance; and some observations on the inheritance of resistance." *Aust. J. Exp. Biol. & Med. Sci.*, **38**, 289.
- Woodroffe, G. M.—
- "The heat inactivation of vaccinia virus." *Virology*, **10**, 379.
- Woodroffe, G. M. and Fenner, F.—
- "Genetic studies with mammalian poxviruses. IV. Hybridization between several different poxviruses." *Virology*, **12**, 272.
- Woodroffe, G. M. and Moulder, J. W.\*—
- "Penicillin-insensitive and non-neutralizable variants of feline pneumonitis virus." *J. Infect. Dis.* **107**, 195.

## DEPARTMENT OF PHYSIOLOGY.

## Staff.

Professor .. .. .	J. C. Eccles, Kt., M.B., B.S., M.A., D.Phil., F.R.A.C.P., F.R.S.N.Z., F.A.A., F.R.S.
Reader .. .. .	W. V. Macfarlane, M.A., M.D.
Senior Fellow .. .. .	D. R. Curtis, M.B., B.S., Ph.D.
Fellow .. .. .	J. S. Coombs, M.Sc.
Senior Research Fellow .. .. .	I. R. McDonald, M.D., B.S. (from January, 1960).
Research Fellows .. .. .	Rosamond M. Eccles, M.Sc., Ph.D.; J. C. Watkins, M.Sc., Ph.D.; R. J. H. Morris, M.Sc. (from April, 1960); R. I. Close, M.Sc., Ph.D. (from September, 1960).

\* Not a member of the Australian National University.

Visiting Fellow .. .. .	E. O. Oscarsson, M.D. (until December, 1960).
Rockefeller Fellows .. .. .	W. Kozak, M.D. (until July, 1960); F. Magni, M.D. (until October, 1960); T. Araki, M.D. (until December, 1960).
U.S. Public Health Fellow .. .. .	W. D. Willis, B.S., B.A., M.D. (from August, 1960).
Research Assistant .. .. .	D. N. Butler, B.Sc. (until June, 1960).
Head Technician .. .. .	L. M. Davies, Dip.Mech. & Elec. Eng., A.M.I.I.T.A., M.Q.E.I.

#### *Student and Teaching Activities.*

During the year there have been eight students proceeding to a Ph.D. degree: R. A. Westerman, M.B., B.S., submitted his thesis "Plastic Changes of Simplest Responses of Mammalian Central Nervous System" on 1st December, 1960; J. W. Phillis, B.V.Sc., submitted his thesis "Assay Methods for Transmitter Substances of the Mammalian Central Nervous System" on 15th November, 1960; J. I. Hubbard, B.Med.Sc., M.A., B.M., B.Ch., submitted his thesis "Factors involved in the release of transmitter substances at the mammalian junctional regions" on 1st December, 1960. M. Ito, M.D., Ph.D., and Rosemary Kinne, B.Sc., continued their research work. Beth Howard, B.Sc. (Hons.) (commenced April, 1960); W. D. Willis, B.S., B.A., M.D. (commenced August, 1960) and R. F. Schmidt, M.D. (commenced end of November, 1960), were enrolled as Ph.D. students and commenced their research. Throughout the year there have been Departmental seminars, usually every week.

#### *Research Activities.*

Much of the work reported for 1959 was completed and written up in 1960 and some appears in the appended list of published papers, the remainder being in press.

During recent years it has been suggested by several investigators that inhibitory action in the central nervous system may be effected by depression of the excitatory action of presynaptic impulses; it is usually considered that this action would be additional to the well established inhibitory action that is produced by hyperpolarizing currents on the postsynaptic membrane of nerve cells. An intensive investigation has greatly extended knowledge on the mechanism of operation of presynaptic inhibition and has indicated that undoubtedly it is of considerable importance in the functioning of the central nervous system. It has been shown that in the phenomenon of presynaptic inhibition there are five events in the spinal cord that are closely related both in their time course and in their production by group I afferent nerve volleys from various muscles: depolarization of both the Ia and Ib primary afferent fibres of all tested muscle nerves; hyperexcitability of these afferent fibres within the spinal cord; generation of impulses in these fibres, which leads to the discharge of impulses out by the dorsal roots, i.e., the dorsal root reflex; generation of a field potential in the spinal cord, the ventral half being relatively negative to the dorsal half; depression of the excitatory postsynaptic potential produced in motoneurons by impulses in the group Ia afferent impulses from muscle. There is now convincing evidence that the first event of this list is primary and this depolarization of the excitatory presynaptic fibres has been fully investigated by intracellular recording. In particular, depression of the synaptic excitatory action would result from the diminished release of transmitter substance from the depolarized presynaptic endings. The experimental evidence has led to the conclusion that the muscle afferent volleys produce the presynaptic depolarization by causing repetitive discharges from interneurons which in turn make the depolarizing synaptic connexions that are located probably near the synaptic terminals of the primary afferent fibres. The prolonged and powerful depolarization is presumed to be due to a chemical transmitter mechanism, though as yet this transmitter is unknown and even the postulated synapses have not been recognized histologically. It can be concluded that a new operative principle has been introduced into our concepts of the working of the central nervous system, but the full implications of this discovery will be realized only after much more investigation (Eccles, Eccles, Kozak, Magni, Willis).

The intracellular recording from the cells of origin of the ventral spino-cerebellar tract has been continued with special reference to the efficiency of the synaptic mechanism at high frequencies of activation and to the patterns of convergence of inhibitory and excitatory actions from the various types of receptors in muscles of different function. The work has been written up for publication (Eccles, Hubbard and Oscarsson). A comparable investigation has been made on the cells of origin of the dorsal spino-cerebellar tract (Eccles, Oscarsson and Willis). These complementary studies have provided the basis for new concepts relating to the manner in which information from the various types of muscle stretch receptors is transferred to the cerebellum and so utilized in the co-ordination of movements. Further investigations on the spino-cerebellar pathways concerned the influence of the cerebral cortex, and the comparative physiology as studied on possums, cats and monkeys (Magni and Oscarsson).

Impulses from the stretch receptors of a muscle act with very brief central delay in inhibiting the reflex discharges from the spinal cord to antagonistic muscles. By a new method it was possible to measure this central delay of the inhibitory action and to show that there was never a discrepancy of more than 0.0001 seconds between the inhibitory action and the onset of the increased electrical charge (hyperpolarization) which was observed on the surface membranes of motoneurons by intracellular recording. These results together with a series of related investigations on the excitability of motoneurons established that the hyperpolarization of nerve cell membrane and the synaptic currents generating it are conjointly responsible for the inhibitory action on the nerve cell. It is claimed that these new investigations provide definitive evidence on several fundamental problems that hitherto have been controversial (Araki, Eccles, Ito).

The investigation of the actions of amino acids and other neuro-pharmacologically active substances on nerve cells has been continued. Several previously untested amino acids have been synthesized (Watkins and Butler) and their potencies as excitatory or depressant agents upon the responses of the isolated spinal cord of the toad have been determined. Under these test conditions, gamma-amino propane sulphonic acid proved to be the strongest depressant, and homocysteic acid and N-methylaspartic acid the strongest excitants, of all of the amino acids yet tested. The D forms of amino acids were found to have stronger actions than the L forms. The toad spinal cord has also been used to investigate cholinergic transmission in the amphibian central nervous system (Phillis). Further studies have been made on the extent of cholinergic synaptic transmission in the mammalian spinal cord. The ionophoretic technique of applying substances into the environment of single neurones was employed in these studies, and this technique is currently being used to test the actions of the most recently synthesized amino acids (Curtis and Watkins). Preliminary work on the extraction of transmitter substances from cattle brain has been begun and methods of testing the extracts are being developed (Curtis and Watkins).

Experiments during the year on transmitter release at the mammalian neuro-muscular junction have revealed that calcium and magnesium ions have striking effects on the spontaneous release of transmitter. As well as having important theoretical implications, this phenomenon may be important clinically as a cause of the neuro-muscular excitability found in patients with low plasma magnesium levels (Hubbard).

The ionic mechanisms involved in the activity of cat motoneurones have been studied by a precise investigation of the effects produced by the electrophoretic injection of many anions and cations into motoneurones. In confirmation of earlier publications from the department, anions could be divided sharply into two classes according as they do or do not participate in the postsynaptic ionic currents that are produced at inhibitory synapses. Seven new effective species have been added to the original four, while fifteen ineffective species have been recognized. With the exception of a slight size discrepancy for formate ions, all of the effective ion species had a smaller hydrated size than any of the ineffective; hence, there has been good support for the original postulate that the inhibitory ionic currents flow through a sieve-like membrane having pores of a uniform diameter. With nine of the eleven effective ion species the time courses of recovery after ionic injections gave a measure of the relative permeabilities of the whole surface membrane of the motoneurone. Three cations, lithium, rubidium and ammonium ions, were also injected electrophoretically. In the effects produced on the spike potential, the after hyperpolarization following the spike potential and the inhibitory postsynaptic potential, rubidium resembled potassium and lithium resembled sodium, while with ammonium there was an intermediate response (Araki, Ito and Oscarsson).

The accommodation of motoneurones to the application of prolonged current flow has been carefully re-examined by the intra-cellular application of linearly-rising as well as steady depolarizing currents. The accommodation of motoneurones is generally slow in cells under good conditions, but becomes much faster when the cell is injured by the microelectrode. It was surprising to find that phasic motoneurones did not have a faster accommodation than the tonic ones (Araki, Ito).

Renal handling of electrolytes in the ruminant differs from that found in man or dogs. Continuous collecting and recording equipment has been devised to examine the effects of hormones on salt and water balance in sheep. The main findings are that within 20 minutes of a meal urine pH falls from 8.5 to 5.5 (the opposite behaviour to that of carnivores). Infusion of vasopressin at urine flows below 2.5 ml/min increases water, salt and potassium excretion. At higher rates of flow it is antidiuretic. Adrenalin causes a large water excretion of very low electrolyte concentration, while nor-adrenalin increases water and sodium excretion. Aldosterone can reduce sodium concentration below 1 m.equiv./l without altering the urine flow (Kinne, Macfarlane).

Field studies at Julia Creek (lat. 21° S.) on water turnover using tritium have shown that in men the turnover increased 3 or 4 times in the tropics and total body water increased 5 per cent. or more. In sheep turnover is doubled (compared with temperate zone animals), and total water is increased up to 15 per cent. Further studies on water conservation by desert mammals have been made, together with measurement of the main hormones and metabolites involved (Kinne, Macfarlane, Morris). In the cool climate of Canberra, fluid distribution and turnover was examined before and after winter shearing of sheep. Poorly nourished animals (9/acre) could not maintain body temperature, lost 30 per cent. of body solids and increased both intracellular and extracellular fluid volumes. Animals with more reserves (6/acre) lost 10 per cent. of solids and increased only the extracellular water. Adrenal exhaustion may account for the considerable disturbance of the 9/acre animals (Howard, Macfarlane, Morris). The long-term fluid distribution and body composition changes of rats have shown a spring peak and autumn trough in fluid spaces at latitude 27°, but these are delayed at latitude 32° (Howard). Estimation of the water content and turnover of the rumen has been undertaken using a rumenostomy, tritium and cobalt-EDTA (Morris).

The nervous system takes part in acclimatization, and the possibility that the reflexes of high spinal cats might be modified in their responses to heat and cold was explored. There was cessation of reflex movement after twice daily exposure to cold for 12 days, and return to full activity in 12 days. During this recovery from cold, the same limb became habituated to heat. Three months later the rate of adaptation to cold was four times faster than that found initially. These slow changes of the responses mediated through the spinal cord are of interest in relation to acclimatization and learning (Kozak, Macfarlane, Westerman).

Investigations on the secretions from the adrenal cortex have been made on sheep by means of a simple canulation method that delivers the blood flowing from the intact adrenal gland without recourse to anaesthesia or significant disturbance. Experiments in progress have so far demonstrated that there are some distinct differences between the responses of the intact and the autotransplanted adrenal gland to the injection of adreno-cortico tropic hormone and to stimuli such as restraint of the animal. Experimental investigation has been continued on the effects exerted by naturally secreted adrenal cortico-steroids on the secretion of electrolytes by the sheep parotid gland. The research programme is being developed with special reference to the relationship of the secretion rate of adrenal cortico-steroids to the activity of "target" organs, and the correlation of such activity with certain aspects of the general physiological status of the animal (McDonald).

Experiments conducted during 1960 have further investigated the effect of use and disuse of the simplest spinal reflex pathways. Unilateral tenotomy leads to enhancement of two types of monosynaptic transmission from nerves supplying tenotomized muscles. Spinal transection prevents all the changes induced by tenotomy. There is some evidence suggesting that these changes are due to an increased group Ia proprioceptor discharge from tenotomized muscles, resulting in enhanced synaptic efficacy following this increased use of synapses. Chronic spinal cats display grossly exaggerated reflexes of cutaneous origin. In accord with this, electrophysiological analysis has shown marked prolongation of the highest threshold cutaneous reflex discharges in chronic spinal cats compared with acute spinal animals (Kozak and Westerman).

#### *Other Activities and Overseas Visits.*

Sir John Eccles was overseas from 28th May to 30th July. He gave two papers at an International Symposium on Nervous Inhibition that was held at the Friday Harbour Laboratories of the University of Washington, Seattle, and one paper at a Symposium on Abnormal Nervous Functions at Boston. He delivered the Ferrier Lecture "The Nature of Central Inhibition" at the Royal Society in June, and later acted as Chairman of a Ciba Symposium on "The Nature of Sleep". He also gave lectures and seminars at the University of British Columbia, Oregon State Medical School, Oregon State University, the Sorbonne and Oxford University. Two communications were given at meetings of the British Physiological Society at Cambridge and Lund. In July Sir John Eccles represented the Australian Academy of Science at the Tercentenary Celebrations of the Royal Society and was given an Honorary Sc.D. by Cambridge University. In November he was appointed to the Research Advisory Committee of the C.S.I.R.O.

Dr. Macfarlane made a contribution to the Indian Ocean Science Congress at Karachi. He was also on the organizing committee of the Arid Zone technical conference, held near Melbourne during December, and presented three papers. In May the inaugural meeting of the Australian Physiological Society was held in Sydney, and Dr. Macfarlane, having been interim secretary, became honorary secretary of the Society.

Dr. Curtis was on leave as a Visiting Professor at Downstate Medical Center, State University of New York, until September. He gave papers at the International Symposium on Inhibition at the Friday Harbour Laboratories and also at the Fourth International Neurochemical Symposium at Varenna, Italy. In addition, he gave lectures at several Universities and Institutes.

Dr. Rosamond Eccles was on leave as Sharpey Scholar of University College, London, until October, and presented communications to meetings of the British Physiological Society. She also gave a lecture at the Sorbonne.

In November, Mr. Phyllis was appointed to a Wellcome Research Fellowship to work for two years in the Laboratories of the Agricultural Research Council at Babraham, England.

#### *Publications.*

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

Araki, T., Eccles, J. C. and Ito, M.—

"Latency of central inhibition." *J. Physiol.*, **154**, 29P.

Buller, A. J., Eccles, J. C. and Eccles, R. M.—

"Differentiation of fast and slow muscles in the cat hind limb." *J. Physiol.*, **150**, 399–416.

"Interactions between motoneurons and muscles in respect of the characteristic speeds of their responses." *J. Physiol.*, **150**, 417–39.

Curtis, D. R. and Eccles, J. C.—

"Synaptic action during and after repetitive stimulation." *J. Physiol.*, **150**, 374–98.

Curtis, D. R., Perrin, D. D.\* and Watkins, J. C.—

"The excitation of spinal neurones by the ionophoretic application of agents which chelate calcium." *J. Neurochem.*, **6**, 1–20.

Curtis, D. R. and Phillis, J. W.—

"The action of procaine and atropine on spinal neurones." *J. Physiol.*, **153**, 17–34.

Curtis, D. R., Phillis, J. W. and Watkins, J. C.—

"The chemical excitation of spinal neurones by certain acidic amino acids." *J. Physiol.*, **150**, 656–82.

\* Not members of the Department of Physiology.

- Curtis, D. R. and Watkins, J. C.—  
 “Investigations upon the possible synaptic transmitter function of gamma-aminobutyric acid and naturally occurring amino acids.” *Inhibitions of the Nervous System and  $\gamma$ -Aminobutyric Acid*. London. Pergamon Press, pp 424–44.  
 “The excitation and depression of spinal neurones by structurally related amino acids.” *J. Neurochem.*, **6**, 117–41.
- Eccles, J. C.—  
 “The properties of the dendrites.” In Proceedings, Second International Meeting of Neurobiologists. Amsterdam. Elsevier Publishing Co.
- Eccles, J. C. Eccles, R. M., Iggo, A. and Lundberg, P. A.—  
 “Electrophysiological studies on gamma motoneurones.” *Acta physiol. scand.*, **50**, 32–40.
- Eccles, J. C., Eccles, R. M. and Lundberg, P. A.  
 “Types of neurone in and around the intermediate nucleus of the lumbosacral cord.” *J. Physiol.*, **154**, 89–114.
- Eccles, J. C., Eccles, R. M. and Magni, F.—  
 “Development of monosynaptic paths following changed motoneurone function.” *J. Physiol.*, **152**, 29–30P.  
 “Monosynaptic excitatory action on motoneurones regenerated to antagonistic muscles.” *J. Physiol.*, **154**, 68–88.  
 “Presynaptic inhibition in the spinal cord.” *J. Physiol.*, **154**, 28P.
- Eccles, J. C. and Krnjevic, K.—  
 “Potential changes recorded inside primary afferent fibres within the spinal cord.” *J. Physiol.*, **149**, 250–73  
 “Presynaptic changes associated with post-tetanic potentiation in the spinal cord.” *J. Physiol.*, **149**, 274–87.
- Eccles, J. C., Kozak, W. and Magni, F.—  
 “Dorsal root reflexes in muscle afferent fibres.” *J. Physiol.*, **153**, 48–49P.
- Eccles, R. M., Iggo, A. and Ito, M.—  
 “The distribution of recurrent inhibition among motoneurones.” *J. Physiol.*, **153**, 49–50P.
- Lundberg, P. A. and Winsbury, G.—  
 “Selective adequate activation of large afferents from muscle spindles and Golgi tendon organs.” *Acta physiol. scand.*, **49**, 155–64.  
 “Functional organization of the dorsal spino-cerebellar tract in the cat.” VI. Further experiments on excitation from tendon organ and muscle spindle afferents. *Acta physiol. scand.*, **49**, 165,70.
- Macfarlane, W. V.—  
 “Antidiuretic hormone assay, and clinical implications.” In *Clinical Endocrinology*, 637–48. Ed. E. Astwood. Grune and Stratton, New York.  
 “The plateau of the action potential of the frog ventricle.” *Circulation Res.*, **8**, 47–56.  
 “Human functions in arid regions.” Arid Zone technical conference, Vol. 1 (48), 1–18. Melbourne. C.S.I.R.O.  
 “Medical service and communication in the semi-desert.” Arid Zone technical conference, Vol. 1 (52), 1–11. Melbourne. C.S.I.R.O.  
 “Animal production in hot arid regions.” Arid Zone technical conference, Vol. 2 (1), 1–25. Melbourne. C.S.I.R.O.
- Macfarlane, W. V. and Spalding, D.\*—  
 “Seasonal conception in Australia.” *Med. J. Aust.*, **1**, 121–24.

## DEPARTMENT OF PHYSICAL BIOCHEMISTRY.

*Staff.*

Professor ..	..	..	..	A. G. Ogston, M.A., D.Phil., F.R.S.
Senior Fellow ..	..	..	..	H. A. McKenzie, M.Sc., Ph.D., F.R.A.C.I.
Research Fellows ...	..	..	..	J. McD. Armstrong, B.Sc., M.Sc.; B. N. Preston, B.Sc., Ph.D.
Research Assistant ..	..	..	..	Laurel Atkinson, B.Sc.
Electron Microscopist (Fellow)	..	..	..	M. C. Taylor, M.Sc.

Professor Ogston arrived in Canberra from Oxford in September. Drs. Armstrong and Preston arrived in December. Miss Atkinson started work in February. Mr. Taylor started work in July.

*Students and Teaching Activities.*

Mr. M. Davies, M.A., Research Scholar, worked for most of the year in Oxford under Professor Ogston, and arrived in Canberra in September; he is carrying out research on the chemical and physico-chemical properties of hyaluronic acids.

\* Not members of the Department of Physiology.

Mr. M. A. W. Thomas, Research Scholar, left in August.

A graduate course of lectures on the physical biochemistry of proteins was given in the John Curtin School, extending over the second and third terms.

#### Research Programme.

(1.) (Ogston, Preston, Davies). Work was continued, first in Oxford and later in Canberra, on substances and systems related to connective tissue. It is intended to pursue this work along the following lines:—

- (a) Osmotic pressures of solutions of hyaluronic acid, alone and in mixtures containing protein;
- (b) The effects of hyaluronic acid (and other gel-forming substances) on the diffusion of solutes of a range of molecular size;
- (c) Light scattering properties of solutions containing hyaluronic acid.

The general object of these researches is to throw light on the microscopic structure of solutions of hyaluronic acid; it is thought that the presence in solution of a molecular meshwork formed by a chain-polymer (hyaluronic acid) may have important effects on the behaviour of other substances and that these effects, observed *in vitro*, will also operate in connective tissue *in vivo*.

(2.) (McKenzie, Armstrong, Atkinson). Many of the physical and chemical properties of proteins are related to the structure and state of association of these molecules. A study is being made of the changes in physico chemical properties of different types of bovine haemoglobin brought about by the action of urea and of the effects of pH, temperature and urea on the structure and association of the  $\beta$ -lactoglobulin.

A study of the physical biochemistry of casein has continued. Special attention has been directed towards development of new methods for the fractionation of casein, particularly  $\kappa$ -casein. A review is being made of present knowledge of the structure of the casein micelle and of the role of calcium in whole milk.

A study is being made of the physico chemical properties of ovine submaxillary gland mucoprotein in collaboration with the Department of Microbiology.

(3.) (Taylor). The Electron Microscope Unit has been moved from Wing C Level 1 to new laboratories in Wing A Level 2. The RCA microscope was dismantled for this move and is now being reassembled in its new location. Electronic maintenance and modifications are being carried out on the instrument. It is expected that a new Siemens electron microscope will be installed in the course of 1961. The electron microscopes are intended primarily to serve the requirements of departments in the John Curtin School.

#### Other Activities.

Dr. McKenzie delivered a guest lecture on the physical biochemistry of the  $\beta$ -lactoglobulins to the Australian Biochemical Society in Sydney in August.

#### Publications.

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

McKenzie, H. A., Hamoir, G.\* and Smith, M. B.\*—

“The isolation and properties of fish myosin.” *Biochim. biophys. Acta*, **40**, 141–9 (1960).

Ogston, A. G.—

“Some tests of the effect of stirring on the rate of dialysis: the Indeculator.” *Arch. Biochem. Biophys.* **89**, 181–3 (1960).

Ogston, A. G. and Phelps, C. F.\*—

“Exclusion of inulin from solutions of hyaluronic acid.” *Nature, Lond.*, **187**, 1024 (1960).

#### BIOLOGICAL INORGANIC CHEMISTRY SECTION.

##### Staff.

Professor .. .. .	.. .. .	.. .. .	.. .. .	F. P. Dwyer, D.Sc., F.R.A.C.I.
Fellow .. .. .	.. .. .	.. .. .	.. .. .	A. M. Sargeson, B.Sc., Ph.D.
Honorary Research Assistant	.. .. .	.. .. .	.. .. .	J. W. Hogarth, B.Sc.
Senior Technical Officer	.. .. .	.. .. .	.. .. .	I. K. Reid.

##### Students.

Five 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. (March 1959, Stereospecific Influences in Metal Complexes); B. Bosnich, B.Sc. (March 1959, Kinetics of Substitution in Octahedral Complexes); G. H. Searle, M.Sc. (September 1960, Stereochemistry and Kinetics). Each member of staff and most of the students contributed two one-hour seminars during the year.

\* Not members of the Australian National University.

*Research Programme.*

The work of the section is concerned with the synthesis of metal complexes, their fundamental chemistry and their application to biology. Clinical trials are proceeding in the Royal Women's Hospital, Royal Melbourne Hospital and the Eye and Ear Hospital in Melbourne, with a group of iron, nickel and ruthenium complexes as anti-bacterial agents. The toxicity is still too high for systemic use, but topically, the substances have been found to be non-irritant and non-toxic. The high activity (2-5  $\mu\text{g}.\text{ml}.$ ) against penicillin resistant *Staph. aureus* and a number of pathogenic fungi (20  $\mu\text{g}.\text{ml}.$ ) suggests that the complexes may be valuable in the treatment of wounds, eye and vaginal infections. It has been found that some of the complexes are effective against the organisms responsible for bovine mastitis, and field tests have been organized. Monsanto Chemicals (Australia) have indicated their interest in the large scale production of some of the metal complexes. At present they have undertaken the supply of materials to the various Melbourne hospitals, and to Sigma (Australia) for the mastitis testing.

The Walden Inversion, that is known to occur when optically active *cis*-dichlorobis(ethylenediamine) cobalt ion is treated with silver carbonate, has been shown to involve the stepwise attack of the cation by hydroxyl ion. The loss of the first co-ordinated chlorine is associated with configurational inversion, but the loss of the second occurs with configurational retention (Sargeson). The rate of electron transfer between the tris(ethylenediamine) cobalt(II.) and cobalt(III.) complex ions in the presence of ethylenediamine follows both first- and second-order kinetics, two separate reactions being involved (Sargeson). The substance B.A.L. diacetic acid has been synthesised for tests as a stereospecific quadridentate molecule, and as an antidote for lead and mercurial poisoning (MacDermott). The ethylenediaminebis(malonato) cobalt(III.) ion has been synthesised and separated into the optical forms for the first time (Reid).

The works on the kinetics of racemization and dissociation of nickel and chromium complexes with "mixed" ligands has been completed. Both reactions are pH dependent, and involve dissociation of the first (weakly bound) ligand as the rate determining process (Broomhead). Redox potential measurements on a large number of osmium complexes have been carried out to determine the thermodynamic constants. This work is related to the haemoporphyrin systems where small changes in the substituents of the porphyrin ring determine a number of important biological properties (Buckingham). The rate of exchange of the cadmium complex of *l*-propylenediaminetetraacetic acid with the dextro form of the ligand has been found to be pH dependent, and to involve stepwise dissociation of the bound ligand, probably at the oxygen atoms (Bosnich). In collaboration with Dr. B. Halpern of Monsanto (Australia) Limited, experiments are proceeding on the resolution of amino acids (Dwyer).

*Other Activities.*

Under the auspices of the Chemical Society of London, a series of lectures were given in Perth, Adelaide, Hobart and Melbourne. Dwyer also presented a research lecture to the Chemistry Department of the University of Sydney, and gave the opening address at the Science Teachers of New South Wales Annual Convention.

*Publications.*

The following papers written by members of the section were published during 1960:—

BOSNICH, B., DWYER, F. P. and SARGESON, A. M.—

"Rate of Ligand exchange with its metal complex by a polarimetric method." *Nature*, **186**, 966.

Dwyer, F. P. and Garvan, F. L.\*—

"Rhodium(III.) complexes with ethylenediaminetetraacetic acid." *J. Amer. Chem. Soc.*, **82**, 4823.

Dwyer, F. P. and Sargeson, A. M.—

"Catalytic racemization of tris(ethylenediamine) cobalt(III.) ion." *Nature*, **187**, 1922.

*Animal Breeding Establishment.*

The Veterinary Officer, Mr. W. K. Whitten, B.Sc., B.V.Sc., left Canberra on 18th February, 1960, to spend a year's study leave at the Jackson Laboratory, Bar Harbour, Maine, United States of America.

## THE RESEARCH SCHOOL OF PHYSICAL SCIENCES.

## DIRECTOR'S REMARKS.

The past year has been a difficult period for this School. Problems arising from the union of the University with Canberra University College, the appointment of a new Vice-Chancellor and the establishment of a Department of Mathematics in the School, occupied a great part of the time of some senior staff. The situation was aggravated by a disastrous fire in the laboratories and by the difficulties of recruitment while salaries in the National University remain below those in some state universities.

The decision to create a Department of Mathematics, to be concerned principally with research and training in pure mathematics, was made three years ago. This was largely a result of the unanimous decision by a representative meeting of Australian mathematicians, convened by this School, urging that a research department of mathematics was a necessity for the development of the subject in this country. At the present time, there is a serious shortage of mathematicians of standing and it is only now that a mathematician of high rank has been persuaded to come to Canberra. The University is very fortunate to have been able to appoint Dr. B. H. Neumann, F.R.S., now Reader in Mathematics in Manchester, to be Head of the Department. He will visit the University in 1961 and will take up his duties in 1962. His wife, also a distinguished mathematician, will be appointed to a Readership at a later date when she is able to leave her children in England. Meanwhile, Professor Neumann will assemble the staff of his department which promises to be one of outstanding importance and achievement. Dr. Neumann plans to attract many of the world's leading mathematicians as visiting professors, each spending up to a year in the University. He wishes also to organize regular Australia-wide seminars in mathematics. In this way, it is believed that many of the problems of the relative isolation of mathematicians in Australia can be solved. This summer the University is providing working space for a gathering of about sixteen mathematicians from all over Australia, who are spending a period working together and attending specialized colloquia as a mathematical institute. Unfortunately, funds were not available to enable the University to assist financially with this important project in the revivifying of Australian mathematics.

The work of the School continues to improve in quantity and quality as is shown in the following departmental reports. Highlights of development have been the arrival and installation of the 10,000,000 electron-volt tandem accelerator from the United States, which should come into operation early in 1961; the remarkable quality of the first stellar spectra obtained with the Coudé spectrograph which Dr. Dunham has designed for use with the 74-inch telescope at the Observatory; the successful operation of the experimental field-station of the Observatory on Mount Bingar, near Griffith, New South Wales; and the rapid progress made in the determination and understanding of rock ages and rock magnetism. Disappointments were the extremely slow progress with the various small building extensions and alterations which have been authorized, especially the restoration of fire damage; the necessity to send the 74-inch telescope mirror back to Britain for refiguring; and the second failure of the bearings of the homopolar generator.

The two top floors of the Cockcroft Building were destroyed by fire during the night of 5th July. The loss of equipment was serious but the complete destruction of the drawing office, with all records and drawings of the homopolar generator and proton-synchrotron, was the most important item of physical loss. More far-reaching individual losses were the destruction of many years of research results and valuable collections of minerals and papers by Dr. Joplin, and the serious set-back to the work of many research students. The cause of the fire was not determined, but immediate action was taken to replace the building in a more fireproof form. Serious damage and inconvenience was caused subsequently through ingress of water into the lower floors due to lack of a proper roof during heavy rains. The roof has now been replaced. Parts of the departments of Geophysics, Nuclear Physics and Particle Physics, which have been crowded into already over-filled laboratories and offices, have suffered severely as a result. There have been continual delays in rebuilding and it now appears that the accommodation will not be available for re-occupation until August, 1961.

## DEPARTMENT OF ASTRONOMY.

*Staff.*

Professor of Astronomy and Director of Observatory .. .. .	Bart J. Bok, Ph.D.
Reader and Deputy Director (Administration) .. .. .	A. R. Hogg, D.Sc., F.Inst.P., F.A.A.
Reader and Assistant Director (Research) .. .. .	S. C. B. Gascoigne, M.Sc., Ph.D.
Reader .. .. .	T. Dunham, Jr., Ph.D.
Head of Time Service (Senior Fellow) .. .. .	H. J. McK. Abraham, M.Sc.
Senior Fellow .. .. .	W. Buscombe, M.A., Ph.D.
Fellows .. .. .	H. R. F. Gollnow, Dr.Phil.; A. Przybylski, Dr.sc.tech., Ph.D.
Research Engineer (Fellow) .. .. .	K. Gottlieb, Dip.Ing.
Research Fellow .. .. .	A. W. Rodgers, Ph.D. (on leave).
Honorary Professor .. .. .	R.v.d.R. Woolley, F.R.S., Astronomer Royal.
Visiting Professor .. .. .	L. H. Aller, Ph.D.
Honorary Fellows .. .. .	G. E. Kron, Ph.D.; B. E. Westerlund, Ph.D.

Dr. Westerlund continues in residence as the Uppsala Observer. He will resign his post as of the middle of 1961, and has accepted appointment, starting in August, 1961, as a Reader in the Department of Astronomy of the Australian National University. Mr. C. E. Jackson continues as the Yale-Columbia Observer.

Dr. Buscombe was promoted to Senior Fellow. He has continued to act as Editor of the Observatory publications.

#### *Student Activities.*

The Department is now close to its goal, set three years ago, of having at the Observatory, six scholars from Australia and two from overseas. There are now five scholars—R. A. Bell, I. J. Danziger, D. J. Faulkner, J. A. Graham and J. B. Whiteoak—from Australia and two—D. Sher and R. R. Shobbrook—from overseas. The doctoral theses of Mr. Bell (White Dwarfs) and Mr. Whiteoak (Southern OB Associations) are near completion. Mr. Faulkner is engaged on a doctoral project with the photoelectric scanner, in which he will deal principally with the relative abundances of the chemical elements and the thermal excitation in the Eta Carinae and 30 Doradus nebulae. Mr. Danziger's thesis project will probably be concerned with the spectra of very cool stars; that of Mr. Shobbrook with studies of colour and brightness distribution and with spectral types and radial velocities of southern galaxies of special interest to radio astronomers; that of Mr. Sher with a combined photographic and photoelectric study of galactic clusters in the Carina section of the Milky Way; and that of Mr. Graham with application to the southern sky of the new Strömrgren photometer.

The programme of Summer Vacation Scholars is now in its fourth year, with eight students, from the Universities of Queensland, Tasmania, Western Australia and Melbourne in attendance. The pattern follows that established during the first three years with, again as one major feature, a special programme of weekly survey colloquia. During 1960 the summer vacation scholars spent two days in and near Sydney as the guests of the Radiophysics Division of C.S.I.R.O., a successful experiment to be repeated in 1961.

#### *Visitors.*

Professor Aller, of the University of Michigan, arrived in June for a year as Visiting Professor. Dr. G. E. Kron from Lick Observatory arrived in September for an extended stay. Dr. R. van der Borgh of the Department of Applied Mathematics of the University of Natal spent six months as a Visiting Lecturer. He returned to South Africa in July, but is expected back shortly as an Associate Professor of the Department of Mathematics in the School of General Studies. Mr. Santoso Nitisastro, from Bosscha Observatory, Indonesia, is at the Observatory under a Colombo Plan Fellowship.

As in the past, the Department had short visits from many distinguished visitors from Australia and overseas. Dr. A. Brown of Melbourne University gave lectures on galactic dynamics and Professor L. Bierman of the Max Planck Institute, Munich, spent two weeks at the Observatory, during which period he lectured at the Observatory and at the School of Physical Sciences. Dr. T. Elvius, from Uppsala, spent several months at the Uppsala Station and took part in many of the Department's activities. Other visitors from overseas were: Dr. T. Gold and Dr. E. E. Salpeter of Cornell University, Dr. G. Gamow of the University of Colorado, Dr. J. Beckers and Dr. C. L. Seeger from the Netherlands and Dr. N. Milford of St. John's University. Mr. G. M. Sisson of Grubb-Parsons was a visitor in November. Several staff members of the Radiophysics Division of C.S.I.R.O., visited the Observatory.

#### *Administration.*

During 1960 important changes were made in the administrative arrangements for the Observatory. Dr. Hogg was made Deputy Director (Administration) with responsibility for the day-to-day administration. As a special assignment he has the major responsibility for the site testing programme. Dr. Gascoigne was appointed Assistant Director (Research). He is responsible for all new equipment, including the co-ordination and initiation of plans, supervision of the preparation of specifications and of testing and putting into operations of new equipment. He is in charge of the co-ordination of all research programmes and is responsible for the technical efficiency of telescopes and auxiliary equipment.

#### *Instrumental Developments.*

The outstanding event of the year was the taking of the first successful coude spectrogram with the 74-inch reflector. It was photographed with the 120-inch focal length camera and is of the bright star Canopus. It shows good definition from the ultraviolet to the red at a dispersion of 2.8 Angstroms per millimeter near H-gamma. At present three cameras are available for photography of coude spectra, the 120-inch, the 32-inch Schmidt and the 8-inch, f/1 Schmidt. The coude spectrograph will be scheduled regularly in 1961.

Extensive maintenance and repair work has been carried out on the 74-inch dome and the telescope was out of commission for a little over four months. New lifting mechanism for the observing carriage has been installed and the dome and its supports have been repaired and adjusted. The temporary replacement mirror is installed and is performing quite well.

The 50-inch reflector was extensively modified to accommodate new optics.

A polar telescope has been designed for use in the site testing programme. A heavy base frame will be mounted permanently at each site, and a detachable drive and mounted mirror will be transported from site to site as required.

Other instrumental improvements include a light off-set photometer for use at the Newtonian focus of the 74-inch reflector, an exposure meter for the Newtonian spectrograph on the 74-inch reflector, a new collimator and camera objectives for the Cassegrain spectrograph and an impersonal setting device for the spectral comparator.

Professor Aller brought with him a photoelectric scanner, designed and built by Dr. W. Liller. It was originally intended for use with an  $f/5$  reflector. It works well on the 74-inch reflector and has been adapted for use on the 50-inch and 26-inch Mount Bingar reflectors, on both of which instruments it works satisfactorily.

A Strömgren photometer is in an advanced stage of construction and should be in operation early in 1961. A new Nebular Spectrograph and an off-set photoelectric photometer should arrive in the early part of 1961.

#### *The Site Testing Programme.*

This programme continues to have a twofold purpose. Firstly to locate a site for a Field Station for Mount Stromlo Observatory, and secondly to locate one or two sites anywhere in Australia that might prove suitable for major observatory development. The choice for a site for a Field Station is now between Mount Bingar, near Griffith and Yenda, Boona Mountain near Condobolin, Siding Springs Mountain near Coonabarabran, and Mount Kaputar near Narrabri, all in New South Wales. In the second survey Mount Singleton near Wubin, Mount Burgess near Kalgoorlie, both in Western Australia, and Mount Woodroffe and a possible site in the Flinders Range in South Australia, head the list. Figures for night cloudiness have eliminated most other sites considered and the next step will be comparative tests for astronomical seeing.

For 1958–59 (average for 19 months) the average percentages of “A-quality” clear nights, from observations taken between 9 and 10 p.m., were, for Mount Stromlo 32 per cent., for Mount Bingar 53 per cent., and for Boona Mountain 54 per cent. During 1960 the corresponding percentages were: Stromlo 32 per cent., Bingar 40 per cent., Boona 48 per cent. The stability of Bingar skies, mostly associated with good seeing, makes Mount Bingar a favourable site for photoelectric work, which is not the case for Mount Stromlo. Good, clear skies prevail especially during the Magellanic Clouds observing season, which comes in spring and summer. In one year at Mount Bingar, one can accomplish four times as much photoelectric work on the Large Magellanic Cloud as with the same telescope placed at Mount Stromlo. The Field Station was occupied on a total of 342 nights during 1960.

Two surveys covering new localities were made during the year, one to the Barrier Range area between Broken Hill and Tibooburra, New South Wales, and one to an area between Meekatharra, Wiluna and Kalgoorlie.

A start has been made on instrumental seeing tests using the polar telescope, and these tests will be supplemented with an 8-inch reflector.

#### *Progress in Research.*

*The Star Clouds of Magellan.*—The past year has been a very active one for research on the Small and Large Magellanic Clouds, the two satellite galaxies that accompany the Milky Way system. Dr. Gascoigne is now President of the International Sub-commission on the Magellanic Clouds and the preparation of a survey of work done at Mount Stromlo and elsewhere has been a major item of activity. Jointly with the Uppsala Observatory, the Department is bringing out an Uppsala-Mount Stromlo Atlas of the Magellanic Clouds, which is almost ready for distribution. Special attention is being given to the measurement of colours and brightnesses of stars and star groupings in both Clouds. In the work the regular Mount Stromlo staff has been joined by visitors from overseas, and the Uppsala Observatory at Mount Stromlo, Dr. Westerlund, has participated actively in these researches. Much profit is accruing from the arrangement under which telescope time is exchanged with the Uppsala Observatory.

Several of the star groupings studied in the Magellanic Clouds are quite young on the cosmic scale, three to ten million years of age, which represents less than one-fifth of one per cent. of the estimated age of the earth. This is shown by the presence of exceedingly blue, hot stars of a wide range of apparent brightness. The presence of much associated bright nebulosity is suggestive also of the recent formation of many of these groupings, formed apparently as recently as anything which we observe in the Milky Way system. However, the colour-brightness arrays for other parts of the Magellanic Clouds show that there are in these two star systems also regions that contain cosmically very old stars—some with maximum ages twice that of the sun and earth. In the Magellanic Clouds young Population I and old Population II occur apparently side by side.

Much interest attaches to spectral studies of the Magellanic Clouds, and here the new scanner is proving to be exceedingly useful. There has been much speculation about whether or not the relative abundances of the major chemical elements in the Milky Way system are the same as in the Magellanic Clouds. The researches to date seem to show that at least the chemical elements hydrogen and helium occur in roughly the same proportions in the Magellanic Clouds and in the Milky Way system. The techniques of six-colour photometry—brought to Mount Stromlo by Dr. Kron—are proving a real help in the study of the precise nature of the globular star clusters in both Magellanic Clouds.

*The Milky Way System.*—The Atlas of H-alpha emission nebulae in the southern Milky Way is ready for distribution. It represents an achievement of which the Department can be truly proud and already, in preliminary form, it has figured in optical identification of objects of interest to radio astronomers.

Several studies in relation to the spiral structure of the Milky Way system are being brought to a close. Studies of galactic clusters are contributing further to the solution of the spiral structure problem and from these, and work on some of the larger southern globular star clusters, much of interest is being learned about the evolution of stars in our Milky Way system. Mount Stromlo Observatory has completed its share in the joint study with Uppsala Observatory of the stellar distribution in the south galactic polar cap.

*Spectrographic Studies.*—Fourteen planetary nebulae south of  $-14^\circ$  are being studied with the photoelectric scanner, together with some clusters and a number of external galaxies. The work on the Scorpio-Centaurus cluster is approaching completion, and luminosity classifications for 220 early-type stars has been published. Much progress is being made with the spectral-radial velocity programme on high-velocity stars and subdwarfs. An interesting by-product of this research has been the discovery of a star unusually rich in elements other than the customarily abundant elements hydrogen and helium. Orbits have been obtained for four spectroscopic binaries and for two eclipsing binaries.

*Theoretical Studies.*—Extensive calculations have been carried out on the interior properties of neutron stars. A hitherto unidentified band in the spectra of certain white dwarfs has been identified as originating from the carbon molecule, and observational identification of another theoretically predicted band has been obtained. Relativistic cosmology has been an active field of research during the past year.

*Future Trends.*—In future, observing time for the 74-inch reflector will be increasingly devoted to spectrographic research with the coudé spectrograph and the nebular spectrograph. The photographic and photoelectric work will be largely transferred to the smaller telescopes, with the 50-inch reflector to carry most of the future photoelectric work on faint stars, and the new 40-inch reflector to be used for both direct photography and photoelectric photometry. The rather slow Zeiss-Newtonian spectrograph will probably be adapted and transferred to one of the smaller telescopes. We are considering removal of the 50-inch reflector to the more favourable sky conditions at the Field Station, where the new 40-inch reflector will be erected. The 26-inch reflector now at Mount Bingar should remain at the Field Station when the present test programme is completed, but the mirror will probably be replaced by a 15-inch mirror, making this an ideal supporting telescope for photoelectric work with the larger instruments.

The need for these changes arises mainly because of the poor climate for observing at Mount Stromlo. While spectrographic research can be done at Mount Stromlo with reasonable efficiency, the climate for photoelectric—and to some extent photographic work—is too poor at Mount Stromlo to permit efficient work, and these activities should be transferred to the Field Station. Before long a Schmidt telescope of adequate aperture should be established at the Field Station also, so that the Department shall no longer be wholly dependent on exchange arrangements with Uppsala Observatory.

#### *The National Time Service.*

While it is agreed that Mount Stromlo Observatory should continue to issue precision time signals, it is felt that developments along the lines of atomic clocks and precision frequency standards are hardly the function of a University Observatory. In future, therefore, emphasis will be on the Time Service becoming the “Division of Positional Astronomy”. This new division should make useful contributions to geophysical-astronomical studies of variations in latitude and longitude, and the related problem of the much needed improvement in star positions for the southern hemisphere.

During the past year the work of the Time Service has been centered on the photographic zenith tube, with which regular observations have been made for time and latitude variation. Arrangements have been made for the construction of a programme machine to operate this instrument automatically.

A number of Time Service operations can now be dealt with by the IBM 610 computer. Programmes have been prepared to verify plate measurements, compute apparent places, print out observing lists and calculate results from observations for clock correction and latitude variation.

As in previous years, the Observatory time signals were transmitted by Belconnen Naval Wireless Station, astronomical tables were issued and time signals received by radio and landline were evaluated.

*The IBM 610 Computer.*

The IBM 610 came into operation in January; the hours of operation have increased from 40 initially to 55 hours per week by the end of the year, and some time has been made available to other University Departments. Not only has much numerical work been accomplished, but the computer has provided valuable experience for staff and scholars. Already there is a need for a faster and more versatile machine, and it is hoped that an IBM 1620 electronic computer will be available at the University soon.

About half the time of the computer is used for routine reductions in the Time Service; much work has also been done on the reduction of photoelectric observations, calculations of tables for transformation from galactic to equatorial co-ordinates, and vice versa, and for tables of atmospheric extinction. Precision corrections are now generally calculated by computer.

*Other Activities.*

In September, Dr. Rodgers completed his year as a Carnegie Fellow at the Mount Wilson and Palomar Observatories and is now on a visit of several months at the Royal Greenwich Observatory. In September, Mr. Bell returned from a year overseas. He completed eight months at Kings College, London University and returned to Australia via the United States, where he visited Princeton University and the California Institute of Technology. Dr. Gascoigne was overseas for several weeks; the principal purpose of his trip was to act as Chairman of a meeting, held in Buenos Aires, Argentina, of the Sub-Commission of the Magellanic Clouds of the International Astronomical Union.

A symposium entitled "Astronomical Optics and Site Testing" was held at the Observatory in connexion with the formal opening of the new coude spectrograph. Astronomical colloquia have been held fairly regularly at two-week intervals.

The number of visitors to the Observatory continues to increase, and the estimated total number of daytime visitors is well in excess of that quoted last year, 15,000. The Monthly Visitors Nights and Wednesday evening visits continue. Several groups of visitors have visited the Mount Bingar Field Station at night. The new edition of the Mount Stromlo Observatory Booklet is proving very popular and a second printing of 2,500 has already been ordered.

The interest in public lectures on astronomy appears to be growing, and the demand has been especially heavy upon the Director, who delivered 28 lectures to university audiences, amateur astronomical groups, schools and civic bodies. Nine country centres were included, demonstrating that interest extends beyond the big cities. Several lectures were for audiences of secondary school pupils. Attendance at one of the public lectures in Melbourne (at the Museum of Science) amounted to 720. Dr. Hogg, Professor Aller, Mr. Abraham and Dr. Buscombe delivered lectures to amateur astronomical organisations in Sydney and Melbourne. The Australian Journal of Science publishes in each issue a column by Dr. Hogg entitled "The Sky Month by Month", which appears to be much appreciated by the scientific community.

Professor Aller has been a prolific lecturer to staff and scholars; his fine series of lectures on such topics as "The Building of the Chemical Elements", "The Formation of Absorption Lines in Stellar Spectra" and "The Physics of Emission Nebulae", were particularly enlightening.

*Publications.*

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- “On the relation between luminosity, distance and Doppler shift in relativistic cosmology.” *Austr. J. of Physics*, **13**, 602, 1960. (Mount Stromlo Reprint No. 34.)

## DEPARTMENT OF GEOPHYSICS.

*Staff.*

Professor .. .. .	J. C. Jaeger, M.A., D.Sc., F.Inst.P., F.A.A.
Reader .. .. .	M. S. Paterson, B.E., Ph.D.
Senior Fellows .. .. .	H. Berry, M.Sc. (Tech.) E. Irving, M.A., M.Sc. Germaine A. Joplin, D.Sc., Ph.D. A. E. Ringwood, Ph.D.
Fellows .. .. .	J. F. Lovering, M.Sc., Ph.D. J. R. Richards, M.Sc., Ph.D.
Research Fellows .. .. .	H. A. Doyle, B.Sc. F. D. Stacey, Ph.D.
Research Assistant .. .. .	Jennifer Clay, B.Sc.
Research Students .. .. .	J. R. Cleary, B.Sc. L. P. Greenland, A.A., S.M. K. A. Gross, Dip.App.Sc. (Tech.) I. R. McDougall, B.Sc. W. A. Robertson, B.Sc. P. M. Stott, M.Sc. D. H. Tarling, B.Sc.

*Visitors.*

Professor J. Evernden of the University of California is spending five months studying the ages of Australian rocks.

Professor Alan Voisey of the University of New England has spent three months working on tectonic problems.

Professor J. A. Jacobs of the University of British Columbia spent a month discussing geophysical problems.

Professor R. D. Russell of the University of British Columbia spent a month working on ages of Australian ore leads.

Dr. N. D. Opdyke of the Rice Institute has been a visiting Fellow working on palaeomagnetism throughout the year.

Dr. C. Bull of the Victoria University of Wellington spent three months working on the palaeomagnetism of Antarctic rocks.

Dr. J. C. Burns of the Victoria University of Wellington is spending his study leave working on hydrological problems.

Mr. J. Gellen of the Victoria University of Wellington is spending a month measuring the magnetization of rock samples from New Zealand.

*Students' Theses.*

The following students either had the Degree of Ph.D. conferred on them in 1960, or have had their theses approved for the degree:—

I. McDougall .. .. .	A study of the Tasmanian dolerites with particular reference to the differentiation of the Red Hill dolerite-granophyre association.
D. S. Kemsley .. .. .	The deformation of metal single crystals by alternating tension and compression.

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|-----------------------|--|
| E. K. Carter .. .. .  | The Precambrian Orogenic Belt of North-western Queensland.   |
| B. P. Walpole .. .. . | The evolution of the Pine Creek Geosyncline, Northern Territory, Australia.  |
| K. R. Walker .. .. .  | Petrology of the Basic Igneous rocks, North-West Queensland: a study of the basic igneous rocks of the lower Proterozoic of North-western Queensland with special reference to their metamorphism and metasomatism in relation to the geological sequence of events. |
| D. W. Smellie .. .. . | Quantitative interpretation of aeromagnetic data.  |
| Ronald Green .. .. .  | The study of the palaeomagnetism of some Kainozoic and Palaeozoic rocks.   |

#### *General Remarks.*

At the end of 1959, the former Department of Radiochemistry, with the exception of Dr. Mills' section, was incorporated in the Department of Geophysics with the immediate object of making a greatly intensified attack on the problem of measuring the ages of Australian rocks. From the scientific point of view this incorporation has proved extremely satisfactory since it has the effect of bringing all the geologists, geochemists and geophysicists together in the one Department. From the administrative point of view, it has the disadvantage of requiring that the department be an extremely large one and the fact that it is housed in four widely separated buildings, all of them makeshift, has led to considerable inconvenience. The necessity of evacuating one building because of the fire has accentuated these difficulties, and has meant that some members have been working under very considerable difficulties.

The expanded programme of age determinations has led to a change in emphasis of the department from geophysics towards geochemistry, several new appointments having to be made in the latter subject. Also, to keep all the mass-spectrometric work in the one building, it has been necessary to add further temporary accommodation to the former Radiochemistry building.

The department suffered badly in the recent fire. Three students lost a great deal of their thesis material, and two members of staff lost many research records and much unpublished material. Apart from this, many have suffered from the disorganization and makeshift accommodation.

#### *Research Activities.*

*Conduction of Heat.*—A series of measurements of temperatures and water-flows during diamond drilling of a hole by the Hydro-Electric Commission of Tasmania has been made. In the past, it has been assumed that the process of drilling changes the temperature of the rock so that it is necessary to wait for a considerable time before measurements can be made in the hole for the purpose of measuring the rate of increase of temperature with depth below the surface. The present experiments and calculations have shown that in many cases this period of waiting is unnecessary. This should make measurements in many more bore holes possible.

An elaborate study of the distribution of temperature in cooling lava flows of various shapes has been made and applied to the discussion of columnar jointing of such flows.

Routine measurements of temperatures in bore holes and of the thermal conductivities of rocks are being continued.

*Deformation of Rocks and Minerals.*—Previous work on the changes of length of deformed marble specimens during subsequent changes of pressure has been extended to simultaneous changes of temperature and pressure. This work was done on D. T. Griggs's apparatus in the University of California and the results were consistent with the hypothesis advanced previously that the effects were due to internal stresses caused by the anisotropy of the calcite grains.

A laboratory investigation has been made of the "flat-jack" method of measuring stresses in rocks which is extensively used for measuring stresses near tunnels and underground power stations. Experiments were made on two-foot cubes of concrete and rock. Results showed that the method is reliable for sound rock, uniformly loaded, but that considerable errors may occur, either with irregular loading or with unsound rock.

*Geochemistry.*—An emission spectrographic study of the distribution of Cu, Co, Cr, Ni, in the dolerite-granophyre association at Red Hill, Tasmania, has been completed. Work is currently in progress on the fractionations observed in the Tasmanian dolerites in general.

Garnet, pyroxene and feldspar phases have been separated for study from granulite and eclogite inclusions in deep-seated igneous pipes. Macro- and trace-element analyses in twenty-two of these rocks have been completed.

A programme has been started in conjunction with the A.A.E.C., Lucas Heights, to determine uranium, thorium and barium distributions in possible upper mantle rocks by neutron activation. The first analyses carried out in September were generally successful.

A reliable method of silicate analysis which combines both classical and "rapid" techniques has been developed. Some very promising preliminary work has been carried out on the application of ion-exchange techniques to replace the unsatisfactory classical method for the determination of the  $R_2 O_3$  group of elements.

X-ray fluorescence methods are being developed in collaboration with the Bureau of Mineral Resources for quantitative simultaneous determination of uranium, thorium and lead in zircon.

A compilation of all available chemical analyses of Australian rocks is being made. So far, about 4,000 analyses have been collected but Victoria is the only state for which results are complete.

*Geological Age Determination.*—There are essentially three methods of determining the age of a rock based on the radioactive decay of uranium to lead, potassium to argon, and rubidium to strontium, respectively. For technical reasons it is highly desirable to use all three methods and the expanded programme envisages doing this.

For some time studies of leads from various ore bodies have been made using a technique developed in the laboratory for production of the gas tetramethyl lead. About 45 samples from Broken Hill, Rum Jungle and Mount Isa have been studied and the results are being prepared for publication. A number of "lead alpha" ages have also been determined from separated zircon mineral from granite rocks.

These methods will be discontinued, temporarily at least, and work has been begun on converting the Metropolitan-Vickers mass-spectrometer to use samples in solid instead of gaseous form. It will be in use early in the new year on the lead and rubidium-strontium methods. All chemical techniques involved in the use of the rubidium-strontium method are now in operation.

For the potassium-argon method, a Reynolds type mass-spectrometer has been purchased and came into operation in October. At present the geological time scale is being checked by determining potassium-argon ages of rocks which are well dated by fossil evidence. Some fifty ages have already been determined.

In collaboration with the Bureau of Mineral Resources, it is hoped to make an Australia-wide survey of the ages of Australian rocks.

*Igneous and Structural Petrology.*—A text-book of petrography for second and third year University students, illustrated entirely with Australian material, is being written.

An elaborate study of the differentiation process in a dolerite sill, using bore core obtained by the Hydro-Electric Commission of Tasmania, is almost complete. A large number of chemical and model analyses showing the trend of differentiation towards granophyre has been made.

A study is being made of the symmetry of the fabric of deformed rocks and of the fundamentals underlying Sander's principle correlating the symmetry of their fabrics with the symmetry of the deforming forces.

Magnetic anisotropy of rocks has been shown to be a usable fabric element in the determination of geological structures. Measurements on a number of different types of foliated rock have shown a coincidence of magnetic and optical determinations of fabric, except in some cases in which the magnetic method gives additional data. The method is most useful for rocks in which grain alignment is very small. Dielectric anisotropy has also been examined for a number of rocks and shown to be a convenient method of measuring average grain alignments.

*Meteorite Studies.*—Work has been completed on (a) thermomagnetic analysis of co-existing kamacite, taenite and plessite in iron meteorites and (b) natural magnetic moments of chondritic meteorites. Colorimetric methods have been developed for the analysis of silicon, nickel, cobalt and iron in the metal phase of meteorites; 30 stony meteorites and 10 iron meteorites have been studied.

A new evaporative technique for the determination of trace amounts of chlorine, bromine and iodine, in rocks and meteorites, has been developed and work has begun on the analysis of a large collection of chondrites.

Experimental and analytical work has been completed on the production of artificial tektites in a solar furnace. Preliminary work has been completed on the spectrographic analysis of Cu, Cr, Co, Ni in tektites. A study of the distribution of zinc in tektites and artificial tektites has been completed.

Measurements on thermal demagnetization, magnetic anisotropy and thermomagnetic analysis on a number of chondrite meteorites are now complete. It is concluded that the chondrites were once parts of a parent body in the solar system which had a terrestrial-type magnetic field.

A very extensive study of the mineralogy, chemistry and conditions of formation of meteorites has been completed. This contributes considerably to the understanding of the chemical and physical processes responsible for the formation of the metal phases in meteorites and in the earth's core.

With the co-operation of scientists of the Department of Supply, attempts to detect micrometeorites in the upper atmosphere are being continued, with particular reference to known meteor showers. A micrometeorite detector was installed in a Long Tom rocket fired at Woomera during the  $\delta$ -Aquadrid shower in June.

*Oceanography.*—A number of tide gauges and long wave recorders installed for the International Geophysical Year is still being run. An attempt is being made to correlate the incidence of long waves with meteorological conditions. A study of the effects of the Chilean tsunami, which was well recorded at several of our stations, is being made.

*Phase Equilibria at High Temperatures and Pressures.*—The “squeezer” apparatus, operating at temperatures of up to 900° C. and pressures of up to 70,000 atmospheres, has been in satisfactory operation for some time. An olivine-spinel transition in  $\text{Ni}_2\text{SiO}_4$  was predicted by thermodynamic reasoning and subsequently confirmed by experiment in the squeezer. This has provided useful data on what is probably the most important single transition occurring in the earth’s mantle.

*Rock Magnetism.*—The year’s work has consisted chiefly of the continued development of laboratory techniques for studying magnetic instability in rocks. Both thermal and alternating current demagnetising apparatus has been completed and is in full operation. The main technical problems have now been solved, with the result that either igneous or sedimentary rocks, which possess unstable magnetic components of magnetization, not greatly in excess of their stable components, can be satisfactorily treated. This increases the number of rock types available for palaeomagnetic work by a factor of about ten.

Our old collections, and many new ones, have been processed using these techniques, and the path of polar movement relative to Australia since the Lower Carboniferous is now well established from a wide range of extrusive and intrusive igneous rocks, as well as sediments. A number of measurements on Antarctic rocks has also been made.

A study of the Aden volcanics has been made which suggests that the Red Sea originated as a tensional rift.

A survey of rock magnetism in the Pacific Islands has been undertaken, partly in order to study the behaviour of the earth’s magnetic field in geologically recent times, and partly for tectonic studies. The first rocks to be measured, those from Samoa, confirm that reversals in the earth’s field occurred at the base of the Pleistocene.

It is proposed that an extended palaeomagnetic survey of Australia should be made in collaboration with the Bureau of Mineral Resources.

A translation has been made of the important Russian work, “Palaeomagnetism and Stratigraphic Correlation”, by A. N. Khramov, and is being produced by the Department.

*Seismology.*—The network of nine stations run jointly by the University, the Snowy Mountains Authority and the Sydney Metropolitan Water Board, is now in full operation. Subsidiary stations have been set up at Inverloch, Mount Bingar and Wyangala Dam and equipment has been provided for the University of New England.

A fairly large number of epicentres is now being accurately located in New South Wales by the I.B.M. program, the most active area being the Gunning-Dalton seismic belt which extends south-east towards Lake George.

A number of quarry blasts has been timed in order to determine the velocities of seismic waves in different areas.

Long period recorders are being installed at various stations to study the movement of surface waves across the network.

#### *Study Leave.*

Dr. Paterson returned in August from a year’s study leave, spent mostly at the University of California.

Dr. Ringwood took two months’ study leave in order to attend geological and geophysical conferences at Copenhagen and Helsinki.

#### *Publications.*

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\* Not a member of the Australian National University. † Fulbright Visitor.

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## DEPARTMENT OF NUCLEAR PHYSICS.

## Staff.

Professor .. .. .	E. W. Titterton, C.M.G., M.Sc., Ph.D., Dip.Ed., F.A.A.
Senior Fellows .. .. .	P. B. Treacy, M.Sc., Ph.D. J. H. Carver, M.Sc., Ph.D.
Research Fellows .. .. .	I. F. Wright, M.Sc. (left August, 1960) R. N. Glover, B.Sc., Ph.D. T. R. Ophel, B.Sc., Ph.D. L. G. Lawrence, M.A., Ph.D. D. R. Hebbard, B.A., M.Sc., Ph.D. (arrived September, 1960).
Selby Fellow .. .. .	W. M. Deuchars, B.Sc., Ph.D. (arrived September, 1960).
Fulbright Research Fellow .. .. .	S. Bashkin, B.S., Ph.D. (left October, 1960).

\* Not a member of the Australian National University.

† Fulbright Visitor.

Mr. Ian Wright left the Department in August, 1960 to take up an appointment at the University of Wisconsin, Madison, U.S.A.

Professor S. Bashkin returned to the State University of Iowa, U.S.A. in October, 1960 after a year in the Department as a Fulbright Research Fellow.

Dr. L. G. Lawrence came to the Department in June, 1960, from the Cavendish Laboratory, Cambridge.

Dr. D. F. Hebbard, who arrived in September, 1960, had been working at the Kellogg Radiation Laboratory, California Institute of Technology, before taking up his appointment.

Dr. W. M. Deuchars is the first holder of the Selby Fellowship awarded by the Australian Academy of Science. He came to the Department in September, 1960, from the Atomic Weapons Research Establishment, Aldermaston, and holds the Fellowship for one year.

#### *Research Students and Teaching Activities.*

Twelve research students have been at work during the year—

- K. H. Purser, M.Sc.
- B. Mainsbridge, B.Sc. (A.A.E.C. Fellow).
- T. R. Sherwood, M.Sc.
- A. G. Gregory, B.Sc.
- R. B. Taylor, B.Sc.
- G. E. Coote, M.Sc.
- E. Weigold, B.Sc. (A.I.N.S.E. Student).
- I. V. Mitchell, B.Sc.
- G. Symons, B.Sc.
- G. Bailey, B.Sc.
- G. P. Lawrence, B.Sc.
- B. Lawergren, Fil. Kand.

Mr. B. Mainsbridge completed his Ph.D. thesis and left in July, 1960, to join the staff of the Rice Institute, Houston, Texas, U.S.A. Mr. K. H. Purser also completed his course and went to the University of Kansas, U.S.A., in September, 1960.

Regular colloquia and research meetings were held during the year, and special courses on nuclear astrophysics, vacuum physics and transistor electronics were given for the research students.

#### *Research Equipment.*

The fire in the Cockcroft building in July, 1960, destroyed the control and counting rooms of the 600 kev accelerator and severely damaged the machine itself. It was therefore decided to close down work on the machine and divert the effort to the tandem accelerator.

The parts of the tandem accelerator reached Canberra in September and erection began immediately. By the end of the year the columns were under compression and the main constructional work completed. The electrical wiring, installation of beam transport devices and testing are expected to occupy a further four months; experimental work should therefore begin after Easter.

Because of the destruction of the 600 kev accelerator it was decided to modify the helium injector to the tandem accelerator so that this device could be employed as an accelerator in its own right. For this purpose the rating of the electrostatic injector was raised from 500 kev to 2 Mev—the machine will be built on a trolley running on rails. In use as a helium ion injector it will be wheeled to the low energy end of the tandem; for use as an accelerator it will be run back and rotated through  $130^\circ$  to provide two beams into a new target area to be set up between the tandem generator building and the HT1 laboratory. The arrangement will provide a complex of three accelerating machines covering the entire energy range from 150 kev to over 12 Mev.

In the tandem target area there will be six major target stations; much thought and work has gone into provision of appropriate facilities. These will include a 24-in. precision particle spectrometer, an angular distribution table for particle-particle correlation experiments and angular correlation equipment for  $\gamma$ - $\gamma$  and  $\gamma$ -charged particle studies. Installation of either a Buechner-type spectrograph or a fixed multi-channel spectrograph is under consideration.

#### *Research Programme.*

*Fast Neutron Studies.*—The triple coincidence counter telescope completed last year was used to study the energy and angular distributions of protons and deuterons from 15.1 Mev neutron reactions in  $\text{Ni}^{58}$  and  $\text{Al}^{27}$ . Results for individual states as well as nuclear temperatures were obtained. Unfortunately the fire destroyed the entire equipment and the work had to be abandoned.

Work on the 14.5 Mev fast neutron ternary fission of  $\text{Th}^{238}$  and  $\text{U}^{252}$  continues; the cross sections are small and events rare. A detailed experiment on the spontaneous fission of  $\text{Cf}^{252}$  is approaching completion; ternary fission has been established and the first examples of true quaternary fission observed. A probable new mode of fission involving two heavy fragments, a long range  $\alpha$ -particle and a short range light nucleus, has been observed.

**Capture  $\gamma$ -Ray Studies.**—The reaction  $\text{Al}^{27}(\text{p}, \gamma)$  has been investigated; the  $\gamma$ -rays were sharply collimated, detected in a heavily shielded 5" diameter x 4" long NaI(Tl) crystal and recorded in the 120 channel kicksorter.

Angular distributions and spectra obtained limit the spinparity assignments to eight states in  $\text{Si}^{28}$  which are involved at seven resonances excited by protons between 600 and 800 kev.

**Polarization of Protons in  $\text{C}^{12}(\text{d}, \text{p})\text{C}^{13}$ .**—Proton polarization from this reaction has been measured at deuteron energies between 750 and 1100 kev at  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ ,  $120^\circ$  and  $135^\circ$  using a carbon polarimeter. Published angular distributions have been analysed in conjunction with the results obtained in terms of compound nucleus theory. Assignments of  $1+$  and  $2-$  for the first two levels are made and the ratios of reduced width amplitude  $\gamma_{2,0} : \gamma_{0,0} = 4.8$  and  $\gamma_{2,1} : \gamma_{0,1} = 0.35$  determined (subscripts refer to incoming angular momentum and channel spin respectively). The results are in conflict with phase angles calculated from the Wigner-Eisenbud theory of resonance reactions.

**Photonuclear Studies.**—A study has been made of photoprotons emitted from Cs and I by irradiating a thin crystal of CsI(Tl) with bremsstrahlung and detecting protons in the same crystal. Photoproton spectra for different end point energies all show a broad peak at 8 Mev after correcting for "escape" protons. The proton yields were measured and a peak cross section of  $18 \pm 2$  mb found at 25 Mev. Photoproton emission from tantalum has also been studied by measuring the yield of the 5.5 hr isomer of  $\text{Hf}^{180}$  produced in the reaction  $\text{Ta}^{181}(\gamma, \text{p})\text{Hf}^{180}$ .

$\gamma$ -Rays from the reactions  $\text{B}^{11}(\text{p}, \gamma)$  and  $\text{Li}^7(\text{p}, \gamma)$  have enabled absolute cross sections for  $\text{Cu}^{63}(\gamma, \text{n})$  to be measured at 12.2, 14.8, 16.7 and 17.6 Mev and the value  $58.7 \text{ mb} \pm 10$  per cent. obtained at 17.6 Mev. The shape of the cross section curve agrees well with bremsstrahlung data but the absolute values are about 30 per cent. lower.

In collaboration with the Department of Theoretical Physics, work has been carried out to exploit a simple relation between the well-known E1 sum rules and the photonuclear giant resonance peak energy. This provides an opportunity to compare previous interpretations of the giant resonance involving coherent hole-particle interactions or classical collective oscillations.

#### Other Activities.

Professor E. W. Titterton gave a series of lectures in nuclear physics at the University of Tasmania and the University of Western Australia. He also attended a number of meetings of the Defence Research and Development Policy Committee, the National Radiation Advisory Committee and the Council of the Institute of Nuclear Science and Engineering.

#### Publications.

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- Carver, J. H., and Peaslee, D. C.\*—"Nuclear Peak Energies." *Phys. Rev.* **120**, 2155 (1960).
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\* Not members of the Department.

- Titterton, E. W. (with Dwyer, L. J.\* and Martin, J. H.\*)—“Fallout Measurements in Australia. Radiation Biology, ed. J. H. Martin (Butterworth's Scientific Publications, London, 1960).  
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*Theses Presented.*

- Gemmell, D. S.—“Radiative capture reactions in light nuclei.”  
 Mainsbridge, B.—“The  $\text{Li}^7(p, \gamma)\text{Be}^8$  reaction and studies in photodisintegration.”

DEPARTMENT OF PARTICLE PHYSICS.

*Staff.*

Professor .. .. .	.. .. .	M. L. Oliphant, K.B.E., F.R.S.
<i>Proton-synchrotron Section—</i>		
Senior Fellows .. .. .	.. .. .	L. U. Hibbard, B.Sc., M.E., Ph.D. J. W. Blamey, M.Sc. W. I. B. Smith, B.Sc., Ph.D. D. S. Robertson, B.Sc., Ph.D. E. K. Inall, B.E., Ph.D.
Research Engineers (Fellows)	.. .. .	P. Carden, B.E. H. Johnson, B.Sc. R. A. Marshall, B.Sc., B.E., S.M. B. F. Wadsworth, M.E.
<i>Plasma Physics Section—</i>		
Fellow .. .. .	.. .. .	A. H. Morton, D.F.C., M.Sc., Ph.D.
Research Students	.. .. .	I. S. Falconer, M.Sc. R. H. Hosking, B.Sc.
<i>Physical Chemistry Section—</i>		
Fellow .. .. .	.. .. .	R. Mills, M.Sc., Ph.D.

*The Proton Synchrotron.*

During the year effort has been concentrated on the completion and testing of the homopolar generator, following the troubles experienced with the bearings at the end of 1959.

Examination of the bottom rotor guide bearings, which “seized” in 1959, led to the introduction of various modifications for further tests, using the top rotor.

Static elasticity of the assembled top guide bearings, and the behaviour under magnetic field torque, were examined, with the conclusion that the bearings and housings are still only about half as stiff as desired and show substantial hysteresis and non-linear and non-symmetrical behaviour. These defects do not preclude the completion of tests under full operational conditions, provided special care is observed when the rotors are turning slowly or are stationary in the magnetic field.

Using carbon brushes, as previously, the dynamic behaviour of the bearings at various speeds up to full speed was studied. Many hours of satisfactory running were obtained which showed that the bearings are capable of controlling the forces experienced by the rotors. Unfortunately, just before the completion of these tests, the small guide bearing failed under conditions that show that the failure was in no way associated with high speed, rotor inertia, or magnetic or electrical effects. Failure by seizure of all pads was preceded by overheating of a central zone of the bearing, heat being transferred from the offending pad to the others via the rotating surface of the shaft. Subsequent complete failure arose from thermal distortion of the pads and thermal expansion of the adjustable oil pockets behind each pad. The reason for initial overheating is not known.

The damaged pads are now half repaired and it is hoped to nurse them through the initial full current pulsing tests of the upper half of the machine, using one rotor.

All jet and drain tanks have been completed, assembled in one stack, bolted together and leak tested.

Extensive stiffening of the homopolar magnet yoke has been carried out by welding.

Most of the copper and aluminium bus bar runs have been fabricated and about half has been installed.

\* Not members of the Department.

One 400,000-amp. switch and its actuator have been constructed. The remaining three will not be constructed until this one has been tested with rotor pulses. For this phase of the work a rapidly variable electrolytic resistance is being designed to simulate an inductive load and to serve as a switch.

The rectifier units, which supply running current for the homopolar generator, have been partially tested and require the addition of some chokes to improve the characteristics.

The installation of the complex series of instruments to record temperatures, oil pressures, radial position and tilt of the rotor, speed and acceleration, was a major operation, but gave information of great value.

A model of the test load inductance has been made to check the calculations of the inductance and the stresses. It will also be used to measure the field around the outer edges of the coils to enable the forces on the connexions to be calculated. The measurements showed that the approximate calculations of the inductance gave a quite accurate value.

Three hundred gallons of NaK have been placed in the system and the whole has been tested.

When the generator is assembled, and the NaK jets have been in operation, it will be necessary to seal each section of the main tank in an envelope of nitrogen to remove it to a point where any adhering NaK can be collected. This sealing has been shown to be practicable.

Four leather suits and air hoods with hoses have been made ready for use by personnel if it should prove necessary to blanket burning NaK with graphite. Each hood has been fitted with a telephone to enable operators to keep in contact. A further two self-contained breathing units are also ready for use.

#### *The Injection Cyclotron.*

Work has continued on this section of the accelerator. The control racks were installed in the control room remote from the cyclotron, and the concrete shielding walls were increased in thickness to lower radiation levels outside the machine. This allowed the machine to be run at full energy and full beam current. An investigation of focussing of the beam near the ion source was made by variation of the injection angle of the beam relative to the dee edge, and by running the machine at off-resonant fields to vary the phase of the beam. These investigations have led to a considerably improved ion source arrangement, resulting in no loss of beam due to electrical defocussing on early turns. The dee voltage of the machine has been stabilized by a system involving anode modulation of the oscillator by a series triode. Orbit centre and beam quality tests are being undertaken prior to extraction of the full beam.

#### *Radiofrequency System.*

The low level section of the radiofrequency system will be finished before the end of January, 1961. During the past year, the system has been assembled into seven cabinet racks, and tests have been in progress for the past few months. The frequency tracks to within  $\pm 0.1$  per cent. over a magnetic field range of 0.8 to 20.2 kilogauss.

The monitor has been finished and works perfectly. It is extremely reliable, and can be used either for checking any one of 43 available check points, or for checking six pre-selected crystal controlled reference points simultaneously.

All that remains to be done is to reduce noise from the photoformers and improve their stability, replace some faulty transformers and write a comprehensive instruction manual.

#### *Plasma Physics.*

The year has been largely one of construction and assembly, with experimental work restricted to initial tests and measurements. A number of small water-cooled air cored magnetic field coils has been made, thirteen large pancakes have been wound as components of the 400 kw. magnet, and a two ton steel magnet was brought into operation during the latter part of the year. This is now being used in the study of rotating discharges.

Experiments were made with a "Scylla" type equipment; discharges have been obtained in air and deuterium, and the characteristics of the circuit have been examined.

#### *Physical Chemistry.*

Work in this section has been in abeyance during the absence of Dr. Mills on study leave.

A grant of £3,500 a year for three years has been made by the Reserve Bank of Australia to enable Dr. Mills to carry out investigations of basic ion-diffusion mechanisms in the electrolytes used in "fuel-cells". These cells, upon which much work is being done in America and Europe, offer possibilities as sources of mobile power, and if development progresses as is hoped, their use could reduce materially the import of petroleum products. The investigations will be carried out in co-operation with C.S.I.R.O.

#### *General Activities.*

Lectures were delivered in various State universities, and to engineering and other professional associations, by various members of staff. In particular, Dr. Hibbard organized a series of twelve lectures on applied nuclear physics, given by eight members of staff to members of the professional staff of the Snowy Mountains Authority. About 180 attended at Cooma and Cabramurra, which were

linked by two-way radio for each weekly lecture which was heard simultaneously in the two centres. A visit to the School by 101 members of the audiences supplemented the lectures. The course was arranged as a result of discussions between Sir William Hudson and Sir Mark Oliphant, and was intended to enable those employed on the Snowy Mountains Project to visualize how the development of nuclear energy for industrial purposes, and the applications of nuclear explosives to civil engineering, could modify the nature of future large-scale power and water conservation projects. It was a very successful experiment.

#### Study Leave.

The Director attended the 300th Anniversary Proceedings of the Royal Society, in London, visited laboratories in Britain and the United States of America, and had discussions on atomic energy and the proposed Commonwealth Astronomical Observatory with experts in both countries. While in the United Kingdom, he had conversations with Dr. and Mrs. Neumann, who have now agreed to join the Australian National University to establish a Department of Mathematics.

Mr. Blamey returned from study leave spent at the Radiation Laboratory, Berkeley, California.

Dr. R. Mills spent the year at the Max-Planck-Institut für Physikalische Chemie, Göttingen, West Germany.

#### Publications.

Kelly, F. J.\*, Mills, R. and Stokes, J. M.\*—"Some transport properties of aqueous pentaerythritol solutions at 25°." *J. Phys. Chem.* **64**, 1448, 1960.

Mills, R.—"Fuel Cells." *Aust. J. Sc.*, **23**, 109, 1960.

Mills, R. and Godbole, E. W.—"Verification of the Onsager limiting law for trace-ion diffusion in electrolyte solutions." *J. Amer. Chem. Soc.*, **82**, 1295, 1960.

Mills, R. and Vernon, M. J.—"Separation of radiocobalt from nickel." *Anal. Chim. Acta*, **23**, 388, 1960.

Oliphant, M. L. E.—"The Dichotomy in our Culture and its Effects upon Education"; The Frank Tate Memorial Lecture, 1960; Victorian Institute of Education. *Australian Journal of Education*, November, 1960. (Reprinted in *Overland*, 18, 1960.)

—"The Physical Sciences in Australian Universities." *Vestis*, **3**, 2, p. 11, 1960.

Reid, A. F. and Mills, R.—"Chlorine exchange between antimony trichloride and trimethylchlorosilane in benzene and hexane. Part I., Apparatus and techniques." *J. Chem. Soc.*, p. 703, 1960.

—"Chlorine exchange between antimony trichloride and trimethylchlorosilane in benzene and hexane. Part II., Kinetics and mechanism of exchange." *J. Chem. Soc.*, p. 708, 1960.

Smith, W. I. B.—"Beam defining slits and focussing grids near the ion source." Sector-Focussed Cyclotrons, 183-191, 1959. *Nuclear Science Series Report No. 26*, National Academy of Sciences, National Research Council, U.S.A.

—"Improved focussing near the Cyclotron Source." *Nuclear Instruments and Methods*, **9** (1960).

#### DEPARTMENT OF THEORETICAL PHYSICS.

##### Staff.

Professor .. .. .	K. J. Le Couteur, M.A., Ph.D., F.A.A.
Reader .. .. .	D. C. Peaslee, Ph.D.
Senior Fellow .. .. .	F. C. Barker, M.Sc., Ph.D.
Research Fellows .. .. .	L. J. Tassie, Ph.D. (on leave). B. Robson, Ph.D. (from March, 1960)
Visiting Fellows .. .. .	K. Kumar, Ph.D. (from September, 1960) N. Hush, D.Sc. (from November, 1960)

During the year the Department was fortunate to receive short visits from Professor L. Rosenfeld of Nordita, Copenhagen, and Professor R. H. Dalitz of the University of Chicago.

In August, Dr. Barker left for America on study leave to attend the Kingston Conference on Nuclear Physics and to work at the Massachusetts Institute of Technology in Professor Weisskopf's Department.

Dr. Tassie was given a year's leave to take up a research appointment at the Argonne National Laboratory in Chicago, and was awarded a Fulbright travelling grant. In his place we were fortunate to secure Dr. Kumar of the Tata Institute for Fundamental Research, Bombay, as a Visiting Fellow for a year. It is hoped that these arrangements will keep us abreast of work in other centres.

\* Not a member of the Australian National University.

### Research Students and Teaching Activities.

Four research students were at work for the Ph.D. degree—

D. W. Lang, M.Sc.

Elizabeth Bradford, B.Sc.

P. W. Seymour, C.G.I.A., A.M.I.E.E., M.N.Y.A.S.

B. A. Faithfull, B.Sc.

In December, Mr. Lang completed his thesis on "Some Aspects of Statistical Theory in Nuclear Reactions."

Courses of postgraduate lectures were given by Dr. Peaslee on "Elementary Particles"; by Professor Le Couteur on "Theory of Fully Ionized Plasmas"; by Dr. Kumar on "Many Body Problems in Quantum Mechanics" and Professor Rosenfeld gave a short course on "Nuclear Reaction Theory".

### Research Activities.

Most of the work of the department has again been on various theoretical aspects of Nuclear Physics and its applications to astrophysics.

Dr. Barker has completed a systematic study of the light nuclei which has yielded some new conclusions about the charge and spin dependence of the forces between particles in the nucleus.

Professor Le Couteur has continued work on the formulation of nuclear reaction theory in a complex space of many dimensions.

The interaction of  $\gamma$ -radiation with nuclei is characterized by a giant resonance, which has been much studied in the Department of Nuclear Physics. Dr. Peaslee has now arrived at a more basic understanding of the nuclear properties that give rise to the observed features of the resonance.

The light elements deuterium,  $\text{He}^3$ , Li, Be and B are relatively rare in the solar system and will be destroyed by the nuclear "cooking" in stellar interiors that produces the heavier elements. Dr. Peaslee and Dr. Bashkin have considered the possibility that such elements could be made in observed abundance by flare phenomena at stellar surfaces, which are known to accelerate particles to very high energies. Such a mechanism seemed adequate, provided that the stars mainly responsible for cosmic abundances had about 100 times the surface activity of the sun—which is not unreasonable, since the sun is known to be an exceptionally quiet star.

Dr. Robson has started a program of nuclear scattering calculations. Analysis of the scattering of high energy polarized deuterons by carbon has been completed and further work is continuing with the assistance of Miss Bradford.

Mr. Seymour has completed the analysis of the heat balance in a high current, low pressure gas discharge, and has calculated that temperatures as high as a million degrees might be produced at the centre if the discharge is constricted there by an external magnetic field. The stability of the system is next to be studied and it is hoped that a transition from stability to instability can be observed experimentally.

### Electronic Computer.

During the year an agreement was entered into with I.B.M. (Australia) to rent an I.B.M. 1620 computer on very favourable terms. Delivery is expected in August, 1961. The computer will not be fully occupied by work for the School of Physical Sciences and machine time, but not computing service, will be available for other departments of the University.

### Publications.

Barker, F. C.—"Calculation of Splitting of  $3s\frac{1}{2}$  neutron levels." *Nuclear Physics*, **19**, 110 (1960).

Barker, F. C., Bradford, E. and Tassie, L. J.—"The 9.63 MeV State of  $\text{C}^{12}$ ." *Nuclear Physics*, **19** 101 (1960).

Lang, D. W., Sherwood, T. R. and Turchinets, W. E.—"Photonuclear Reaction Cross Sections. Analysis from Residual Radio-activity Measurement." *Proceedings of the Karlsruhe Photonuclear Conference*, 1960.

Le Couteur, K. J.—"Supra-Thermal Particles." *Proceedings of the Fourth International Conference on Ionization Phenomena in Gases*, Uppsala, August, 1959.

—"Integral Representation of a Double Commutator." *11 Nuovo Cimento*, **16**, 10 (1960).

—"The structure of a Non-relativistic S-matrix." *Proc. Roy. Soc. A* **256**, 115 (1960).

Peaslee, D. C.—"Seven-dimensional Charge Space." *Phys. Rev.*, **117**, 3 (1960).

Peaslee, D. C. and Carver, J. H.—"Nuclear Peak Energies." *Phys. Rev.*, **120**, 2155 (1960).

Peaslee, D. C., King, R. W.\* and Perkins, J. F.\*—"Electron-Neutrino and Electron-Antineutrino Scattering." *Phys. Rev.*, **117**, 6 (1960).

Peaslee, D. C. and Vaughn, M. T.\*—"Boson Furry Theorem." *Phys. Rev.*, **119**, 460 (1960).

Robson, B.—"Spin Orbit effects in the inelastic scattering of 12 MeV Neutrons in Carbon." *Proc. Phys. Soc.*, **76**, 611 (1960).

\* Not a member of the Australian National University.

## RESEARCH SCHOOL OF SOCIAL SCIENCES.

## ACTING DIRECTOR'S REMARKS.

Because of personal circumstances, Sir Keith Hancock was granted leave of absence from the office of Director in March. In September, Sir Keith submitted to the Council his resignation from the Directorship. He will continue as Professor and Head of the Department of History, but he expressed a strong wish to be relieved of the duties of the Director to allow him more time for writing and research and for cultivating closer relations with the other Australian Universities. The Council accepted his resignation, which will take effect upon his return to the University from study leave, with very great regret. Professor Partridge has been acting Director of the School since March.

Sir Keith's decision is regretted by all members of the School. His period of office has been one of great progress; all Departments and activities of the School have profited from his interest and leadership; and he has succeeded in moulding a School which has steadily become more sure of itself, more productive, and in which morale is particularly high. Although he has resigned from the Directorship, his intellectual influence will continue to be felt strongly within the School and throughout the University. The Council will make a decision early in 1961 concerning the future administration of the School.

There were 33 members of staff at the end of the year. Although some new senior appointments were made, some Departments (e.g., Statistics, Law, Social Philosophy) have found it difficult to make appointments at the Fellow/Senior Fellow level. This is partly due to the keen competition for able research men of this status amongst all the Universities, including those of Britain and the United States. During this year, problems of recruitment have not been made easier by the prolonged delay in announcing a decision concerning the revision of university salaries.

The planning of the permanent building for the Schools of Pacific Studies and Social Sciences made good progress during the year, and it is hoped that building will commence well before the end of 1961. In general, plans have come out very satisfactorily, except that some types of accommodation may be barely adequate by the time the building is ready for occupation. Problems of accommodation are now becoming very acute in the existing temporary building, and if all appointments which have been budgeted for in the 1960-61 financial year are made, the School will have trouble in housing all its staff under reasonably satisfactory conditions. Accommodation for students is also inadequate; it is therefore to be hoped that the completion of the permanent building will not be delayed.

The Council in September accepted a proposal from the School for the establishment of a Chair and Department of Sociology, and for enlarging research in the History of Ideas. These developments had both been foreshadowed in plans for the 1961-63 triennium which were submitted to the Universities Commission. Steps have been taken to advertise the first position in Sociology. It is not expected that it will be possible to make an early appointment to the Chair (although an appointment will be made immediately should a suitable occupant be found); but it may prove more practicable for the School to begin by appointing more junior staff who may be attached for administrative purposes to the Department of Demography until the Chair is filled and the separate Department set up. The new Department should play a very important part in the work of the School, partly by providing for students and staff of other Departments continuous training in methods and techniques of empirical social research, and more especially by promoting research into aspects of social structure and change in Australia and elsewhere which are at present somewhat neglected in this and in other Australian universities. If the Department is successful in training a body of graduate students in Sociology, it will make an important contribution to the belated growth of sociological teaching and research in all the Australian universities.

Work in the History of Ideas will not necessarily lead to the creation of another Department; it may be more convenient to attach specialists in this field to other Departments where some study of intellectual history is already in progress. This also is an important step in rounding out the School's programme. A Research School of Social Sciences necessarily concentrates heavily upon recent or contemporary social problems and developments, and upon comparatively recent theories and ways of thinking. It therefore benefits from the presence of a group of scholars who have a sense of depth in time, and who can help to correct tendencies towards provincialism both of place and time. However in this field as in sociology, the School expects to find some difficulty in making suitable appointments.

Thirty-eight students were enrolled at the end of the year. The number of applications for scholarships was very gratifying, and there is reason to believe that the number of students reading for the Ph.D. degree will rise appreciably during the next few years. The following students were awarded doctorates: R. D. Bradley (Social Philosophy), C. Forster (Economics); T. L. Suttor and J. M. Tregenza (History); H. Y. T'ien (Demography).

During the year discussions between corresponding Departments of the School and of the School of General Studies have been held to explore ways of co-operating in the teaching and supervision of M.A. and Ph.D. students. Most Departments have made arrangements to collaborate in courses for graduate students and in supervision. To some extent, these discussions superseded those which commenced in the School in 1959, and which were concerned with the desirability of providing more formal teaching than has been the practice in the past. The decision taken by the School in 1959 to establish a "teaching M.A. degree course" has had to be abandoned as a result of the amalgamation.

There are still a number of problems concerning the teaching and training of Ph.D. students which have not been settled to the satisfaction of all members of the School, and more consideration will have to be given to this in 1961.

The scheme for visiting fellowships has been an important and successful part of the School's policy; in 1960 we were again fortunate in having a number of visitors from other universities for some part of the year. Professor Asa Briggs, Professor of Modern History in the University of Leeds, was a Visiting Fellow from June to November. He delivered a course of lectures on British Social History in the 19th Century, led a seminar on the Culture of Cities which was organized by the Department of History and attended by historians and sociologists from other universities, and read papers to a number of university groups, in addition to visiting and lecturing at the other Australian universities. Dr. Lloyd Ross, New South Wales State Secretary of the Australian Railways Union, was a Visiting Fellow for a period of about three months, during which he brought almost to completion his biography of John Curtin. Dr. G. S. L. Tucker of the University of Melbourne (recently appointed to the Chair of Economic History at the School of General Studies) was Visiting Fellow in the Department of Economics from July to December. Other visitors who took part in teaching and research within the School included Dr. P. Erdős, a distinguished Hungarian mathematician (Statistics); Dr. Cherry Gertzel, University College of East Africa (History); Dr. A. J. Reitsma, University of Queensland (Economics); Mr. Norman McKenzie of London who carried out the study of the role of women in Australian public life initiated by the Social Science Research Council; and Dr. Craufurd Goodwin, Duke University Commonwealth Studies Center (Economics).

In August, the Department of Demography organized a conference on migration which was attended by scholars from other universities and by members of other bodies which are concerned with migration studies.

#### DEPARTMENT OF DEMOGRAPHY.

##### *Staff.*

Professor .. .. .	W. D. Borrie, M.A.
Senior Fellows .. .. .	C. A. Price, M.A., D.Phil. Norma R. McArthur, B.A., Ph.D.
Fellow .. .. .	J. Zubrzycki, M.B.E., M.Sc., Ph.D.
Research Fellow .. .. .	R. T. Appleyard, M.A.
Research Assistants .. .. .	Miriam Gilson, M.A. Margaret J. Mansfield, B.A. (appointed December, 1960).
Departmental Assistant .. .. .	Nancy V. Kuskie (from September, 1960).

In addition to the above persons who fill the formal establishment of the Department, the following persons were employed as Assistants during the year specifically for work connected with the study of British migrants, to which reference is made below in the body of the report:—

Mrs. L. Nicholson .. .. .	Full-time.
Mrs. C. Burton .. .. .	} Part-time.
Mrs. M. Salter .. .. .	

Dr. C. A. Price was Acting-Head of the Department until July.

Professor W. D. Borrie returned from study leave in July after spending the academic year September, 1959–June, 1960, as Visiting Professor of Demography at Princeton University. He also attended meetings of the International Population Union in Vienna in August, 1959, and of the American Population Association in Washington in May, 1960.

In March Dr. C. A. Price and Dr. Norma McArthur were promoted to Senior Fellowships.

##### *Students and Teaching.*

Mr. F. L. Jones, B.A., a second-year scholar, was engaged in fieldwork in Melbourne from February until October studying "The Italianate Community in Carlton".

Mr. J. C. Caldwell, B.A., also a second-year scholar, studying population trends in south-east Asia, returned from his fieldwork in Malaya in February, since when he has been analysing his data and drafting the initial chapters of his thesis.

Mr. L. L. Robson, M.A., a graduate in history from the University of Tasmania, joined the Department as a scholar in May. His research field is the demographic and social characteristics of the Australian convicts, particularly as revealed through an analysis of the convict registers. Mr. Robson is being supervised jointly by this Department and the Department of History.

No regular seminar programme (other than discussions on work in progress by staff and students) was held by the Department in 1960, but Dr. Price and Dr. McArthur read papers in a seminar series of the Department of Economics in April and May. In October Professor Borrie participated in a conference of the History Department on the Culture of Cities.

In November a joint seminar was held with the Department of Geography on the study of internal migration in Australia. The Department wishes to express its appreciation of the papers delivered to this seminar by Mr. L. Hazlewood of the Department of National Development and by Dr. D. Jeans of the Geography Department of the University of Sydney.

#### *Research Programme.*

In the field of immigration studies the main developments were—

- (1) The preparation of a major manuscript by Dr. Price on Southern European Settlers in Australia. This incorporates the results of Dr. Price's researches in this field since he joined the Department in 1952.
- (2) The completion by Dr. Zubrzycki of a statistical study of post-war immigration based upon the censuses of 1947 and 1954. Dr. Zubrzycki also completed much of the analysis of his field survey of immigrant communities in the Yallourn valley and continued the collection of data for studies of displaced persons and of the immigrant press.
- (3) The study of British immigrants being carried out by Mr. Appleyard and based upon an initial sample of some 900 families who left the United Kingdom in 1959, was carried through the following stages:—
  - (a) the coding and translation to punched cards of the data collected in the United Kingdom.
  - (b) The preparation of the interview schedule, the testing through a pilot study, and the organization of interviewing teams throughout Australia for the first "follow-up" interview of these same families in Australia.
  - (c) The preparation of the following draft reports arising from Mr. Appleyard's field work in the United Kingdom in 1959:—
    - (i) Notes on the Socio-Economic Determinants of Emigration from the United Kingdom (4 pp.).
    - (ii) Housing in the United Kingdom (11 pp.).
    - (iii) The return movement of British migrants to Australia (vi + 104 pp.).
    - (iv) Sources of information of United Kingdom emigrants about Australia (14 pp.).

In the studies of the populations of the Pacific Islands, Dr. McArthur was basically concerned with two matters—

- (1) In her visits to various Polynesian territories late in 1959 Dr. McArthur collected further data on patterns of mortality and fertility in these populations and these are being incorporated in the revision of her earlier studies on this area.
- (2) The tabulations of the census of the population living in selected sample areas of the British Solomon Islands Protectorate in 1959 were received in July and August and a report on the present and future state of this population was prepared for the Western Pacific High Commission.

The other major interest of the Department continued to be further analysis of the composition of the Australian population. While in the United States Professor Borrie examined recent research methods and results relating to the study of marriage and fertility with a view to expanding this field of work in the Department. After his return in July, and in collaboration with Dr. S. H. Solomon of the Department of Labour and National Service, he completed the basic calculations for a new set of Australian population projections which should be available for distribution before June, 1961.

In the latter half of the year Dr. McArthur, in collaboration with Mr. H. P. Brown of the Department of Economics, began an investigation by cohort analysis of patterns in marriage in recent years in Australia. In May, Dr. McArthur addressed the First National Conference of Social Welfare on the social implications of population trends in Australia.

In December, Professor Borrie completed a manuscript of a pamphlet on the perspective and prospects of world population growth.

#### *Other Activities.*

From 22nd to 25th August the Department held a conference on Immigration. The object was to bring together representatives from Universities, governmental and private organizations who are actively engaged in migration research, to discuss research methods and results, and to assess the state of existing knowledge and the gaps in which further research might be encouraged. Some thirty persons, about twenty of whom came from beyond Canberra, attended the Conference. Topics discussed included a comparative survey of assimilation studies in Australia and elsewhere, the research methods and

objectives of different disciplines, reports on field surveys in rural and urban areas, psychiatric problems associated with immigration, and the roles of government and private organizations in research. A duplicated Report on the Conference, edited by Dr. Price, will be available early in 1961.

#### *Support of Work.*

The Department wishes again to acknowledge the generous help of the Commonwealth Bureau of Census and Statistics, particularly for card punching and processing the data of the British Immigrant Survey, and of the Department of Immigration for their continued financial assistance for the same project. But for this assistance in kind and cash this project could not have continued.

#### *Publications.*

Borrie, W. D.—

“Demographic cycles and economic development: some observations based upon Australian experience”, *Population Index*, XXVI, i (1960), 3–16.

“The (Australian) people”, *The Encyclopedia Americana*, 1960 ed., II, 565–7. (Americana Corporation, N.Y., 1960.)

“The population explosion and the Far East: review article”, *Pacific Affairs*, XXXIII, ii (1960), 181–91.

McArthur, N. R.—

“The social implications of population trends”, *Proceedings of First National Conference of Social Welfare*, Australian Council of Social Service, Melbourne, May, 1960.

“Census enumerations in Melanesia”. Pacific, Commentary, *Journal of the Polynesian Society*, LXVIII, iv (1959), 390–1.

Zubrzycki, J.—

“The Soviet population census”, *Current Affairs Bulletin*, XXV, x, (1960), 146–60.

*Immigrants in Australia: A Demographic Survey Based upon the 1954 Census*, Melbourne University Press, 1960. (A.N.U. Social Science Monograph No. 17.)

*Immigrants in Australia: A Statistical Supplement*, Australian National University, 1960. (A.N.U. Social Science Monograph No. 18.)

“Immigration”, commentary prepared for *Atlas of Australian Resources*, Department of National Development, Canberra, 1960.

#### DEPARTMENT OF ECONOMICS.

##### *Staff.*

Professor .. .. .	..	T. W. Swan, B.Ec.
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.
Senior Fellow .. .. .	..	A. R. Hall, Ph.D.
Fellow .. .. .	..	J. A. Barnard, Ph.D.
Senior Research Fellow	..	F. H. Gruen, M.A., M.Sc.
Research Fellows .. .. .	..	K. H. Burley, Ph.D. W. E. G. Salter, Ph.D.
Research Assistants .. .. .	..	S. Zywczyk, Dr. Ec. M. Gough, B.Sc. (Econ.). R. J. Inall.

During the year Dr. Burley and Dr. Salter completed their research fellowships and took up appointments in the University of Birmingham and the Commonwealth Public Service, respectively.

Dr. G. S. L. Tucker of the University of Melbourne was a Visiting Fellow for the second half of the year. The Department also acted as host to a number of visitors, including Dr. A. J. Reitsma (University of Queensland), Professor Ian Bowen (University of Western Australia), and Dr. Craufurd Goodwin (Duke University).

##### *Students.*

Three students continued their courses on the following topics:—the economics of drought; Australian non-life insurance; and the theory of international trade.

##### *Public Service Fellow.*

The tenure of Mr. S. F. Harris as Public Service Fellow was extended for a further year. Mr. Harris is studying the history and implications of import licensing in Australia.

*Research.*

The Department's central interest is in processes of economic growth and fluctuation. Research work is carried on within three sections of the Department. In economic statistics Mr. Brown continued his work on problems of social accounting, economic forecasting and population analysis. Research in economics continued in the theory of international trade and theoretical and statistical analysis of consumer demand (Dr. Pearce); models of capital accumulation and economic growth (Professor Swan, Dr. Pearce and Dr. Salter); the Australian capital market and industrial trends (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 included 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 (Mr. Butlin and Dr. Zywczyk).

Dr. Barnard's business biography of T. S. Mort is in the press. Mr. Butlin completed the manuscript of his two volume history of Australian economic development since 1860.

*Other Activities.*

Dr. Barnard completed the editing of "Studies in the Australian Wool Industry", which records the proceedings of Professor Sir Keith Hancock's wool seminar. Dr. Pearce conducted seminars in the Universities of Sydney, New South Wales, Melbourne and Adelaide. Dr. Pearce and Professor Swan took part in a seminar on capital theory in the University of Adelaide, at which economists from several Australian universities were present. Professor Swan read a paper "Of Golden Ages and Production Functions" at the meeting of the International Economic Association held at Gamagori, Japan. A paper by Dr. Pearce "An Exact Method of Consumer Demand Analysis" was read at a meeting of the Econometric Society at Stanford, United States of America.

*Publications.*

Brown, H. P.—

"State capital differences in the basic wage." *Economic Record*, March, 1960.

"Giblin and the grants commission", in *Giblin, The Scholar and The Man* (ed. D. B. Copland).

Burley, K. H.—

"The overseas trade in N.S.W. coal and the British shipping industry, 1860-1914." *Economic Record*, August, 1960.

Gruen, F. H.—

"Economic aspects of pasture improvement in the Australian wool industry." *Economic Record*, April, 1960.

"Goulburn, forward prices and pies." *Review of Marketing and Agricultural Economics*, June, 1960.

"The pros and cons of futures for woolgrowers." *Review of Marketing and Agricultural Economics*, September, 1960.

"Shed classing versus store classing" (with J. O. White). *Australian Journal of Agricultural Economics*, December, 1960.

Hall, A. R.—

"Housing demand in Australia, 1959-1974" (with M. R. Hill). *Economic Record*, December, 1960.

Swan, T. W.—

"Economic control in a dependent economy". *Economic Record*, March, 1960.

## DEPARTMENT OF HISTORY.

*Staff.*

Professor .. .. .	W. K. Hancock, Kt., M.A., F.B.A.
Reader .. .. .	L. F. Fitzhardinge, B.Litt., M.A.
Senior Fellow .. .. .	R. A. Gollan, M.A., Ph.D.
Fellow .. .. .	D. A. Low, M.A., D.Phil.
Research Fellows .. .. .	G. C. Bolton, M.A., D.Phil. Mrs. Ann Mozley, B.A.
Research Assistant .. .. .	Miss Marjorie Eyre

Professor Hancock went on study leave to Britain in July and expects to return to Canberra in March, 1961. In July he was awarded the honorary degree of D.Litt by the University of Birmingham. In October he delivered the Wiles lectures at Belfast. He has also lectured at seven or eight English Universities. The greater part of his time has been spent at Oxford and Cambridge where he has prepared a number of works for the press.

Dr. Low and two scholars, J. Broomfield and P. Reeves, went to India in October and expect to return in March, 1961. They are working on Indian records in New Delhi and other centres.

Professor Asa Briggs, Professor of Modern History at Leeds, was Visiting Fellow in the Department from June to December. As well as carrying on research and conducting a lecture course and seminars at the Australian National University, he lectured in Sydney, Melbourne, Adelaide, Hobart and Christchurch. His emphasis on the importance of urban studies is likely to have a significant effect on the direction of research in Australian social history.

#### *Students and Teaching Activities.*

During the year there were twelve scholars in the Department, eleven working towards the Ph.D. degree and one the M.A. Of the twelve students, five took up their scholarships during 1960. These five scholars and their fields of research are: Mrs. M. Rechter, 'The Labour Movement in N.S.W., 1920-30'; J. Rundle, 'Victorian Politics, 1870-90'; L. Atkinson, 'Australia's Participation in the Boer War'; P. Reeves, 'Zamindari Politics in the Punjab and United Provinces, 1921-37'; J. Broomfield, 'The Bengal Legislative Council, 1905-35'.

Three scholars, T. L. L. Suttor, P. J. O'Farrell and O. M. Roe submitted theses for examination for the Ph.D. degree. All were successful. D. L. Carrington submitted a thesis on, 'The Gold Fields of New South Wales, 1851-74', for the M.A. degree. The examiners will report early in 1961. R. J. Lawrence left the University at the end of 1960 two months before the termination of his scholarship. He expects to submit his thesis, on 'The Development of Social Work Training in Australia', early in 1961.

Three students will take up scholarships in the Department in 1960: Miss P. Peter, H. J. Barrett, and D. B. Waterson.

During the year the Department worked closely with the History Department of the Canberra University College. The co-operation continued when the College became the School of General Studies of the University. Professor C. M. H. Clark continued to assist in the supervision of scholars.

#### *Research Programme.*

The research programme as outlined in 1959 has been continued. In the press, but not published at the time of writing are: 'Four Studies of War and Peace in this Century' by Professor Hancock; 'The Smuts Archive: Selected Papers 1886-1919', edited jointly by Professor Hancock and Dr. Jean Van der Poel. 'Smuts: The Sanguine Years, 1870-1919' by Professor Hancock is expected to go to press in March, 1961. In the press also is 'The First Four Years of Sydney', being the journals of Captain Watkin Tench of the Marines, edited with introduction and notes by L. F. Fitzhardinge. Dr. Gollan has contributed chapters to two books at present in the press: 'Edward Bellamy Abroad' (edited by Sylvia Bowman, University of Indiana) and 'Studies in the Australian Wool Industry' (Melbourne University Press).

Dr. Low has done a great deal of the preliminary work, such as the location and collection of sources necessary for the study in Australia of Indian History. He and the students under his supervision have also done substantial research.

Organization and planning of the Australian Dictionary of Biography has moved forward this year. Permanent machinery for an Editorial Board centred in the A.N.U. and a National Committee representing the State Universities was set up at a Dictionary Conference held in Canberra in April, and the title Australian Dictionary of Biography adopted. The Melbourne University Press has undertaken to publish the Dictionary on behalf of the Australian National University. Separate editorships of the first two volumes have been agreed upon; Mr. M. H. Ellis will edit Volume I, 1788-1825; Professor C. M. H. Clark, Volume II, 1826-50. Lists of inclusions for these volumes are being completed. Provisional editors reflecting State interests, have been nominated to begin work on the period 1851-90. Working Parties are now operating in all States, and several specialist Working Parties on particular aspects of Australian affairs have been convened. Professor Sawyer has acted as Chairman of the Editorial Board during the absence abroad of Sir Keith Hancock.

#### *Work in Progress.*

Professor Hancock: as reported in 1959.

Mr. Fitzhardinge: as reported in 1959.

Dr. Gollan: as reported in 1959.

Dr. Low: as reported in 1959.

Dr. Bolton: as reported in 1959.

Mrs. Mozley: as reported in 1959.

#### *Seminars and Lectures.*

A lecture course on the British Background to Australian History was conducted jointly with the History Department in the School of General Studies. Lectures were given by Professor Clark, Professor Briggs, Dr. Bolton and Dr. Gollan.

A Seminar on British Commonwealth History was conducted by Professor Hancock and Dr. Low during first and second terms.

A Work in Progress seminar was held for scholars and staff during first and second terms.

Professor Briggs conducted a seminar on 'The Culture of Cities', to which a number of historians and sociologists from other universities were invited. Coinciding with this seminar Professor Briggs led a discussion on the formation of a Society for the study of Labour History.

Mr. Fitzhardinge gave a course of lectures mainly for undergraduate Honours students on "Athenian Democracy and Imperialism 590-404 B.C."

#### Publications.

Barcan, A.—

"The Socialist left in Australia, 1949-1959", *Australian Political Studies Association, Occasional Monograph* No. 2. 1st edit. April, 1960, 2nd edit. Aug. 1960.

"The Catholic system of education in Australia; a critical review", *Forum of Education*, XIX, i, Sydney, 1960.

"Education without instruction", *The Australian Highway*, XLI, iv, Sydney, 1960.

"Yugoslavia and the Hungarian revolution", *Australian Outlook*, XIV, i, Sydney, 1960.

Carrington, D. L.—

"Riots at Lambing Flat, 1860-61", *J.R.A.H.S.*, XLVI, 1960, pt. iv.

FITZHARDINGE, L. F.—

"Writings on Australian history, 1959", *Historical Studies*, May, 1960.

"Letters from Australia", *J.R.A.H.S.*, XLVI, 1960, pt. iii.

Gollan, Robin—

*Radical and working class politics: a study of Eastern Australia, 1850-1910*, M.U.P., 1960.

Low, D. A. and Pratt, R. C.—

*Buganda and British over-rule, 1900-1955*, O.U.P., 1960.

Mozley, Ann—

"The Australian dictionary of biography", *Historical Studies*, November, 1960.

Steven, M.—

"Robert Campbell—his Scottish background", *J.R.A.H.S.*, XLVI, 1960, pt. iii.

Turner, I. A.—

"Communism and workers' democracy", *Australian Outlook*, XIV, ii, Sydney, 1960.

#### DEPARTMENT OF LAW.

##### Staff.

Professor . . . . . G. Sawyer, S.M., B.A., LL.M., of the Victorian Bar.

Senior Fellow (on leave) . . . . . S. J. Stoljar, LL.B., LL.M., Ph.D., of Gray's Inn, Barrister-at-Law.

Mr. P. Brazil came to the Department as a visiting Public Service Fellow from February, 1960, for a period of about a year. Mr. Brazil is a member of the staff of the Commonwealth Attorney-General's Department, and Lecturer in Evidence at the Law Department of the School of General Studies.

In February, 1960, Dr. Stoljar went on study leave to England, where he revised his book on Agency, arranged for its publication and saw the proofs through the first stages. He also spent periods working in Paris and in West Germany.

For short periods during the year, Messrs. Michael Roe (who had just completed his work as a scholar in the Department of History) and A. Harari acted as Research Assistants. In December, Mrs. B. J. Ashton, B.A., LL.B. (Adelaide), who had had research experience in Economics at Cambridge and legal experience with the Attorney-General's Department in Canberra, was appointed to this position for a year with the expectation that she would be a member of the department for a considerable period.

##### Students and Teaching Activities.

Mr. A. Harari completed his course and submitted a thesis on Causation in the law of Torts which is under examination.

Mr. D. K. Singh continued his comparative examination of problems of excess power and breach of prohibitions under federal constitutions.

Professor Sawyer and Mr. Brazil participated in seminars on the structure of the British Commonwealth, and on the development of British rule in India, organized by the Department of History; Mr. Brazil delivered a paper on theories of parliamentary sovereignty, and Professor Sawyer delivered papers on the history of the Judicial Committee of the Privy Council, and the application of English law in India before 1860.

A departmental seminar on work in progress was held each Monday afternoon in term time.

*Research Programme.*

Mr. Brazil carried out a detailed examination of the positive content of the powers with respect to interstate trade, commerce and intercourse possessed by the Federal authorities in the United States of America and Australia.

Professor Sawyer carried his work on the legislative and constitutional history of the Commonwealth to 1943. In July, Mr. Justice Kriewaldt of the Supreme Court of the Northern Territory died suddenly and left his papers in the care of Professor Sawyer, who prepared for publication a study by the late Judge of the application of civilized law to the Australian aborigine; Professor Sawyer also wrote a detailed study of his Honour's principal judgments, and began to prepare the more important ones for publication in the newly-established Australian Federal Reporter.

*Other Activities.*

In March, Professor Sawyer spent two days at the Australian Administrative Staff College in Melbourne, lecturing and conducting tutorials on relations between business and government in the Australian constitutional system. In July he lectured to the Institute of Public Administration and the Institute of International Affairs in Melbourne, the respective topics being recent judicial decisions affecting public administration, and the relationship between the Constitution and politics in contemporary West Germany; in August he gave lectures on federal government to classes of Asian public service students undergoing Colombo Plan training in Australia, and participated in a conference on constitutionalism in Asia held under the auspices of the Association for Cultural Freedom. From 15th to 19th August, Professor Sawyer attended the annual conference of the Australian Universities Law Schools Association in Perth, where he led a discussion on the application of law to the aborigines based upon the work of Judge Kriewaldt mentioned above. Professor Sawyer sat as a Magistrate in the Canberra Court of Petty Sessions on nine occasions and one of these cases led to a study of reciprocal enforcement of maintenance agreements within the British Commonwealth, which will be published.

*Publications.*

Brazil, P.—

- “Border hopping and s. 92 of the Constitution” (1960) 34 *Australian Law Journal*, 77–87.  
 “A matter of theology” (1960) 34 *Australian Law Journal*, 195–99.

Harari, A.—

- Translation of “Studies in Israel Law” by Professor G. Tedeschi, Hebrew University Students’ Press, Jerusalem (1960).

Sawyer, G.—

- “State and private property in Australian law”, in “Staat und Privateigentum” (ed. Strebel) (1960) Carl Heymanns Verlag K. G., Köln, 209–21.  
 “‘Implied powers’ in bundesstaatlichen Verfassungen des britischen Commonwealth” (1960) 20 *Zeitschrift für Ausländisches Öffentliches Recht und Völkerrecht*, 562–89.  
 “Politics and the constitution of West Germany” (1960) 14 *Australian Outlook*, 136–46.  
 “Federal legal persons and dual citizenship” (1960) *University of Malaya Law Review*, II, i, 1–16.  
 “Australia” in Annual Register of World Events 1959, 75–80.  
 “Reforming the Federal Constitution” (1960) 32 *Australian Quarterly*, 29–33.  
 “Judicial decisions affecting public administration” (1960) XIX *Public Administration*, 230–47.

Stoljar, S. J.—

- “The discharge of contracts by agreement” (1959) 3 *University of Queensland Law Journal*, 356–76.

## DEPARTMENT OF POLITICAL SCIENCE.

*Staff.*

Professor .. .. .	..	..	..	L. C. Webb, M.A.
Reader in Public Administration	..	..	..	R. S. Parker, M.B.E., M.Ec.
Fellow .. .. .	..	..	..	D. W. Rawson, M.A., Ph.D.
Research Fellow .. .. .	..	..	..	B. D. Graham, M.A., Ph.D.
Research Assistant .. .. .	..	..	..	Mrs. N. Heathcote, B.A.

Dr. Lloyd Ross, B.A., LL.B., D.Litt., who is New South Wales State Secretary of the Australian Railways Union, joined the Department as a Visiting Fellow for the months of October and November, 1960, and January, 1961. Dr. Ross, who had secured leave from his union position, completed during his Visiting Fellowship a biography of John Curtin on which he had been working for some years. He was also a valued member of the Department's seminars and discussions and delivered a paper on “Meanings of Trade Union Responsibility” to a seminar attended by members of the Australian National University and other universities.

*Staff Changes.*

Dr. Rawson, formerly a Research Fellow, was appointed a Fellow in July. He has accepted a Readership in Political Science in the University of Queensland and will take up this position early in 1961.

Dr. B. D. Graham was appointed to a Research Fellowship and joined the Department in October. He was formerly a student in the Department and for the last two years has been at St. Antony's College, Oxford, on a British Council Scholarship.

Dr. G. E. Caiden, who was awarded a Ph.D. of the University of London for a comparative study of the Canadian and Australian public services, was appointed a Research Fellow and will join the Department in February, 1961.

Mrs. Heathcote, Research Assistant, transferred to the Department of International Relations in April.

*Students.*

Mr. E. E. Crichton, B.Com., an officer of the Commonwealth Public Service Board, who took up a Public Service Fellowship in the Department in March, 1959, completed his research project on "Arbitration in the Public Service" and has resumed his public service duties.

Mr. D. Hindley, M.A., who went to Indonesia in August, 1959, to gather material for his Ph.D. thesis on the development of the Indonesian party system, returned to Canberra in June.

Mr. R. Wettenhall, M.A., a research scholar enrolled for the Ph.D. degree, has been working on a comparative study of six Australian public corporations in the transport field.

Mr. Glenn Barclay, M.A., a research officer of the New Zealand Treasury, was awarded a post-graduate scholarship and joined the Department in June and is enrolled as a Ph.D. candidate. He is studying political aspects of the development of the European Economic Community.

Mr. J. D. Playford, B.A., a research scholar enrolled for the Ph.D. degree, has continued his work on the development of the Australian Communist Party since 1949.

Mr. Mao-Tsai Wu, Ll.B., who has been preparing an M.A. thesis on "Administrative Relations between Federal, State and Local Governments in the Southern Tablelands Region of New South Wales", left in September to take up an appointment at the Royal Australian Air Force language school at Point Cook.

*Research Activities.*

Professor Webb continued his work on the development of television in Australia and on the origins of the South-East Asia Treaty Organization.

Mr. Parker continued his study of administrative theory in relation to Australian conditions and while in London collected material for his study of the development of the Australian public services in the second half of the 19th century.

Dr. D. W. Rawson completed his study of the 1958 Commonwealth elections which is now in the press and will be published under the title *Australia Votes*.

Dr. Graham completed a draft of a study of the French Socialist Party during the period of "tripartisme", 1944-1947, on which he has been working for the past two years under the supervision of Mr. Philip Williams of Nuffield College, Oxford. He is now revising the draft for publication in book form.

*Other Activities.*

In February Professor Webb visited Lahore as a member of the Australian delegation to a seminar organized by the South-East Asia Treaty Organization. After the seminar he lectured in the University of the Punjab and also visited Rawalpindi and Azad Kashmir. On his way back to Australia he spent a week in New Delhi, where he conducted a seminar on the work of Seato at the Indian Institute of International Affairs, and a week in Kuala Lumpur where he visited the University of Malaya. Professor Webb took part in the organization of the Committee for Cultural Freedom's seminar on Asian constitutions held in the Australian National University from 22nd August to 25th August and was a participant in the seminar. In July he delivered a course of lectures on the theology of Paul Tillich at the clergy school of the Victorian province of the Church of England. In December he took part in a seminar on public service management organized by the Commonwealth Public Service Board and the New Zealand Public Service Commission and attended by representatives of public service authorities in India, Pakistan, Burma, Malaya and Thailand. During the year Professor Webb attended meetings of the Research Advisory Committee set up by the Australian Broadcasting Control Board.

Mr. Parker was in London on study leave throughout the year. He worked at the Institute of Commonwealth Studies and on archives at the Public Record Office and the Civil Service Commission. He consulted colleagues in a number of universities, conducting seminars at Manchester and Leicester, and renewed close contacts with the work of the Royal Institute of Public Administration.

The Department assumed responsibility for organizing a conference of the Australian Political Science Association held in Canberra from 25th January to 27th January. The organizing work was carried out by Dr. Rawson, who also contributed a paper on "Interest Groups in the 1958 Election." Professor Webb has been elected president of the Association.

In June Dr. Rawson attended a conference on Decentralization organized by the University of New England and gave a paper on "Political Implications of Decentralization." During the second term he gave a course of lectures on Australian politics to a class of External Affairs officers at the Canberra University College. He also gave a paper at a conference of teachers of industrial relations held in Canberra in September.

Dr. Graham spent part of 1960 at the Fondation Nationale des Sciences Politiques in Paris. As a member of the Troisième Cycle, a post-graduate seminar course organized by the Fondation, he worked under Professor Maurice Duverger and Professor René Rémond, whose specialization is the theory of party systems. On his way back to Australia Dr. Graham spent two weeks in New Delhi inquiring into the materials available for studies of Indian party politics in the post-Independence period. He visited Sapru House, Delhi University, the library of the New Secretariat Building, and the library of the All India National Congress.

#### Publications.

Parker, R. S.—

"Policy and administration", *Public Administration*, XIX, ii, 113-20.

Rawson, D. W.—

"Collective bargaining and the white collar wage earner", (with Helen Hughes). *Journal of Industrial Relations*, II, ii, 75-89.

"Recent developments in trade unionism", *Journal of Industrial Relations*, II, ii, 124-7.

*Political Implications of Decentralization* (multilithographed), University of New England, 1960.

Webb, L. C.—

*Politics and Polity*, Melbourne University Press, 1960, pp 16.

"Pakistan as an Islamic State", *Australian Outlook*, XIV, ii, 157-72.

"Churches and the Australian Community", in *Melbourne Studies in Education*, Melbourne University Press, 1960, 89-131.

"The social control of television", *Public Administration*, XIX, iii, 193-214.

Wettenhall, R. L.—

"Early railway management legislation in New South Wales", *Tasmanian University Law Review*, I, iii, 446-74.

"Public service and public corporations in Australia", *Public Administration*, XVIII, iv, 297-312.

Graham, B. D.—

"The place of finance committees in non-labour politics, 1910-1940", *The Australian Journal of Politics and History*, VI, i, 41-52.

#### DEPARTMENT OF SOCIAL PHILOSOPHY.

##### Staff.

Professor of Social Philosophy	..	P. H. Partridge, M.A.
Professor of Philosophy	..	J. A. Passmore, M.A. (on leave, 1960)
Senior Fellow	..	J. C. Harsanyi, M.A., Ph.D., Dr. Phil.
Research Fellows	..	R. R. Brown, B.A., Ph.D. H. O. Pappé, Dr. Jur.

##### Students and Teaching Activities.

Mr. N. S. Thornton's scholarship expired during the year. He was appointed to a Lectureship in the External Studies Department of the University of Queensland; his thesis is expected to be ready for examination about the middle of 1961. Mr. Bhattacharyya worked for a few weeks on Indian Theories of Education—a paper on this subject has been accepted for publication by the Australian Journal of Education. For most of the year, he has been engaged on a study of the philosophy and social and educational theories of John Dewey which will become the subject of his thesis. Mr. David Dockrill has completed a series of studies on Nineteenth Century Agnosticism which will be incorporated in the final version of his thesis. Mr. D. B. Heron has continued to work on his thesis on the theory of meaning with special reference to the philosophy of Locke. A first draft of the thesis is almost completed. Mr. K. G. Pont, whose thesis will deal with the early logical work of Bertrand Russell, studied the logical theories of philosophers immediately preceding Russell, and especially Mill and Frege. Mr. Colin Ross has been studying modern conceptions of formal logic. Mr. Brian Smith, who began his course in September, has not yet decided upon his topic of research; he has been reading generally in the field of epistemology, and especially in theories of perception.

Professor Partridge and Dr. Harsanyi collaborated in conducting a seminar on Recent Developments in Social Theory which ran throughout the year, and was attended by students of the Department as well as by some members of other Departments. Members of the Department joined with the staff of the Department of Philosophy of the School of General Studies in conducting a weekly seminar devoted to the discussion of contemporary philosophical problems. In the absence of Professor Passmore, Dr. Brown and Dr. Harsanyi took over most of the supervision of the students normally supervised by Professor Passmore. In this connection, Dr. Brown held individual and group tutorial meetings regularly.

#### *Research Programme.*

Professor Partridge completed a paper on Some Features of Recent Political Theory; made some progress with a series of studies of problems of liberty in contemporary societies; and continued with a general work on Modern Social and Political Theory. He also commenced some preliminary studies of recent philosophies of law.

Professor Passmore was Ziskind Visiting Professor at Brandeis University during the first half of 1960. He gave a series of seminars which were attended by teachers and students from the Boston area, and lectured in a number of other American Universities. The second half of the year was spent mainly in Oxford where he was jointly responsible with Professor Gilbert Ryle for a seminar-class during Michaelmas Term. He also lectured in Cambridge and Manchester. During the year he completed a book on "Philosophical Reasoning", and a number of papers on methodological topics.

Dr. Harsanyi has been working mainly on (a) Game-theoretical bargaining models; (b) Explanation and the use of analytical models in the social sciences; (c) Criteria of choice among scientific hypotheses. He completed and submitted for publication a number of papers dealing with these matters. He carried out preliminary work, including computations on the I.B.M. 650 computer in Sydney and on the I.B.M. 610 computer at Mt. Stromlo, on a book dealing with game-theoretical bargaining models to be published by Stanford University Press.

Dr. Brown completed the manuscript of a large book entitled "Explanation in the Social Sciences" which has been submitted to Cambridge University Press. Three papers dealing with general philosophical problems were completed and accepted for publication during the year. He also commenced work on a study of the relationship between explanation and prediction.

Dr. Pappé completed a study of the intellectual relations between J. S. Mill and Harriet Taylor; and a paper on the validity of judicial decisions in Germany in the Nazi period. He completed and submitted for publication several papers on other topics, including studies in the history of ideas. He has made progress with work on Henry Handel Richardson and on John Stuart Mill.

#### *Other Activities.*

Professor Partridge has acted as Director of the School since March 1960. He has been one of the representatives of the Institute on the Board of the School of General Studies, and has represented the University on the Committee which considers applications for scholarships under the British Commonwealth Post-Graduate Scholarship scheme. He also sat on the Committee concerned with applications for Rockefeller Fellowships in the Social Sciences, Duke University Commonwealth Studies Center Graduate Scholarships, and Fulbright Fellowships. During the year, he read a paper to the Canberra Branch of the Australasian Association of Philosophy, to the Sociological Society, and delivered a lecture to the A.N.U. Convocation Group in Melbourne.

Dr. Harsanyi was invited to attend and read a paper at the International Congress for Logic, Methodology and Philosophy of Science held at Stanford in September. He gave two addresses to meetings of the Canberra Branch of the Economic Society of Australia and New Zealand and was this year President of the Canberra Branch of the Australasian Association of Philosophy.

Dr. Brown has continued to serve as Bursar of University House.

#### *Publications.*

Harsanyi, J. C.—

"Explanation and comparative dynamics in social science", *Behavioral Science*, V (April, 1960), 136-45.

"Popper's improbability criterion for the choice of scientific hypotheses", *Philosophy*, XXXV (Oct. 1960), 332-40.

Pappé, H. O.—

"John Stuart Mill and the Harriet Taylor Myth", Melbourne University Press, 1960.

"On the validity of decisions in the Nazi era", *Modern Law Review* (May, 1960), 260-74.

Passmore, J. A.—

"The meeting of extremes in contemporary philosophy", *Philosophical Review*, LXIX, 363-75.

"Popper's account of scientific method", *Philosophy*, XXXV, 326-31.

Partridge, P. H.—

"Lament for social philosophy", *Australian Journal of Politics and History*, VI, 109-13.

## THE RESEARCH SCHOOL OF PACIFIC STUDIES.

## ACTING-DIRECTOR'S REMARKS.

The Director-elect, Professor Sir John Crawford, joined the staff of the University on 1st October; but he will remain abroad, mainly in the United States, till February, 1961. When the Director assumed office, the designation of Professor Davidson was changed from Dean to Acting-Director. Professor Davidson was himself absent from Canberra, as Constitutional Adviser to the Government of Western Samoa, for about six months (including most of the Long Vacation). During these periods, Professor Barnes acted as head of the School.

Professor Crawford has spent the last quarter of the year visiting centres in which research is being undertaken into the economics of under-developed areas. He has also sought likely recruits both to the Department of Economics and to other Departments in the School. Professor Davidson has been able to undertake a few academic duties while engaged on Western Samoan business: in the United States, he had discussions with Sir John Crawford and with American scholars concerned with Pacific research; in New Zealand, he informally represented the University at the official opening of the Palmerston North University College; and, in Fiji, he had discussions—of particular importance to the Department of Pacific History—at the Central Archives of Fiji and the Western Pacific High Commission. Professor Spate was absent on study leave in the United States from March till the end of December.

During the year the School has made substantial progress in implementing the plan of development drawn up in 1958. The New Guinea Research Unit was brought near to reality with the appointment of Dr. D. G. Bettison, of the University of Queensland, as Senior Fellow and Executive Officer of the Unit. Dr. Bettison will assume duty early in January, 1961. Dr. Donald Walker, of the University of Cambridge, was appointed to the Readership in Biogeography in the Department of Geography early in the year and arrived in Australia at the end of December. Mr. Jack Golson, of the University of Auckland, was appointed to the Fellowship in Archaeology in the Department of Anthropology and Sociology. He visited Canberra briefly in August to discuss the provision of laboratory and other facilities but has not yet taken up his appointment. Professor Crawford, despite his absence from Canberra, has given considerable attention to the building up of the Department of Economics. Mr. E. K. Fisk, who had previously been working in Malaya under the Colombo Plan, joined the Department as Senior Research Fellow; and other appointments to the staff are under consideration. Several students have been accepted by the Department and are expected to begin their courses early in the new year.

As foreshadowed in last year's *Annual Report*, the Department of International Relations was transferred back to the School on 1st January. The Acting-Head of the Department, Mr. A. L. Burns, who was formerly a Senior Fellow, became a Reader on 9th December.

Apart from the many short-term visitors, several Visiting Fellows spent a longer period in the School and contributed substantially to its work. Dr. C. Hartley Grattan, who has been working for some time on a comprehensive study of the history of Australia, New Zealand, and the Pacific, held a Visiting Fellowship in the Department of Pacific History. Professor Douglas Oliver, of Harvard University and Professor Max Gluckman, of the University of Manchester, held similar appointments in the Department of Anthropology and Sociology. Dr. John Burton, formerly Secretary of the Department of External Affairs, took up an appointment as Visiting Fellow in the Department of International Relations in the latter part of the year and will remain in the School for part of 1961. During November-December he obtained leave of absence in order to attend the Pugwash Conference in Moscow and to make contact with scholars in the field of international relations in India, Britain, and the United States.

Professor Gluckman is an anthropologist of great distinction and the University arranged the visit to enable him, first, to contribute to the work of the Department of Anthropology and Sociology in Canberra by speaking to seminars, discussion with staff and students, &c.; second, to contribute to the development of the Department's research programme in New Guinea as a result of visiting that area and assessing research problems on the spot. The second of these two objectives was not attained, owing to the refusal of the Australian authorities to grant Professor Gluckman a permit to enter the Territory of Papua and New Guinea. The Dutch authorities were anxious that he should visit Netherlands New Guinea; but, owing to the attitude of the Australian authorities, he decided to abandon his visits to both halves of the island.

In general, members of the School have maintained excellent relations with the Minister for Territories, the Department of Territories, and the Administration of the Territory. The School has reason to be grateful for the sympathetic interest in social science research shown by the Minister and his officers and for the practical help given to research workers both in Canberra and in the Territory. None the less, Professor Gluckman's difficulty does not stand alone in the School's experience. There have been previous occasions on which apparent lack of confidence in a new member of the School or doubts about the granting of facilities necessary for a particular project have seriously hindered research. The School has always sought to develop a substantial programme of research in Papua and New Guinea,

on account both of the scientific interest of the area and of the University's particular responsibilities as an Australian institution. At the present time, with the New Guinea Research Unit beginning work early in 1961, that programme is about to be expanded—with the full support of the governmental authorities concerned. On the other hand, the planning of research in Papua and New Guinea has always been more difficult than the planning of work elsewhere. However a more satisfactory procedure for the consideration of the School's requests for the admission of research-workers to the Territory has now been decided upon.

The considerable growth of the School, together with expanding numbers in the Research School of Social Sciences, has placed acute pressure upon accommodation in the Old Hospital Buildings. Laboratories have had to be provided for both the Reader in Biogeography and the Fellow in Archaeology. The space originally allocated to the Department of Economics will become inadequate early in the new year; and arrangements have been made, with some reluctance, to sub-divide the theatre (formerly occupied by the Film Division of the National Library) into additional offices for the Department. The Department of International Relations has been forced to move into a house in Balmain Crescent. The School, therefore, had good reason for welcoming Council's final approval of Messrs. Mockridge, Stahle, and Mitchell's sketch plans for the permanent building for the Research Schools of Social Sciences and Pacific Studies. The building itself promises to be both pleasing and convenient. The accommodation problem will not be solved till it is ready for occupation.

During the year there were thirty-three students enrolled in the departments of the School (including some for part of the year only). Six former students received the Ph.D. degree in May; three have been recommended for the award of the degree; and others are currently under examination.

#### 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). J. D. Freeman, Ph.D. (Social Anthropology).
Senior Fellow .. .. .	S. A. Wurm, Ph.D. (Linguistics).
Research Fellows .. .. .	Paula Brown, M.A., Ph.D. A. L. Epstein, LL.B., Ph.D. M. A. Jaspan, B.A., B.Sc. (from December). Marie O. Reay, M.A., Ph.D.
Research Assistant .. .. .	Maricke H. van de Graaff, Cand.

Mr. M. A. Jaspan assumed his Research Fellowship in December. Mr. Jaspan gained his B.A. at the University of Natal, and his B.Sc. in Oxford in 1952. He was Professor of Sociology at Gadjah Mada University, Jogjakarta, from 1955 to 1958 and has been Director of the Social Research Centre, Padjadjaran State University, Bandung, since 1959 until taking up his Research Fellowship.

Mr. J. Golson, Senior Lecturer in Prehistory in the Department of Anthropology at the University of Auckland, was appointed to a Fellowship in Prehistory in April. Mr. Golson expects to take up his appointment at the beginning of May, 1961.

Dr. Paula Brown returned from Chimbu in the New Guinea Highlands in March. Dr. Marie Reay returned from the Northern Territory in November. Dr. A. L. Epstein returned from Rabaul in October. Dr. Wurm carried out linguistic research in south-eastern Queensland, north-eastern New South Wales and north Queensland during September-October. Professor Barnes spent six weeks in the Northern Territory and Indonesia in September-October.

##### *Students and Teaching Activities.*

During the year there were eighteen students enrolled in the Department as Ph.D. candidates, eleven of whom were pursuing their course of study at the University for all or part of the year. Seven students were working on their theses after completing their courses; five of these submitted their theses for examination; one returned to the University to complete her writing. Three Fulbright students were enrolled as not proceeding to a degree here. The award of a Ph.D. to Mr. K. S. Mathur was recommended in October, and to Mr. D. J. Tugby in December. Three students were under examination at the end of the year. One student resigned his Scholarship in January before completing his course.

The effect is beginning to be felt of the changes introduced in 1958 whereby students will normally complete their theses before leaving Canberra, and whereby under certain conditions Scholarships may be held for four years. It is hoped that by the middle of 1961 all students will be working under the new arrangements.

Seminars on work in progress were held throughout the year. Papers on one or more topics were read by: Mr. Appell (recent fieldwork among the Dusun of North Borneo); Mr. Allen (kinship and local organization on Aoba; authority and leadership on Aoba); Mr. Beckett (politics and religion on Murray Island; the German wislin movement on Saibai Island); Dr. Brown (social relations in Chimbu death ceremonies); Dr. Freeman (Iban augury); Mr. Ganguly (Gluckman's contribution to the theory of anthropology); Miss MacEachern (plans for studying assimilation in urban Australia); Miss McArthur (Kunimaipa local organization; Kunimaipa kinship and marriage); Dr. de Martinoir (the Kajang of Sarawak); Mr. Ploeg (Bohannan's *Justice and judgment among the Tiv*); Mr. Scheffler (kindred and kindred groups in Simbo social structure); Mr. Singarimbun (Karo Batak segmentary structure; Karo Batak family and local organization); Dr. Stanner (the analysis of aboriginal religion).

Professor Max Gluckman, Professor of Social Anthropology in the University of Manchester who was a Visiting Fellow in the Research School of Pacific Studies during 1960, read four papers on "The limits of naiveté" to the Departmental seminar.

Dr. J. D. Freeman gave a lecture on "The peoples of Malaysia" in the Public Lecture series on Southeast Asia.

A series of Public Lectures on Social Anthropology was given by members of the Department in August and September. The lectures included: "Tribalism in Central Africa" (Professor Gluckman); "Countrymen in the twentieth century: a Norwegian example" (Professor Barnes); "New Guinea peoples" (Dr. Brown); and "The aborigines of Australia" (Dr. Stanner).

Mr. P. G. Ganguly read a paper in the History Department seminar, entitled "An Indian steel town".

Dr. A. L. Epstein participated in the Senior Officers' Course on urbanisation held at the Australian School of Pacific Administration at Mosman in October.

Dr. S. A. Wurm gave a course in general linguistics at the Canberra University College during the academic year 1960.

Professor Douglas Oliver of Harvard University was a Visiting Fellow during March-April and gave a series of seminar papers on his research in Tahiti and related topics.

In August Dr. Murray Groves of Auckland University visited the Department and gave a series of papers on the results of a social survey carried out in Port Moresby in 1959.

Mrs. J. Inglis, formerly of the Institute of Social Anthropology, Oxford University, visited the Department in August and read a paper on her research among aborigines in Adelaide.

Several members of the Department attended a course in Elementary Dutch arranged by Canberra University College throughout the year.

#### *Research Programme.*

Professor Barnes spent six weeks in September-October visiting fieldworkers in the Northern Territory and Indonesia, and visiting universities and government institutions concerned with social research in Indonesia. He lectured at the Faculty of Education and the Social Research Centre at Padjadjaran State University, the Department of Anthropology, University of Indonesia, and the Faculty of Education, University of North Sumatra. Professor Barnes is working on a book provisionally entitled "Island Peasants" describing certain aspects of social life in Western Norway.

Dr. Stanner continued writing up the results of his research on aboriginal religion, which is appearing as a series of articles in *Oceania*.

Dr. Freeman continued work on his account of the Iban of Sarawak.

Dr. Wurm made three short field trips during 1960, carrying out linguistic research in south-eastern Queensland, in north-eastern New South Wales, and in the Mornington Island area and Palm Island, North Queensland. Dr. Wurm is preparing for publication an account of the languages of the New Guinea Highlands.

Dr. Paula Brown returned from Chimbu in the Eastern Highlands District, New Guinea, in March and is now writing up the results of her research.

Dr. Epstein returned to Canberra in October, after carrying out a year's field study of social conditions in the township of Rabaul, with special reference to the indigenous population.

Dr. Reay returned to Canberra in November after a year spent at Borroloola, Northern Territory, during which she made a study of the position of aboriginal women. Dr. Reay intends to return to the Northern Territory in 1961 to complete this study, visiting Borroloola, Katherine, the Barkly Tablelands, Beswick Creek, the Roper River and Doomadgee Mission.

During the year Mrs. van de Graaff worked on an ethnographic gazetteer of New Guinea.

Mr. Allen returned to Aoba, New Hebrides, in October to complete his field study of political and economic life on the island.

Mr. Appell returned to Canberra in October, after a year's fieldwork among the Dusun people of North Borneo. He expects to return to North Borneo in 1961 to complete his fieldwork.

Mr. Beckett returned to the Torres Straits in October to complete his field investigation of the working of Native Councils and economic enterprises.

Mr. Ganguly left Canberra in November for India, where he will carry out a field study in the town of Jamshedpur on tribal politics in an urban environment.

Mr. Hiatt left Canberra in February to continue his field research at Maningrida, Arnhem Land. He expects to complete his field research into processes of social control in the area and return to Canberra early in 1961.

Mr. Laycock returned to Canberra in April after spending nine months in the Sepik District, New Guinea, investigating the distribution and structure of indigenous languages in this region. Mr. Laycock is now writing up the results of his research.

Miss MacEachern arrived in Canberra in July, and in December commenced a field study of the assimilation of an ethnic minority in Victoria.

Dr. de Martinoir left Canberra in April to carry out field research among the Kajang of the Upper Rejang, Sarawak.

Mr. Newman, a Fulbright student, completed his field research at Miruma, Eastern Highlands District, New Guinea, in September and returned to the United States.

Mr. Ploeg left Canberra in April for Bokondini, Baliem Valley, Netherlands New Guinea, to begin field research on processes of social control among the indigenous inhabitants of the area.

Mr. Scheffler, a Fulbright student, joined the Department in May after carrying out field research on Choiseul, British Solomon Islands Protectorate. Mr. Scheffler will spend a year in Canberra writing up the results of his research.

Mr. Silverman, a Fulbright student, arrived in Canberra in October and intends making a study of culture contact among displaced populations in the Pacific.

Mr. Singarimbun left Canberra in July to carry out a field study of the Karo Batak of North Sumatra.

Mr. Verma left Canberra in February to carry out research into social change among the Mailu of Eastern Papua.

#### *Other Activities.*

Members of the staff and students of the Department attended a meeting of the Australian Branch of the Association of Social Anthropologists in Sydney in May. Papers were read by Professor Jaspán and Mr. Ganguly.

During the year, other visitors to the Department, several of whom read seminar papers, have included Dr. Jean Guiart of the Ecole Pratique des Hautes Etudes, Paris; Dr. Leonard Glick of the University of Pennsylvania; Mr. R. N. H. Bulmer, and Mr. J. Golson, both of the University of Auckland; Professor M. A. Jaspán of Padjadjaran State University, Bandung; Dr. W. Davenport of Yale University; Mr. H. van den Hout of the Netherlands New Guinea Department of Education; and Mr. Lewis L. Langness, University of Washington, Seattle.

Dr. J. D. Freeman was awarded a Curl Bequest Prize for 1960 by the Royal Anthropological Institute for his essay on "The concept of the kindred".

#### *Publications.*

Barnes, J. A.—

"Indigenous politics and colonial administration with special reference to Australia." *Comparative studies in society and history*, II, 133-49.

"Social anthropology, the university and the public." (Presidential Address, Section F, ANZAAS, Perth Congress 1959). *Australian Journal of Science*, XXII, 371-77.

"Future developments in anthropological studies." *Australian Journal of Psychology*, XII, 21-33.

"Anthropology in Britain before and after Darwin." *Mankind*, V, 369-85.

Contribution to *Cultures and societies of Africa* (eds. Simon and Phoebe Ottenberg; Random House, New York): "History in a changing society," pp. 318-27.

"Marriage and residential continuity." *American Anthropologist*, LXII, 850-66.

Brown, Paula.—

“Chimbu tribes: political organization in the Eastern Highlands of New Guinea.”  
*Southwestern Journal of Anthropology*, XVI, 22–35.

Bulmer, R. N. H.—

\*“Political aspects of the Moka ceremonial exchange system among the Kyaka people of the Western Highlands of New Guinea.” *Oceania*, XXXI, 1–13.

Burridge, K. O. L.—

\**Mambu: a Melanesian millennium*. Methuen, London, XXIII, 296 pp.

Freeman, J. D.—

Contribution to *The birds of Borneo* (by B. E. Smythies; Oliver and Boyd, Edinburgh):  
“Iban augury”, 73–98.

Laycock, D. C.—

“Language and society: twenty years after.” *Lingua*, IX, 16–29.

McArthur, A. M.—

(Ed.) “1. Report of the Nutrition Unit.” *Records of the American-Australian Scientific Expedition to Arnhem Land*, II, 1–13.

“2. Food consumption and dietary levels of the aborigines at the settlements.” *Records of the American-Australian Scientific Expedition to Arnhem Land*, II, 14–26.

“6. Food consumption and dietary levels of groups of aborigines living on naturally occurring foods.” *Records of the American-Australian Scientific Expedition to Arnhem Land*, II, 90–134.

McCarthy, Frederick D.† and McArthur, A. M.—

“The food quest and the time factor in aboriginal economic life.” *Records of the American-Australian Scientific Expedition to Arnhem Land*, II, 145–94.

Reay, Marie O.—

“‘Mushroom madness’ in the New Guinea Highlands.” *Oceania*, XXXI, 137–39.

Stanner, W. E. H.—

“Aboriginal rock paintings.” *The Etruscan*, IX, 18–23.

Contribution to *In the company of man* (ed. Joseph B. Casagrande; Harper and Bros., New York): “Durmugan: a Nangiomeri,” 64–100.

“On aboriginal religion. II. Sacramentalism, rite and myth.” *Oceania*, XXX, 245–78.

Wurm, S. A.—

“The changing linguistic picture of New Guinea.” *Oceania*, XXXI, 121–136.

“The question of aboriginal place names.” *Cartography*, III, 134–39.

#### Theses.

During the year the following theses were submitted and deposited in the Library after examination for the degree shown:—

T. N. Madan, for Ph.D.—“Family and kinship: a study of the Pandits of rural Kashmir.”

K. S. Mathur, for Ph.D.—“Caste and ritual in a Malwa village.”

D. J. Tugby, for Ph.D.—“Modern social structure and social organisation in Upper Mandailing, Sumatra.”

#### DEPARTMENT OF ECONOMICS.

##### Staff.

Professor .. .. .	J. G. Crawford, Kt. C.B.E., M.Ec., (from September, 1960)
Senior Research Fellow .. .. .	E. K. Fisk, M.A. (from August, 1960)
Public Service Fellow .. .. .	Margery G. N. Morris, B.Com. (from March, 1960)
Research Fellow .. .. .	T. S. Epstein, B.A., Ph.D. (from February, 1959)
Research Assistant .. .. .	R. K. Hefford, B.Ec. (from January, 1960)

The Department is a new one, and has been in process of formation during 1960. Professor Sir John Crawford, whose appointment became effective from September, 1960, has been completing a visit to universities and other institutions in America and is due to arrive in February, 1961. Dr. Epstein, who was originally appointed to a School Research Fellowship in February, 1959, was transferred to this Department in January, 1960.

##### Students and Teaching Activities.

No students were recruited to the Department in 1960 pending the recruitment of staff, but in the last quarter of the year members of the staff were assisting in the supervision of two students from other Departments of the School who were engaged in research with economic aspects.

\* Based on research carried out while a member of the Australian National University.

† Not a member of the Australian National University.

*Research Programme.*

The Department of Economics is concerned with the study of underdeveloped areas, with emphasis on the building up of a systematic empirical knowledge of the Pacific and South-east Asia. Studies in current problems of economic growth and of Australia's economic relations with the region are proposed, and particular attention is being paid to the development of New Guinea.

Dr. Epstein is engaged on a study of economic and social change amongst the Tolai of New Britain, and returned in October from twelve months field work amongst those people.

Mr. Fisk is engaged on a study of the special development problems of plural societies, and with the preparation of papers dealing with the results of empirical research undertaken in the rural areas of Malaya.

Sir John Crawford and Miss Morris are collaborating in research on the development of Australian Trade Policy during and since the 1939-45 war.

*Other Activities.*

In September, 1960, Sir John Crawford gave a paper on "Australia in the Pacific" to an Economics Seminar conducted at Lausanne by the Australian Government. In October and November he gave papers at the Littauer Centre (Graduate School of Government) at Harvard University on "Australia's trade policy" and on "Policy-making functions of the Civil Service".

In January, 1961, Sir John served as a member and chairman of a group invited by the Secretary-General of United Nations to advise on compensatory measures designed to mitigate the adverse effects of instability in commodity trade, with particular reference to underdeveloped countries. The Group's report will be considered by appropriate U.N. bodies during 1961.

## DEPARTMENT OF FAR EASTERN HISTORY.

*Staff.*

Professor .. .. .	C. P. FitzGerald.
Senior Fellow .. .. .	G. Mulder, Drs.
Senior Research Fellow .. .. .	T. W. Eckersley, B.A.
Research Fellows .. .. .	N. Barnard, B.A., Ph.D.; E. S. Crawcour, M.A., Ph.D.
Research Assistant .. .. .	Sybil M. van der Sprenkel, B.A., M.Sc.

In September Mr. Mulder was offered appointment as Senior Fellow, and Dr. Crawcour returned from a field trip in Japan.

*Students and Teaching Activities.*

There were two students working for the Ph.D. in the Department this year. Mr. R. H. P. Mason went to Japan early in the year to gather source materials for his work on "The First General Election Held in Japan in 1890, and Selected Debates in the First Session of the Imperial Diet, 1890-91". He returned at the end of the year. In August, Mr. A. Fraser accepted appointment at The School of Oriental and African Studies, London University, as Lecturer in Japanese History, and left Canberra.

In October, Professor FitzGerald took over Mr. van der Sprenkel's course in Oriental Civilization at the School of General Studies, during Mr. van der Sprenkel's absence on sick leave. During the second and third terms of this year Mr. Eckersley taught Japanese Part I (the written language) at the School of General Studies.

Towards the end of the year seminars were conducted by Dr. Noel Barnard on "Sinological Shelving of Sinological Cinderellas—the problem of misprints in Chinese research", and "On the Suitability of Far Eastern studies as teaching subjects in secondary schools".

*Research Programme.*

Professor FitzGerald completed research into the origin of the use of chairs in China and the development of Chinese furniture.

Mr. Mulder completed the typescript for the first volume of *The Imperial Relatives by Marriage of the Former Han*, and copies were sent abroad for comment to Professors Hightower, Wilbur and Pulleyblank. The material for the second and third volumes has been collected. Work is proceeding on the General Introduction which will be incorporated with the first volume.

Mr. Eckersley has completed five chapters of his book, *Japanese Society and Culture in Transition*, and a number of others are ready to be written up.

Dr. E. S. Crawcour has continued his research on the economic history of Japan (Tokugawa period) and the following articles for publication have been completed—"Trade and Finance in the early Tokugawa period", "Some Observations on Merchants", "The development of a credit system in 17th century Japan" and "Some documentary sources of Tokugawa social and economic history".

Dr. Barnard has continued his research into bronze inscriptions of early Chinese Civilization, his major project being *Archaeological Documents of Ancient China*. For this the bulk of some 15,000 inscriptions has been compiled into the potential order in which the materials will appear; of some 2,000 long and difficult inscriptions over 1,000 are transcribed into modern character form and tentatively translated; a systematic method of serial-number reference has been devised and applied to more than a third of the inscriptions. Early next year full-time work on the final manuscript for the first volume will commence.

#### *Other Activities.*

Professor FitzGerald attended the 32nd Annual Summer School of the Adult Education Board, University of Western Australia, in Perth, from 19th-24th January, where he gave lectures on topics of recent Chinese history, and led discussion groups. On 26th April he gave a lecture on "Chinese knowledge of the Roman Empire in the Han period" to the Canberra Classical Association. In May he visited the University of Melbourne where he gave two lectures and two staff seminars on topics of Chinese history. For the second year Professor FitzGerald also acted as external examiner for the University of Malaya History Department.

While in Japan Dr. Crawcour was elected a member of the Council of the Asiatic Society of Japan, and lectured to the Society in February on "Trade and finance in the early Tokugawa period". In August-September he participated in the Conference on Modern Japan of the American Association for Asian Studies, and contributed a paper on "Modernization and economic change".

Dr. Barnard has accepted the honorary post of Associate Editor with *Monumenta Serica* (Japan) and has since been requested to compile the style-sheet for the journal. This is at present under review by the Editor and other Associate Editors.

#### *Publications.*

Barnard, N.—

"A Recently Excavated Inscribed Bronze of the Reign of King Mu of Chou". *Monumenta Serica*, XIX, 1960.

Eckersley, T. W.—

"The Covert and Overt Use of Force in Politics in Japan". *The Australian Outlook*, XIV, (May, 1960), 40-49.

FitzGerald, C. P.—

Contributions to *Encyclopaedia Britannica*—"The Empress Wu", "Min Chia", "Hsiung Nu".

Contributions to *Chamber's Encyclopaedia*—revision of articles on "Boxers", "Confucius", "Kublai Khan", "Manchuria", "Formosa", "Sun Yat-sen", new article on "Mao Tse-tung".

#### 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.
Reader in Biogeography ..	..	..	..	D. Walker, B.Sc., Ph.D. (from 14th October).
Research Fellow .. .. .	..	..	..	G. J. R. Linge, B.Sc. (Econ.), Ph.D.

Dr. Donald Walker, of the Quaternary Research Sub-department in the University of Cambridge and a Tutor of Clare College, was elected to the Readership in Biogeography early in the year but was unable to leave England to join the University till October.

It did not prove possible to fill the two vacant Research Fellowships in 1960; they were re-advertised late in the year.

The Department regrets having lost the services from the map room of Mr. K. Matveev. Mr. I. Heyward has been appointed to the cartographic staff.

During Professor Spate's absence on study leave from 15th March, Mr. Jennings has had charge of the Department, except during his absence on field work when Dr. Brookfield was acting head.

### *Students and Teaching Activities.*

There were eight Ph.D. students in the Department during the whole or part of the year. Mr. R. H. T. Smith was engaged in statistical work in connexion with his study of railway transport in the southwest of New South Wales for much of the year and is now writing his thesis. So also is Mr. R. Frazer, who completed a second field work period in the Ra province of Fiji during the year. Miss D. R. Howlett returned to the field in the Eastern Highlands of New Guinea for the second half of the year.

Five new students joined early in the year and their interests maintained the present balance between studies in Australia and those in the Pacific Islands. Mr. P. N. D. Pirie is continuing studies, begun in New Zealand, of population distribution and growth in West Samoa. The historical geography of the railway system of central Queensland engages the attention of Mr. S. H. H. Naqavi, whilst Mr. R. L. Heathcote's subject is the exploration and settlement of a semi-arid area lying across the state border north of Bourke, paying special attention to the influence of opinion of land potential on the actual course of development. Mr. J. G. Mosley is investigating the tourist industry of Tasmania with particular reference to the planning of land use for recreation in its broadest sense. The urban geography of Noumea in New Caledonia is the topic of Mr. W. D. McTaggart's research. With the exception of Mr. Pirie, all these students have been in the field during the course of the year.

In the First Term a series of seminars by staff and students was held. The perennial problem of regular attendance in a Department where everyone is involved in field work suggests a policy of holding seminar programmes concentrated into a few days.

### *Staff Research Activities.*

Mr. Jennings spent part of the year writing up work on the limestone geomorphology of the Fitzroy Basin (Kimberleys, Western Australia) carried out in 1959 in association with Dr. Marjorie Sweeting (University of Oxford). Later in the year he spent three months investigating limestone geomorphology in differing climatic conditions in New Guinea. He was generously enabled to join a C.S.I.R.O. Land Research team in the Western Highlands for part of the time, and was also the guest of Oil Search Ltd., during a brief visit to the Kikori limestone region.

Dr. Brookfield returned to New Guinea for a short period early in the year to continue his joint investigations with Dr. Paula Brown (Anthropology) on agricultural systems, society and the territorial distribution of social and political groups in the Chimbu area of the Eastern Highlands. He and Dr. Brown have since been preparing their material for publication in the form of a joint monograph. Dr. Brookfield has also written up the results of some earlier work in New Guinea.

Dr. Linge continued research on industrial distributions in Australia, and at the request of the National Capital Development Commission submitted a report on the future employment structure of Canberra. He also completed a book on the geography of manufacturing in Auckland, New Zealand.

Dr. Walker arrived in Canberra in December, after spending a period en route in Malaya, investigating newly-discovered plant-bearing beds of late Tertiary or Pleistocene age.

### *Other Activities.*

Professor Spate has travelled extensively in the United States during his study leave. He has lectured at many universities and attended two conferences of the Association of American Geographers, as well as a seminar on "Urbanization in India" held at the University of California (Berkeley).

Before his departure, he was elected President of the Institute of Australian Geographers. Dr. Brookfield is Editor for this institute, and for most of the year has been its Acting Secretary. Dr. Brookfield has also acted for Professor Spate in the latter's capacity as Joint Editor of *The Australian Geographer*.

With the help of a local Canberra committee and correspondents in Tasmania and New Zealand, Mr. Jennings assembled data from the S.W. Pacific for incorporation in two world maps of present and fossil periglacial phenomena prepared for the International Geographical Congress at Stockholm in August. At this congress two former Visiting Fellows, Dr. M. M. Sweeting and Dr. H. Valentin, read papers on work they had carried out in Australia.

During the year Dr. Brookfield and Dr. Linge gave courses of lectures in the University of Adelaide. Dr. Brookfield also delivered occasional lectures at the Universities of Melbourne and Queensland, and in Melbourne addressed the United Nations Association. During the year Mr. Jennings, Dr. Brookfield and Dr. Linge have all addressed the New South Wales Geographical Society or its Research Group. Professor Spate and Dr. Brookfield read papers at the Melbourne Conference of the Institute of Australian Geographers in January, and Miss D. R. Howlett read a paper to the U.N.E.S.C.O. symposium on the influence of man on the vegetation of the humid tropics at Goroka, New Guinea, in September. Mr. R. L. Heathcote attended the C.S.I.R.O. Arid Zone Technical Conference at Warburton in December.

Dr. Walker lectured in the University of Malaya at Singapore and at Kuala Lumpur in December.

Visitors during the year have included Professor L. Washburn, Yale University, Dr. M. M. Cole, University of North Staffordshire, and Dr. S. Duncan, University of Manchester.

*Publications.*

Anas, M.\*—

“The Highlands of Australian New Guinea”. *Geogr. Rev.* L (1960) 467–90. 11 plates and 3 maps.

Bauer, F. H.\*—

*Historical geographic survey of part of Northern Australia Part 1. Introduction and the Eastern Gulf Region.* C.S.I.R.O. Division of Land Research and Regional Survey Divisional Report LIX, ii, Canberra, 1959. 74 pp. and 7 maps.

Bird, E. C. F.\*—

“The formation of sand beach ridges”. *Aust. J. Sci.* XX, (1960), 349–50. 2 maps.

Brookfield, H. C.—

Contributions on Australia and southern and eastern Africa in *The Caxton World Atlas*, ed. W. G. East, London, 1960, 316–37, 354–5, 363–5, 375–7, 379–81, 384, 393–94, 398–404.

“Population distribution and labour migration in New Guinea (A preliminary survey).” *Aust. Geogr.*, VII (1960), vi., 233–42. 5 maps.

“Population distribution in Mauritius: An inquiry into the determinants of distribution in a tropical sugar island”. *J. Trop. Geogr.* XIII (1959), 1–22. 11 figs.

“Prospects for New Guinea.” *Current Affairs Bulletin* XXVI (1960), ix. 1 map.

Heathcote, R. L.—

“Geographical implications of some zoological topics”. *Annals Association American Geographers* L (1960), 191–2.

Jennings, J. N. (with J. M. Lambert†)—

“Stratigraphical and associated evidence”. Part One of *The making of the Broads*, Royal Geographical Society Research Memoir No. 3. London, 1960. 1–61, 5 plates and 40 figures.

Langford-Smith, T.\*—

“The dead river systems of the Murrumbidgee”. *Geogr. Rev.* L (1960), 368–89. 10 figures.

Linge, G. J. R.—

“The concentration and dispersion of manufacturing in New Zealand”, *Econ. Geog.*, XXXVI (1960), iv, 326–43.

“Recent literature on manufacturing in Australia”, *N.Z. Geogr.*, XVI, (1960), ii, 204–09.

*The Future Work-Force of Canberra.* National Capital Development Commission, Canberra, December, 1960, 84 pp.

Rutherford, J.\*—

“Integration of irrigation and dryland farming in the Southern Murray Basin. Part III, The evolution of integration and some lessons for the future”. *Review of Marketing and Agricultural Economics*, XXVIII (1960), 97–150. 7 figures.

Smith, R. H. T.—

“Rigidity of rail hinterland boundaries in Australia”. *Annals of the Association American Geographers*, L, iv., (1960), 55–7.

Sweeting, M. M.\*—

“The caves of the Buchan area, Victoria, Australia.” *Zeitschrift für Geomorphologie*, Supplement, Band 2, 1960, 81–9. 7 figures.

Sweeting, M. M.\* & Gerstenhauer, A.—

“Zur Frage der absoluten Geschwindigkeit der Kalkkorrosion in verschiedenen Klimaten.” *Zeitschrift für Geomorphologie*, Supplementband 2, 1960, 66–73. 4 figures.

Spathe, O. H. K.—

“‘Integrated Surveys’ in Australia”, *Oriental Geographer* (Dacca), IV, (1960), 59–61.

“The Burns Commission Report”, *Journal of the Polynesian Society*, LXIX (1960), 54–6.

\* Based on work carried out while a member of the Australian National University,

† Not a member of the Australian National University.

- “Under two laws: the Fijian dilemma”, *Meanjin* VI (1960), 166–81.  
 “Lord Kelvin rides again”, *Econ. Geography*, XXXVI (1960), 95 (Guest Editorial).  
 “New perspectives in geography”, *Aust. J. Sci.*, XX (1960), 436–39.  
 “Geography in a quantifying age”, *Geogr. Rev.*, L (1960), 124–25.  
 “Quantity and quality in geography”, *Annals of the Association of American Geographers*, L, iv, (1960), 377–94.

#### *Theses.*

During the year the following theses were submitted and deposited in the Library after examination for the degree shown:—

- R. K. Wilson, for Ph.D.—“Type-of-Farming Areas in Victoria, Australia.”  
 J. Rutherford, for Ph.D.—“Integration of Irrigated and Dryland Farming in the Southern Murray Basin: A Geographical Interpretation”.

#### DEPARTMENT OF INTERNATIONAL RELATIONS.

##### *Staff.*

Reader	..	..	..	..	A. L. Burns, M.A.
Senior Research Fellow	..	..	..	..	J. A. Modelski, Ph.D.
Research Fellows	..	..	..	..	R. G. Boyd, B.A. Rosemary Brissenden, B.A.
Visiting Fellow	..	..	..	..	J. W. Burton, B.A., Ph. D. (Econ.).
Research Assistants	..	..	..	..	Rima Rathausky, B.A. Nina Heathcote, B.A.

At the end of 1959 the members of the combined Department of Political Science and of International Relations whose work had been in the International Relations field were transferred to the Research School of Pacific Studies as the Department of International Relations. The two parts of the former combined Department have, however, continued to cooperate in academic work.

##### *Staff Changes.*

Mrs. Rosemary Brissenden, formerly Research Assistant in the combined Department, was appointed to a Research Fellowship in January, 1960. Miss Rima Rathausky was appointed to the position of Research Assistant on 29th February, 1960. Dr. J. A. Modelski was appointed to the position of Senior Research Fellow in December, 1959. Mrs Heathcote who had been a Research Assistant in the Department of Political Science was transferred to the Department of International Relations in April and resigned in December to accompany her husband to Stanford University. Dr. John Burton took up a Visiting Fellowship in the Department in August to prepare a study concerned with agreement by negotiation in current international politics. In November and December he was absent for a month at a Conference in the U.S.S.R. and on visits to academic institutions in India, Britain and the U.S.A. Mr. A. L. Burns was appointed Reader in December.

##### *Students.*

Mr. G. P. King B.A., a Research Scholar at first enrolled for the M.A. degree, took up his scholarship in February and, upon completion of a preliminary study of the arms race, was later enrolled for the Ph.D. degree. He is studying negotiations for arms control. Mr. J. A. Stockwin, B.A., was enrolled for a Ph.D. and took up his appointment in March. He is working in the field of Russo-Japanese relations, and is at present continuing a study of Japanese language, and gathering material on the foreign policies of the non-Communist left-wing parties in Japan.

##### *Research Activities.*

Mrs. Brissenden has begun preliminary research on the pattern of Malayan foreign policy, and has been studying the background of Australia's interest in the West New Guinea question.

Mr. Boyd wrote and revised a book-length study of Chinese Communist foreign policy and undertook a number of shorter research projects—on Australian foreign policy, Sino-Soviet relations, Japanese foreign policy, the Association of South East Asian States, and the situation in Laos. He also compiled quarterly reviews mainly concerned with Asian foreign relations.

Mr. G. M. Kelly returned to the University for a few weeks at the end of the year to revise his book-length study of the history of foreign relations in Indo-China.

Mr. Burns revised his Chicago lectures on international theory and historical explanation; and, assisted by Mrs. Heathcote, he composed a number of studies on technology of weapons, the methodology of international studies, current developments in international systems, proposals for an international military force, and disarmament and other forms of arms control. With the assistance of

Miss Rathausky, who has been collecting newspaper material on the European Economic Community, and in collaboration with members of the Department of Political Science, Mr. Burns began a study of political integration in Europe.

The manuscript of a book on the South East Asia Treaty Organization was revised by several members of the SEATO group, both before and after its submission to a reader.

#### *Other Activities.*

After an interval of about 18 months, the Department recommenced its sponsorship of fortnightly lunch hour discussions on current affairs, organized by Mr. Stockwin. Though members of the Department provided most of the papers, others were delivered by journalists, members of the staff of foreign legations, and academics from the School of General Studies and other Departments in the Institute.

Mrs. Brissenden delivered a course of lectures at the School of General Studies on Indonesian Politics.

Dr. Modelski was on leave of absence during the whole of 1960. Until July he was Visiting Assistant Professor in Political Science at the University of Chicago where he taught a series of graduate courses—on the study of international politics, on the international politics of South East Asia and on international law. He also conducted a seminar course on international systems. From August to December he was a Visiting Research Associate at the Center of International Studies, Princeton University. There he took part in a “workshop” on international systems, for which he wrote a paper; he completed a monograph on “the Communist International System”; and participated in the Internal War Project, to which he contributed a paper. In December, before returning to the A.N.U., he toured South East Asia to collect up-to-date information bearing upon the SEATO project. While in the United States he had attended conferences and read papers for several American research organizations—the Association of Asian Studies, the American Political Science Association, the Conference on World Tensions and the American Academy of Political and Social Sciences. At the lastmentioned, he represented the A.N.U.

In September and October Mr. Burns visited Melbourne to deliver the Chifley Memorial Lecture on “Disarmament”, and to lecture and conduct seminars in History and Political Science.

Under the general supervision of Miss Rathausky a file of thirteen English-language Asian newspapers was opened. A classification according to subject matter was adopted, and the material was accommodated within an International Relations Reading Room.

In December the Department moved from its previous quarters in the Old Hospital Building to a pleasant house in Balmain Crescent.

#### *Publications.*

Boyd, R. G.—

- “Sino-Japanese relations”, *Australian Outlook*, XIV, i, (1960), 50–68.
- “Problems of Australian foreign policy”, *Journal of Politics and History*, VI, i, (1960), 1–13.
- “China’s policy towards South East Asia”, *Australian Quarterly*, XXXII, ii, (1960), 65–73.
- “International Review”, *Australian Quarterly*, XXXII, ii, (1960), 89–99.
- “International Review”, *Australian Quarterly*, XXXII, iii, (1960), 85–94.
- “The cleavage between China and the U.S.S.R.”, *Prospect*, III, iv, (1960), 10–17.
- “The Association of South East Asia States”, *Australian Outlook*, XIV, ii, (1960), 246–56.
- “International Review”, *Australian Quarterly*, XXXII, iv, (1960), 86–96.
- “The situation in Laos”, *Australia’s Neighbours*, September-October, 1960.
- “Japan’s foreign policy”, *Australia’s Neighbours*, December 1960.

Brissenden, Rosemary—

- “India and the Northern Frontier”, *Australian Outlook*, XIV, i, (1960), 15–29.
- “India and Tibet”, *Australia’s Neighbours*, February 1960.
- “India and Seato: A case study in neutralist diplomacy”, *Australian Journal of Politics and History*, VI, (1960), 219–32.

Burns, A. L.—

- “The hydrogen bomb in international affairs”, *St. Mark’s Review*, XIX, February, 1960, 7–12.
- “A new balance of power?”, *Journal of International Affairs*, XIV, i, (1960), 61–70.
- “International theory and historical explanation”, in *History and Theory*, I, i, (1960), 55–74.
- “The thinking General: American defence administration” in *Public Administration*, XIX, ii, (1960), 134–40.
- “Problems of Disarmament”, *Chifley Memorial Lecture*, Melbourne University, October (1960), 25 pp.
- Two essays on deterrence*, Technical Military Planning Operation, Santa Barbara, California, December (1969), 66 pp.
- With M. A. Kaplan and R. E. Quandt, “Theoretical analysis of the balance of power”, in *Behavioral Science*, V, iii, (1960), 240–52.

King, G. P.—

“On banning nuclear tests”, *Australian Outlook*, XIV, iii, 306–17.

Modelski, J. A.—

*Atomic Energy in the Communist Bloc*, Melbourne, 1959, 222 pp.

“The Communist International System”, *Princeton University Center of International Studies Research Monograph*, 1 December, 1960, 78 pp.

“Australia and SEATO”, *International Organization*, Summer 1960.

#### DEPARTMENT OF PACIFIC HISTORY.

##### *Staff.*

Professor .. .. .	.. .. .	J. W. Davidson, M.A., Ph.D.
Senior Fellow .. .. .	.. .. .	H. E. Maude, O.B.E., M.A.
Senior Research Fellow .. .. .	.. .. .	F. J. West, B.A., Ph.D.
Visiting Fellows .. .. .	.. .. .	C. Hartley Grattan, A.B., D.Litt. (from 26th February to 22nd April, 1960). Ann Savours, B.A. (from 11th April, 1960).
Research Fellows .. .. .	.. .. .	Ethel Drus, M.A. (to 16th January, 1960). H. Feith, M.A. (from 26th September, 1960). Emily Sadka, B.A. (from 9th December, 1960).
Research Assistant .. .. .	.. .. .	Honore Forster, B.A.

Two Research Fellows joined the Department during the year: Mr. H. Feith, from Cornell University, where he completed the requirements for a Ph.D. degree in Government; and Miss E. Sadka, a former lecturer in the Department of History at the Victoria University of Wellington. Miss E. Drus relinquished her appointment as Research Fellow in January to take up teaching work in the United Kingdom, where she has been appointed lecturer in the Department of History at the University of Hull.

##### *Students and Training Activities.*

Nine Ph.D. students were attached to the Department during the period under review. Mr. W. R. Roff was absent for the entire year on field research for his study of the growth of Malay nationalism in the twentieth century. Three others returned from field work and commenced the preparation of their theses: Mr. R. G. Crocombe, on land tenure in the Cook Islands; Mr. I. J. Fairbairn, on economic development in Western Samoa; and Mr. A. M. Healy, on local government in Papua.

Mr. H. D. Chiang was engaged throughout the year on the preliminary stages of his thesis on the trade of the Straits Settlements, 1867–1914, under the supervision of Mr. N. G. Butlin of the Department of Economics; and Mr. C. Jack-Hinton on a study of the discovery of the Solomon Islands.

Mrs. M. Roe completed the first draft of her thesis on the administrative history of the Eastern Division of Papua and was granted permission to spend the last term of her course at the University of Tasmania while engaged in revising it for final submission.

Mr. K. Penny, who is preparing a thesis on factors in the administration and use of Australian departmental archives, was granted an extension to the 18th August, 1961, in which to submit it. The preliminary draft was completed during the year and work commenced on a final revision.

Miss E. Sadka completed her thesis on “The Residential System in the Protected Malay States, 1874–1895”, on the 8th December.

During the third term a series of fourteen seminars was conducted by staff members and scholars on their research, in progress or completed, introduced by a paper by Dr. West entitled, “The Study of Colonial History”. In addition Mr. J. Kamikamica conducted a seminar on marketing schemes and economic development in Fiji, and Miss Ann Savours on the history of Antarctic exploration.

##### *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.

Mr. Maude completed his research on the exploration of the Central Pacific with a paper on post-Spanish discoveries, and continued studies on the area which were embodied in studies on early trade and the development of local government. Work was in progress at the end of the year on an ethnohistorical reconstruction of the Gilbertese *boti* and *kainga* systems.

Dr. West was engaged in finishing a book entitled, *Political Advancement in the South Pacific: a Comparative Study of Colonial Practice in Fiji, Tahiti, and American Samoa*, which is about to be published by the Oxford University Press. In addition, Dr. West continued his research for two forthcoming books on Sir Hubert Murray, Lieutenant-Governor of Papua from 1908 to 1940, the first of which is due to appear in 1961; while work was commenced on the preparation of a study of government control in the Central Highlands of Papua-New Guinea, for which the research has already been done.

Of the two new members of the Department, Mr. Feith has continued the rewriting of his doctoral dissertation, with a view to publication under the title of *Indonesian Politics 1949-57: the Failure of Constitutional Democracy*; while Miss Sadka completed a paper on the State Councils of Perak and Selangor, 1877-1895, for the International Conference of South-east Asian Historians at Singapore, to be held in January, 1961.

#### *Other Activities.*

Professor Davidson was occupied in Western Samoa and New Zealand during January-March, May-July and August-October as Constitutional Adviser to the Government of Western Samoa. During the year the Constitution of the Independent State of Western Samoa was drafted and subsequently considered and adopted by a Constitutional Convention. A number of other matters, constitutional, political and economic, relating to Western Samoa's attainment of independence and to the ability of the new state to assume adequately the added responsibilities of its sovereign status were examined, and policy recommendations were submitted to, and adopted by, the Constitutional Convention. In December, Professor Davidson accompanied the Prime Minister of Western Samoa to the General Assembly of the United Nations, where they joined the New Zealand Delegation for the discussion of the procedure for the termination of the Trusteeship Agreement for the Territory.

The Department was instrumental in arranging a co-operative scheme, involving the Central Archives of Fiji and the Western Pacific High Commission and ten libraries, for copying the letter-books of the Cakobau Government and of H.B.M.'s Consulate in Fiji, which had deteriorated to an extent which precluded their reproduction by photography.

The search was continued for documentary sources on Pacific history, and in particular arrangements were made for the Post records of the British Consulate in Tahiti, now transferred from the Foreign Office to the Public Records Office, to be microfilmed by the University of Hawaii, with copies to Australian libraries in Canberra and Sydney.

Mr. R. P. Gilson, a former Research Fellow, completed the cataloguing for the Department of manuscripts in New Zealand libraries and archives of value to Pacific historians. Mrs. H. Forster, Research Assistant, began indexing the John T. Arundel papers on the Central Pacific guano industry, which include his personal journal kept between 1870 and 1919, and continued work on calendaring references to the Pacific Islands in Australian newspapers published before 1835. Additions were also made to the card index of social science theses on the Pacific area, Malaya and Indonesia and to the Departmental library of research material, including theses, on microfilm.

Miss Ann Savours, of the Scott Polar Research Institute, was attached to the department while engaged in research into the documentation on Antarctic exploration in Australian libraries. Professor Davidson lectured during the year at the Canberra University College and Dr. West at the University of Melbourne.

#### *Publications.*

Bastin, J. A.—

\**The Changing Balance of the Early South-east Asian Pepper Trade*. Kuala Lumpur, 1960, 67 pp.

Davidson, J. W.—

"The Pacific in the first world war and in the settlement", Chapter XV, 416-442, in *The New Cambridge Modern History*, vol. xii (The Era of Violence, 1898-1945, ed. David Thomson). Cambridge, 1960.

"Pacific Islands research of the Research School of Pacific Studies in the Australian National University". *Journal of the Polynesian Society*, LXIX, ii, 153-159.

Newbury, C. W.—

\*“ L’administration de l’Océanie Française de 1849 à 1866 ”. *Revue Française d’Histoire d’Outre Mer*, XLVI (1959), 97–154.

\*“ Missionary policy in Mangareva: an early contact situation ”. *Journal de la Société des Océanistes*, XV (1959), xv, 97–112.

Penny, K.—

“ Evolution in the archives—1 ”. *Historical Studies*, IX, xxxv, 308–312.

Smith, B.—

\**European Vision and the South Pacific, 1768–1850: A Study in the History of Art and Ideas*. Oxford, 1960, xx + 288 pp. 171 plates.

West, F. J.—

“ Background to the Fijian riots ”. *Australian Quarterly*, XXXII, i, 46–53.

“ Political advancement in Fiji ”. *Pacific Affairs*, XXXIII, i, 23–37.

## JOINT ACTIVITIES OF THE RESEARCH SCHOOLS OF SOCIAL SCIENCES AND PACIFIC STUDIES.

### *Publications Committee.*

At the end of 1959 the activities of the Publications Committee were widened to include responsibility for publications from all Schools of the University, and the membership of the Committee was increased to ten—

Professor Webb (Chairman), Professor Davidson, Dr. Freeman, Dr. Gollan, Dr. Hogg, Dr. Macfarlane, Mr. Maude, Professor Sawyer, Professor Spate and Professor Swan.

After the amalgamation of the University and the Canberra University College, Council agreed that the Committee function for the entire University as now constituted. Representatives of the School attended the last two meetings of the Committee in 1960, and the Committee recommended that two members of the School be appointed to the Committee.

### *Staff.*

Publications Officer	..	..	Patricia Croft, B.A.
Editorial Assistant	..	..	Penelope Hope.

### *Activities.*

Since the report of Publications Committee activities was omitted from the 1959 Annual Report, works listed below include those published both in 1959 and the current year.

Five monographs were published in the Social Science series: M. R. Hill, *Housing Finance in Australia, 1945–1956*; J. A. Modelski, *Atomic Energy in the Communist Bloc*; A. W. Martin and P. Wardle, *Members of the Legislative Assembly of New South Wales, 1856–1901*; Jerzy Zubrzycki, *Immigrants in Australia and Immigrants in Australia: Statistical Supplement*; and H. O. Pappé, *John Stuart Mill and the Harriot Taylor Myth*. Two new books were published: Marie Reay, *The Kuma and Robin Gollan, Radical and Working Class Politics*; and there was a new impression of B. J. Bok, *The Astronomer’s Universe*.

It is very pleasing to report that two of the Committee’s publications—Dr. Reay’s *The Kuma* and Dr. Modelski’s *Atomic Energy in the Communist Bloc*—were both selected for their technical excellence as among the Twenty Best Books of the year.

On behalf of Central Administration, two Morrison Orations—*The Narrow Lane*, by Professor A. R. Davis, and *The Khmer Temple of Prah Vihar*, by Dr. C. N. Spinks—and Professor L. C. Webb’s Inaugural Lecture, *Politics and Polity*, were seen through the press.

The Committee has a heavy forthcoming programme. Five studies are in course of publication: Alan Barnard, ‘Visions and Profits: Studies in the business career of Thomas Sutcliffe Mort’; Noel Barnard, ‘Bronze Casting and Bronze Alloys in Ancient China’; Norma McArthur, ‘Introducing Population Statistics’; D. W. Rawson, ‘Australia Votes: The 1958 Federal Election’; and Richard Rosecrance, ‘Australian Diplomacy and Japan, 1945–51’—and six others are being prepared for publication: Alan Barnard (ed.) ‘The Simple Fleece: Studies in the Australian Wool Industry’; G. Bolton and A. V. Mozley, ‘Members of the Legislative Council and Assembly of Western Australia, 1870–1930’; T. M. Perry, ‘Spread of Settlement in New South Wales, 1788–1821’; R. F. Salisbury, ‘From Stone to Steel’; and a revised edition of B. J. Bok, *The Astronomer’s Universe*.

The Editorial section is collaborating with the Law Department to produce by electric typewriter and multilithography an experimental small-run edition of ‘The Sociology of Law’ (edited by Geoffrey Sawyer).

## SCHOOL OF GENERAL STUDIES.

(For descriptions of the work of the School, see pages 10-12.)

1960 STAFF PUBLICATIONS.

*Faculty of Arts.**English.*

Hope, A. D.—

“Free Verse: a Post Mortem.” *Quadrant* IV (1960), 49-58.

Brissenden, R. F.—

*Patrick White.* (Commonwealth Literary Fund Lecture), Canberra University College.

Jones, E. L.—

*Inside the Whale* (verse), F. W. Cheshire Ltd., December, 1960.*History.*

Penny, B.—

“The Blake Case.” *The Australian Journal of Politics and History*, November, 1960.

Suttor, T. L. L.—

“Dogma, Literary Judgment, and Liberal Education.” *Twentieth Century*, Spring, 1960.“The Criticism of Religious Certitude in Australia, 1875-1900.” *The Journal of Religious History*, June, 1960.

Clark, C. M. H.—

“Noel Ebbels, a memoir.” *The Australian Labor Movement, 1850-1907* (ed. L. G. Churchward), Sydney, 1960.*Meeting Soviet Man.* Angus & Robertson, Sydney, 1960.“The Choice of Botany Bay.” *Historical Studies, Australia and New Zealand*, November, 1960.*Mathematics.*

Miller, J. B.—

“Hilbert Spaces of Generalized Functions extending  $L^2$ .” *Journal of the Australian Mathematical Society*, I, (1960), 281-98.

Atkinson, F. V.—

“A Constant Area Principle for Steady Oscillations I.” *Journal of Mathematical Analysis and Applications* I, ii, (1960), 133-44.With Watterson, G. A. and Moran, P. A. P., “A Matrix Inequality.” *Quarterly Journal of Mathematics* (Oxford), XI, xlii, (1960), 137-40.*Oriental Studies.*

Johns, A. H.—

“Towards a Modern Literature in Indonesia.” *Meanjin* XIX, (1960).

van der Sprenkel, O. B.—

“Geschichte Chinas von den drei Reichen (220 n. Chr.) bis zum Ende des Taiping Aufstandes (1864).” *Historia Mundi*, VIII, Bern 1960, 119-72.

Wang Ling—

With Needham, J. and Price, D., “Heavenly Clockwork”. *The Great Astronomical Clocks of Mediaeval China*, Cambridge, 1960, 254 pp.*Philosophy.*

Baier, K. E. M.—

“Anscombe's ‘Intention’.” *Australasian Journal of Philosophy*, XXXVIII, 71-81.“Melden's Essays in Moral Philosophy.” *American Philosophical Review*, LXIX, iii, 414-18.“Existence.” *Proceedings of Aristotelian Society*, October, 1960, 19-40.

Gibson, Q. B.—

*The Logic of Social Enquiry.* Routledge and Kegan Paul.

Schlesinger, G.—

“The Principle of Minimum Assumption.” (Discussion.) *The British Journal for the Philosophy of Science*, X, xl, 56-9.*Psychology.*

Seagram, G. N.—

With Papert, S., “Aniseikonic Lenses: I. Surface Texture”. National Physical Laboratory, 12 pp. + plates.

Cox, F. N.—

“Correlates of General and Test Anxiety in children.” *Australian Journal of Psychology*, 1960, XII, 169-77.

*Faculty of Economics.**Economics.*

Arndt, H. W.—

*The Australian Trading Banks*, ix + 238 pp., revised edition, Cheshire, 1960.

“Wages and Inflation.” *Current Affairs Bulletin*, June, 1960.

“Australia’s Changing Financial Structure.” *Current Affairs Bulletin*, October, 1960.

“Wages and Employment.” *Journal of Industrial Relations*, October, 1960.

“Control of Inflation through Fiscal Policy.” *Economic Record*, December, 1960.

Cameron, B. D.—

“Anatomy of High Employment.” *Economic Record*, December, 1960.

Hieser, R. O.—

“Money Wages and the Arbitration Commission.” *Australian Quarterly*, September, 1960.

*Political Science.*

Corbett, D. C.—

With Professor Hodgetts, *Public Administration in Canada*. Macmillans of Canada, pp. xii + 575.

Crisp, L. F.—

“Promotion and Leadership.” *Public Administration (Australia)*, March, 1960, 80–92.

Encel, S.—

“Public Corporations in Australia: Some Recent Developments.” *Public Administration*, Autumn 1960.

“The Concept of the State in Australian Politics.” *Australian Journal of Politics and History*, May, 1960.

“The Machinery of Government.” *Public Administration*, December, 1960.

*Statistics.*

Leser, C. E. V.—

“Die Konstruktion eines Systems von Konsumfunktionen mit Hilfe von Annahmen über die Substitutions-elasticitäten.” *IFO-Studien (Germany)*, 5. Jahrgang 1959 Heft 1/2. (Issue appeared late.)

“Demand functions for nine commodity groups in Australia.” *Australian Journal of Statistics*, II, iii.

Hannan, E. J.—

“The Estimation of Seasonal Variation.” *The Australian Journal of Statistics*, 1960, II, i, pp. 1–15.

*Time Series Analysis*. Methuens, 1960.

*Faculty of Law.*

Ford, H. A. J.—

“Trade Union Law and Aid to Political Parties.” 2 *Journal of Industrial Relations*, (1960), 20–30.

“Unit Trusts.” 23 *Modern Law Review*, (1960), 129–150.

“Illegal Trusts.” 2 *University of Malaya Law Review*, 1960, 165–77.

“Federal Estate Duty—Valuation of Gifts *Inter Vivos*.” 34 *Australian Law Journal*, 1960, 139–42.

Tarlo, H.—

“Australian Encyclopaedia of Forms and Precedents, Cumulative Supplement 1956–1960.” (One of the editors), Butterworth, Sydney.

*Faculty of Science.**Chemistry.*

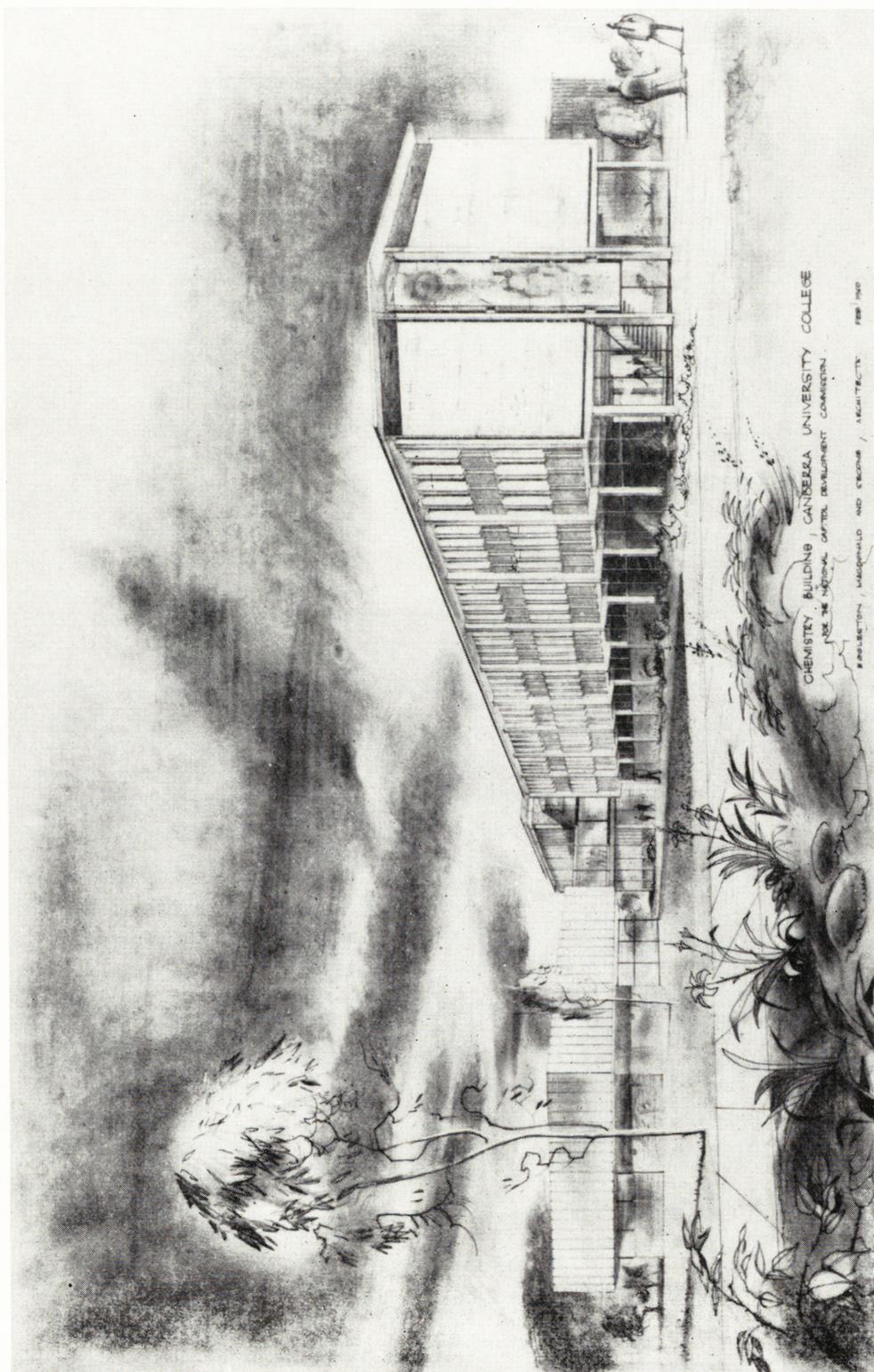
Hawes, L. L.—

“A method for the direct determination of lattice parameters.” *American Mineralogist*: 45, 1285–88, (1960).

“The development of an accurate, low angle, X-ray powder diffraction camera.” *American Mineralogist*: 45, 1288–96, (1960).

Hambly, A. N.—

With Ham, N. S. and Laby, R. H., “Vibrational Spectra of Sulphonyl Derivatives V. A reassignment of the SO<sub>2</sub> stretching frequencies in sulphonyl fluorides.” *Australian Journal of Chemistry*: 13, 443–55, (1960).



[Face page 80.]  
F.1669/61.

The proposed new chemistry building for the School of General Studies.

Zoology.

Smyth, J. D.—

With Mofty, M. El., "Endocrine control of sexual reproduction in *Opalina ranarum* parasitic in *Rana temporaria*". *Nature*, 186, 559.

Nicholas, W. L.—

With Dougherty, E. C. and Hansen, E. L., "The incorporation of <sup>14</sup>C from sodium acetate—2-<sup>14</sup>C into the amino acids of the soil-inhabiting nematode, *Caenorhabditis briggsae*." *Journal of Experimental Biology*, 37 (1960), 435-43.

With Hansen, E. L., Yarwood, E. A. and Sayre, F. W., "Differential nutritional requirements for reproduction of two strains of *Caenorhabditis elegans* in axenic culture." *Nematologica*, 5, (1960), 27-31.

## THE LIBRARY.

## 1. LIBRARIAN.

Mr. A. L. G. McDonald, the University's first librarian, retired through ill-health on 10th March, 1960. In his long and close association with the University dating from his appointment on 1st May, 1948, Mr. McDonald rapidly assembled an excellent collection of more than 150,000 volumes. At the same time he organized and provided a full library service for the University as it developed. At its meeting in May, Council appointed Mr. McDonald Librarian-Emeritus in recognition of his outstanding services to the University.

The appointment has been announced of Mr. J. J. Graneek as the new University Librarian. Mr. Graneek who is at present Librarian of Queen's University of Belfast will be taking up his appointment on 1st April, 1961.

## 2. ASSOCIATION OF THE A.N.U. AND C.U.C.

Following the implementation of Part 2 of the Australian National University Act on the 30th September, 1960, it has become necessary to reorganize the two former libraries into an integrated university library service. The Librarian-elect, Mr. J. J. Graneek, visited Canberra for two weeks at the end of October to make a survey of the problem. As a result of this survey and following discussions with members of the University he has submitted for approval a "Plan of Library Development" and recommendations on the staffing of the Library.

Following association the library resources of the University now total some 237,235 volumes.

## 3. ACCESSIONS.

	In Library at 31st December, 1959.	Added During 1960.	In Library at 31st December, 1960.
(a) BOOKS AND PAMPHLETS IN WESTERN LANGUAGES.			
<i>Institute of Advanced Studies Library—</i>			
Books .. .. .	122,577	9,645	132,222
Pamphlets .. .. .	7,611	576	8,187
			140,409*
<i>School of General Studies Library—</i>			
Books and Pamphlets .. .. .	43,464	6,352	49,816
			190,225
(b) BOOKS IN ORIENTAL LANGUAGES.			
<i>Institute of Advanced Studies Library—</i>			
	24,298	1,344	25,642
<i>School of General Studies Library—</i>			
	18,906	2,462	21,368
			47,010
		Total ..	237,235

## 4. NOTABLE ACCESSIONS: SELECT LIST.

*Institute of Advanced Studies Library.*

Grande encyclopédie, 31 V. 1886–1902.

Enciclopedia Italiana di scienze, lettere ed arti, 36 V. + 3 V. appendice, 1929–39.

Grimme, F. M.—Correspondance littéraire, philosophique et critique, 16 V. 1877–82.

Diderot, D.—Oeuvres complètes 20 V. 1875.

Aguesseau, N. F. d'—Oeuvres 13 V. 1757.

Brucker, J. J.—Historia critica philosophiae 6 V.

Tulane law review, V. 5–31, 1930–57.

Netherlands. *Centraal Bureau voor de Statistiek*. Statistiek van Nederland 405 V. 1895–1924.

American Historical Association. Reports, 115 V. 1889–1951.

Journal of ecology, V. 1–41.

Dictionnaire universel raisonné de justice . . . 13 V. 1777.

American Ceramic Society. Journal. V. 23–41.

\* 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.

Encyclopaedia Americana, 30 V. 1960.  
 Bureau of American Ethnology Bulletin, 55 V.  
 China review, V. 1-25, 1872-1901.  
 Bengal District Gazetteers, 34 V.  
 Nouvelle biographie generale . . . 46 V. 1855-66.  
 Bayle, P.—Dictionnaire historique et critique, 4V. 1740.  
 Encyclopédie française, 17 V.  
 Abegg, R.—Handbuch der anorganische Chemie.

*School of General Studies Library* (October-December, 1960\*).

Biblio V. 1-16, 1934-1949.  
 Poole's Index to periodical literature, 1802-1906 (reprint).  
 Kirk—Encyclopaedia of chemical technology, 15 V.

## 5. GIFTS.

*Institute of Advanced Studies Library.*

1510 items were presented to the library during the year. Professor Gilbert Ryle, Waynflete Professor of Metaphysical Philosophy at the University of Oxford, kindly presented some 8 volumes of rare philosophical and mathematical works.

*School of General Studies Library* (October-December, 1960\*).

660 items were presented during the year. In November Dr. B. T. Dickson who was Chairman of the Council of the former Canberra University College presented twenty volumes of rare botanical works for inclusion in the library.

## 6. ENQUIRIES AND LOANS.

*Institute of Advanced Studies Library.*

During the year 25,520 items were borrowed from the library. Of these 1180 represents items made available on loan to other libraries. In addition photocopies of 515 references were supplied. 1450 items were borrowed from external sources. These figures reveal a significant increase over those for 1959. The loans represent an increase of some 10,000 and 200 more items were borrowed from outside libraries.

This increased use of the library is also reflected in the reference section. In March a new post of Senior Assistant was created to provide a permanent reference officer. The increased demand for services during the year has placed a heavy strain on this section and additional staff will be necessary.

*School of General Studies Library.*

The keeping of statistics of loans commenced in May. In the period May-December, 1960, 25,760 loans were recorded of which 11,537 were from the reserved book stock. 796 items were borrowed from external sources and 69 items were made available on loan to other libraries.

## 7. PHYSICS FIRE.

79 books and volumes and parts of periodicals on loan to staff and students were destroyed in the fire in the Cockcroft Building on July 6th. The majority have now been replaced. However, some of the older works and odd volumes from periodical sets are no longer readily available and are proving to be difficult to obtain.

## 8. COSTS OF BOOKS AND SERIALS.

There has not been any appreciable rise in the over-all cost of books although scientific and technical works now tend to be disproportionately more expensive than those in the social sciences and humanities.

There have been rises in the subscription rates for scientific periodicals during the year. The subscriptions to current periodicals now consume about a third of the Institute Library grant.

## 9. BUILDINGS.

Work on the permanent building for the Institute Library commenced in May, 1960.

The Australian Universities Commission has recommended that funds be made available in the triennium 1961-1963 for Stage 1 of a building for the School of General Studies Library.

## 10. STAFF.

There were six resignations during the year. Two were to higher appointments in other libraries, one was to attend the School of Librarianship at the University of New South Wales as a full-time student and one to another appointment within the University. The National Diet Library in Tokyo kindly agreed to second a senior officer, Mr. Y. Nakada, to work in the Oriental Collection for three years. Mr. Nakada commenced duty in July.

## 11. EXPENDITURE.

Expenditure on books and serials from July 1959 to June 1960 was £27,273. This applies to the Library before association.

\* For the period January-September, 1960, see the report of the Canberra University College Library.

## UNIVERSITY HOUSE.

## 1. 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, 1961.*

Professor C. P. FitzGerald (Deputy Master).

Professor J. A. Barnes.

Dr. A. M. Sargeson (Steward).

Mr. E. Irving.

*Retiring 15th August, 1962.*

Dr. R. R. Brown (Bursar).

Dr. W. H. Elliott.

Dr. E. K. Inall.

Dr. F. J. West.

In April the Master received the honorary degree of D.Litt. from the University of Adelaide. He left Canberra in the middle of November for a three-months' trip to Europe and America to continue his researches on South Italian pottery.

## 2. MEMBERS AND RESIDENTS.

The number of members has remained fairly constant at about 425 but the number of permanent residents has risen to over 120, of whom at present 37 are members of staff, 65 research students, 8 research or library assistants, 9 wives of staff or students, and 3 members of the House.

Slight modifications were made in the conditions of eligibility for membership following on the association of the Canberra University College with the University, but the rights of all existing members remain unchanged so long as they continue in the employment of the University. Visitor Membership will in future be granted for periods of up to one year to persons attached to the University as visiting research workers or visiting students.

During the year the rates for all types of rooms and for casual meals had to be increased slightly to counter rising costs and an increase in the basic wage.

There has been an increasing demand for casual rooms, especially for conference purposes, but the availability of over 20 new rooms in the Eastern Annexe Extension has enabled most of the demands to be met, although on several occasions the House has been completely full.

## 3. VISITORS.

The flow of academic and other distinguished visitors increases steadily, and the wide range of universities and countries from which they come shows how the University is succeeding in attracting to Canberra scholars from all parts of the world. Visitors this year, who have stayed in the House, include—Professor D. Barker (Hong Kong); Professor B. H. Beckhart (Columbia University) and Mrs. Beckhart (Vassar College); Professor L. Biermann (Munich); Professor J. Bonner (Californian Institute of Technology); Sir Lawrence and Lady Bragg (Royal Institution, London); Professor V. J. Cheadle (California); Professor R. H. Dalitz (Chicago); Mr. Howard Drake (Institute of Advanced Legal Studies, London); Dr. T. Elvius (Uppsala); Dr. P. Erdős (Haifa); Mr. H. Fail (Durham); Professor H. E. Field (Canterbury, New Zealand); Sir Ronald Fisher; Professor J. H. Franklin (Brooklyn College); Professor H. M. Gluckman (Manchester); Dr. C. Hartley Grattan; Professor R. Gustilo (Manila); Mr. L. M. Harrod (Malaya); Mr. R. F. Henderson (Corpus Christi College, Cambridge); Professor A. Bradford Hill (London); Professor Urban T. Holmes (Duke University); Dr. N. F. Hush (Bristol); Professor J. A. Jacobs (British Columbia); Professor A. R. M. Lower (Queen's University, Kingston); Professor A. W. Macmahon (Columbia) and Mrs. Macmahon (Vassar College); Professor B. Morris (Bristol); Sir Harrie Massey (University College, London); Professor W. R. Niblett (London); Professor Margaret Parke (Brooklyn); Professor H. Roddier (Lyons); Professor L. Rosenfeld (Copenhagen); Dr. P. C. Sestieri (Salerno); Dr. P. D. Shukla (New Delhi); Professor T. H. Silcock; Professor H. A. Simon (Pittsburgh); Professor T. Sizer (Yale); Sir David Smith (Chancellor of the University of New Zealand); Professor H. W. Thompson (Oxford); Professor H. Tingsten (Stockholm); Sir Alexander Todd (Cambridge); and Professor F. G. Young (Cambridge).

On 21st March the House was honoured by a visit from Their Excellencies the late Governor-General and Viscountess Dunrossil, who were subsequently entertained to luncheon in Hall by the Master and Fellows. The Governor of Victoria, Sir Dallas Brooks, accompanied by Lady Brooks visited the House on 14th January. The Chancellor, Lord Bruce, was in residence for a short period at the beginning of the year.

#### 4. BUILDINGS AND GROUNDS.

The approach to the Main Entrance has been redesigned, and the paving extended for about five yards to prevent any further damage to the steps from cars coming too close.

The extension to the Eastern Annexe was completed in September and has already proved its value both for accommodating visitors to conferences and for providing them with a suitable place in which to hold their meetings. The new Meetings Room is very well adapted for this purpose as it will seat 100-120 for a lecture or 40 for a round-table conference. It is equipped with a movable stage for play-readings and makes a most delightful setting for informal parties or dances. It is excellently sound-proofed and must be regarded as filling a long-felt want in the amenities of the House. The bedrooms in the new wing are of two sizes (ca. 140 sq. ft. on the North side and ca. 155 sq. ft. on the South), but the provision of some built-in furniture leaves a much larger proportion of free space than in the older rooms. The top floor has been opened for use by women residents: it is not intended to open the other two floors for permanents until the need arises (probably early in 1961).

It is proposed to replan the Parking Area beside the East Wing, with a view to making it more attractive, by the planting of flowering trees and the provision of a small garden, as well as a more efficient car park.

The electric stove in the kitchen has now been replaced by an oil-burning stove which has so far proved quite efficient and should result in a substantial saving in fuel costs.

The completion of the Eastern Annexe Extension raises the problem of future accommodation for staff and research students. University House cannot accommodate more than about 140 permanent residents, assuming that some rooms are always kept available for visiting scholars, nor will the Hall seat more than about 180 if efficient service is to be given. The planning of a second University House will therefore become necessary during the coming triennium and a Committee has been set up to consider this and related matters.

#### 5. HOUSE LIBRARY AND RECORD COLLECTION.

The Library and Gramophone Committee have continued their work under the Chairmanship of the Deputy Master, and both collections have greatly benefited from donations by members and visitors to the House. The Library received two very substantial gifts of current British and French books from the British Council and the French Embassy respectively, as well as a beautifully bound set of the first 100 volumes of *Punch* from Mr. J. V. Gordon. There is a steadily increasing use of the facilities offered by the two collections, especially on the part of non-resident members.

#### 6. GIFTS AND DONATIONS.

Apart from the gifts to the Library mentioned above, the House received from the British Council a most useful collection of prints of contemporary British paintings and of posters. The prints have been framed and hung up in various rooms in the House, and the posters have been used to great advantage as decorations for the new Meetings Room.

#### 7. FUNCTIONS AND ACTIVITIES.

Commencement Dinners were held as usual to mark the beginning of each of the three terms; the speakers were Professors G. Sawyer, J. H. Franklin and H. M. Gluckman. Guest-nights and the Annual Dance proved so popular that it was not possible to provide for all who wished to attend, and consideration is being given to duplicating Guest-nights in 1961.

The residents have organized several informal dances, the new Meetings Room proving particularly popular for this purpose.

Several lectures were given in the Main Common Room under the auspices of the House or of various learned societies; they covered a very wide range of topics and were normally very well attended.

The Morrison lecture was given in October by H. E. Dr. Chen Chih-Mai, the Chinese Ambassador, on "Chinese Figure Painting"; it was followed by a screening of the film "A City of Cathay", a cinematographic study of the famous painting *Ch'ing-ming-shang-ho t'u*, with a commentary by Dr. Chen.

The first annual lecture sponsored by the Research Students' Association was given in the Hall on 2nd November, when Professor Asa Briggs spoke on "The Map of Learning".

The facilities of the Hall were again made available to the Chamber Music Society, and four concerts were held, all very well attended.

#### 8. PUBLICATIONS.

Trendall, A. D.—

"Paestan Addenda", in *Papers of the British School at Rome* XXVII, 1959, pp. 1-37, 7 pls.

"New Acquisitions in Australia and New Zealand", in *Fasti Archeologici* XII, 1960, pp. 14-15 and 22.

"The Cassandra Painter and his Circle", in *Jahrbuch der Berliner Museen* II, 1960, pp. 7-33.

## UNIVERSITY STATISTICS.

## INSTITUTE OF ADVANCED STUDIES.

## No. 1.—STAFF.

Year 1960.

Particulars.	Full-time.			Part-time.		
	Males.	Females.	Total.	Males.	Females.	Total.
<b>(a) Teaching and Research—</b>						
1. Professors .. .. .	24	..	24	..	..	..
2. Readers .. .. .	20	..	20	..	..	..
3. Senior Fellows and Fellows .. .. .	53	2	55	..	..	..
4. Senior Research Fellows and Research Fellows .. .. .	43	8	51	..	..	..
5. Research and Departmental Assistants ..	2	24	26	1	7	8
<b>Total .. .. .</b>	<b>142</b>	<b>34</b>	<b>176</b>	<b>1</b>	<b>7</b>	<b>8</b>
<b>(b) Library (including departmental sections)—</b>						
1. Engaged in Professional Work .. .. .	3	13	16	..	..	..
2. Other Assistants .. .. .	2	4	6	..	..	..
<b>Total .. .. .</b>	<b>5</b>	<b>17</b>	<b>22</b>	<b>..</b>	<b>..</b>	<b>..</b>
<b>(c) Central Administration—</b>						
1. Chief Administrative Officers .. .. .	3	..	3	..	..	..
2. Senior Administrative Assistants .. .. .	7	3	10	..	..	..
3. Clerks, Typists, Telephonists .. .. .	38	53	91	..	3	3
4. Porters, Messengers, &c. .. .. .	4	..	4	..	1	1
<b>Total .. .. .</b>	<b>52</b>	<b>56</b>	<b>108</b>	<b>..</b>	<b>4</b>	<b>4</b>
<b>(d) Departmental Clerks and Typists .. .. .</b>	<b>22</b>	<b>69</b>	<b>91</b>	<b>..</b>	<b>..</b>	<b>..</b>
<b>(e) Maintenance—</b>						
1. Cleaning .. .. .	29	7	36	1	4	5
2. Gardening .. .. .	13	..	13	..	..	..
3. Upkeep of buildings .. .. .	35	..	35	..	..	..
<b>Total .. .. .</b>	<b>77</b>	<b>7</b>	<b>84</b>	<b>1</b>	<b>4</b>	<b>5</b>
<b>(f) Laboratories—</b>						
1. Adult Assistants .. .. .	179	42	221	..	2	2
2. Junior Assistants, under 21, including Cadets	9	22	31	..	..	..
<b>Total .. .. .</b>	<b>188</b>	<b>64</b>	<b>252</b>	<b>..</b>	<b>2</b>	<b>2</b>
<b>SUMMARY—</b>						
(a) Teaching and Research .. .. .	142	34	176	1	7	8
(b) Library .. .. .	5	17	22	..	..	..
(c) Central Administration .. .. .	52	56	108	..	4	4
(d) Departmental Clerks and Typists .. .. .	22	69	91	..	..	..
(e) Maintenance .. .. .	77	7	84	1	4	5
(f) Laboratories .. .. .	188	64	252	..	2	2
<b>Total .. .. .</b>	<b>486</b>	<b>247</b>	<b>733</b>	<b>2</b>	<b>17</b>	<b>19</b>

## No. 2.—DETAILS OF TEACHING AND RESEARCH STAFF (INSTITUTE OF ADVANCED STUDIES).

Year 1960.

Department.	1		2		3				4				5			
	Professors.		Readers.		Senior Fellows and Fellows.				Senior Research Fellows and Research Fellows.				Research and Departmental Assistants.			
					Full-time.		Part-time.		Full-time.		Part-time.		Full-time.		Part-time.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
John Curtin School of Medical Research—																
Biochemistry .. ..	1	..	..	..	4	..	..	..	1	..	..	..	..	..	..	..
Physical Biochemistry ..	1	..	..	..	2	..	..	..	1	..	..	..	..	1	..	..
Experimental Pathology ..	1	..	1	..	2	..	..	..	2	..	..	..	..	..	..	..
Medical Chemistry .. ..	1	..	..	..	2	..	..	..	4	1	..	..	..	..	..	..
Microbiology .. .. .	1	..	1	..	3	..	..	..	4	1	..	..	1	..	..	..
Physiology .. .. .	1	..	1	..	2	..	..	..	4	1	..	..	..	..	..	..
Biological Inorganic Chemistry Unit .. ..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..
Animal Breeding .. ..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Research School of Physical Sciences—																
Astronomy .. .. .	1	..	3	..	5	..	..	..	1	..	..	..	..	3	..	..
Geophysics .. .. .	1	..	1	..	5	1	..	..	2	..	..	..	..	4	1	..
Nuclear Physics .. ..	1	..	..	..	2	..	..	..	4	..	..	..	..	..	..	..
Particle Physics .. ..	1	..	..	..	9	..	..	..	2	..	..	..	..	..	..	..
Theoretical Physics ..	1	..	1	..	1	..	..	..	2	..	..	..	..	1	..	..
Electronics .. .. .	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Research School of Social Sciences—																
Demography .. .. .	1	..	..	..	2	1	..	..	1	..	..	..	..	4	..	2
Economics .. .. .	1	..	3	..	2	..	..	..	1	..	..	..	..	5	..	1
History .. .. .	1	..	1	..	2	..	..	..	1	1	..	..	..	1	..	..
Law .. .. .	1	..	..	..	1	..	..	..	..	..	..	..	..	1	..	..
Political Science .. ..	1	..	1	..	1	..	..	..	1	..	..	..	..	..	..	2
Social Philosophy .. ..	2	..	..	..	1	..	..	..	2	..	..	..	..	..	..	..
Statistics .. .. .	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Research School of Pacific Studies—																
Anthropology .. .. .	1	..	2	..	1	..	..	..	1	2	..	..	..	1	..	..
Economics .. .. .	1	..	..	..	..	..	..	..	1	1	..	..	1	..	..	..
Far Eastern History .. ..	1	..	..	..	1	..	..	..	3	..	..	..	..	1	..	1
Geography .. .. .	1	..	3	..	..	..	..	..	1	..	..	..	..	..	..	..
International Relations ..	..	..	..	..	1	..	..	..	2	1	..	..	..	1	..	1
Pacific History .. .. .	1	..	..	..	1	..	..	..	2	..	..	..	..	1	..	..
Total .. .. .	24	..	20	..	53	2	..	..	43	8	..	..	2	24	1	7

## No. 3.—SPECIAL RESEARCH WORKERS (THE INSTITUTE OF ADVANCED STUDIES).

Year 1960.

Particulars.	Males.		Females.		Total.	
	Working in Australia.	Abroad.	Working in Australia.	Abroad.	Working in Australia.	Abroad.
Students and others (not being members of the staff as in Table 1 (a)) engaged in research—						
Subsidized by—						
1. Commonwealth Government .. ..	17	2	..	..	19	..
2. State Government .. .. .	..	..	..	..	..	..
3. Other Sources .. .. .	3	..	1	..	4	..
Unsubsidized .. .. .	3	..	..	..	3	..
Total .. .. .	23	2	1	..	26	..

No. 4.—STUDENTS: FULL-COURSE AND PART-COURSE. (INSTITUTE OF ADVANCED STUDIES.)

Classification of Students.	Total for Previous Year.	Year 1960.		
		Males.	Females.	Total.
Students Attending—				
Full-Course .. .. .	117	131	15	146
Part-Course .. .. .	1	1	..	1
External Students .. .. .	..	..	..	..
Total .. .. .	118	132	15	147

TABLE 5.—STUDENT ENROLMENT 1960. (INSTITUTE OF ADVANCED STUDIES.)

	Ph.D.		M.A. or M.Sc.		Not Enrolled for Degree.		Total.		
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Students.
<b>John Curtin School of Medical Research—</b>									
Biochemistry .. .. .	6	6	..	..	..	..	6	6	12
Experimental Pathology .. .. .	2	..	..	..	..	..	2	..	2
Medical Chemistry .. .. .	5	..	..	..	..	..	5	..	5
Microbiology .. .. .	7	1	..	..	..	..	7	1	8
Physiology .. .. .	6	2	1	..	..	..	7	2	9
Physical Biochemistry .. .. .	1	..	..	..	1	..	2	..	2
Inorganic Chemistry .. .. .	5	..	..	..	..	..	5	..	5
									43
<b>Research School of Physical Sciences—</b>									
Geophysics .. .. .	8	..	..	..	..	..	8	..	8
Astronomy .. .. .	6	..	..	..	..	..	6	..	6
Nuclear Physics .. .. .	11	..	..	..	..	..	11	..	11
Theoretical Physics .. .. .	3	1	..	..	..	..	3	1	4
Particle Physics .. .. .	2	..	..	..	..	..	2	..	2
									31
<b>Research School of Social Sciences—</b>									
Demography .. .. .	3	..	..	..	..	..	3	..	3
Economics .. .. .	4	..	..	..	1	..	5	..	5
History .. .. .	9	2	..	..	2	..	11	2	13
Law .. .. .	2	..	..	..	..	..	2	..	2
Political Science .. .. .	4	..	1	..	..	..	5	..	5
Social Philosophy .. .. .	7	..	..	..	..	..	7	..	7
Statistics .. .. .	3	..	..	..	..	..	3	..	3
									38
<b>Research School of Pacific Studies—</b>									
Anthropology and Sociology .. .. .	10	1	..	..	3	..	13	1	14
Far Eastern History .. .. .	2	..	..	..	..	..	2	..	2
Geography .. .. .	7	1	..	..	..	..	7	1	8
International Relations .. .. .	2	..	..	..	..	..	2	..	2
Pacific History .. .. .	6	1	..	..	..	..	6	1	7
									33
	121	15	2	..	7	..	130	15	145
<b>School of General Studies</b> .. .. .	1	..	..	..	1	..	2	..	2
<b>Totals</b> .. .. .	..	..	..	..	..	..	132	15	147

TABLE 5A.—NEW STUDENTS 1960. (INSTITUTE OF ADVANCED STUDIES.)

	Ph.D.		M.A. or M.Sc.		Not Enrolled for Degree.		Total.		Students.
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	
<b>John Curtin School of Medical Research—</b>									
Biochemistry .. .. .	2	2	..	..	..	..	2	2	4
Experimental Pathology .. .. .	2	..	..	..	..	..	2	..	2
Medical Chemistry .. .. .	2	..	..	..	..	..	2	..	2
Microbiology .. .. .	3	..	..	..	..	..	3	..	3
Physiology .. .. .	2	1	..	..	..	..	2	1	3
Inorganic Chemistry .. .. .	1	..	..	..	..	..	1	..	1
Physical Biochemistry .. .. .	..	..	..	..	..	..	..	..	..
									15
<b>Research School of Physical Sciences—</b>									
Geophysics .. .. .	3	..	..	..	..	..	3	..	3
Astronomy .. .. .	4	..	..	..	..	..	4	..	4
Nuclear Physics .. .. .	5	..	..	..	..	..	5	..	5
Theoretical Physics .. .. .	..	..	..	..	..	..	..	..	..
Particle Physics .. .. .	..	..	..	..	..	..	..	..	..
									12
<b>Research School of Social Sciences—</b>									
Statistics .. .. .	..	..	..	..	..	..	..	..	..
Demography .. .. .	1	..	..	..	..	..	1	..	1
Economics .. .. .	..	..	..	..	1	..	1	..	1
History .. .. .	4	1	..	..	..	..	4	1	5
Law .. .. .	..	..	..	..	..	..	..	..	..
Political Science .. .. .	1	..	..	..	..	..	1	..	1
Social Philosophy .. .. .	1	..	..	..	..	..	1	..	1
									9
<b>Research School of Pacific Studies—</b>									
Anthropology and Sociology .. .. .	1	1	..	..	2	..	3	1	4
Far Eastern History .. .. .	..	..	..	..	..	..	..	..	..
Geography .. .. .	4	..	..	..	..	..	4	..	4
Pacific History .. .. .	1	..	..	..	..	..	1	..	1
International Relations .. .. .	2	..	..	..	..	..	2	..	2
									11
<b>School of General Studies—</b>									
Department of History .. .. .	..	..	..	..	1	..	1	..	1
Department of Chemistry .. .. .	1	..	..	..	..	..	1	..	1
									2
<b>Total .. .. .</b>	<b>40</b>	<b>5</b>	<b>..</b>	<b>..</b>	<b>4</b>	<b>..</b>	<b>44</b>	<b>5</b>	<b>49</b>

## NO. 6A.—AGE DISTRIBUTION OF MALE STUDENTS ENROLLED—(NEW STUDENTS ONLY—INSTITUTE OF ADVANCED STUDIES).

Age as at 1st March, 1960.

Males.

Courses.	Age.																	Total.		
	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.		Over 36.	
John Curtin School of Medical Research ..	..	1	..	1	1	3	..	2	1	..	1	..	..	..	..	1	..	1	12	
Research School of Physical Sciences ..	1	2	1	4	..	1	..	..	1	..	1	..	..	..	..	..	..	..	1	12
Research School of Social Sciences ..	..	..	..	..	1	1	2	..	1	1	1	..	..	..	1	..	..	..	..	8
Research School of Pacific Studies ..	1	..	..	..	2	2	1	2	1	1	..	..	..	..	..	..	..	..	..	10
School of General Studies ..	..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	2
<b>Total</b> ..	<b>2</b>	<b>4</b>	<b>1</b>	<b>5</b>	<b>4</b>	<b>7</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>..</b>	<b>..</b>	<b>..</b>	<b>1</b>	<b>1</b>	<b>..</b>	<b>2</b>	<b>44</b>	

## NO. 6B.—AGE DISTRIBUTION OF FEMALE STUDENTS ENROLLED—(NEW STUDENTS ONLY—INSTITUTE OF ADVANCED STUDIES)

Age as at 1st March, 1960.

Females.

Courses.	Age.																	Total.		
	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.		Over 36.	
John Curtin School of Medical Research ..	..	1	..	1	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	3
Research School of Physical Sciences ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Research School of Social Sciences ..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Research School of Pacific Studies ..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
School of General Studies ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<b>Total</b> ..	<b>..</b>	<b>2</b>	<b>..</b>	<b>1</b>	<b>..</b>	<b>..</b>	<b>..</b>	<b>..</b>	<b>..</b>	<b>1</b>	<b>1</b>	<b>..</b>	<b>5</b>							

## NO. 7.—MATRICULATION QUALIFICATIONS OF NEW STUDENTS ENROLLED. (INSTITUTE OF ADVANCED STUDIES.)

Matriculation Qualifications.						Males.	Females.	Total.
Graduate ..	..	..	..	..	..	44	5	49
<b>Total</b> ..	..	..	..	..	..	<b>44</b>	<b>5</b>	<b>49</b>

## NO. 8.—HOME RESIDENCE DISTRIBUTION OF ALL STUDENTS ENROLLED. (INSTITUTE OF ADVANCED STUDIES.)

Home Residence.						Males.	Females.	Total.
Australian Capital Territory	..	..	..	..	..	3	..	3
New South Wales	..	..	..	..	..	21	..	21
Victoria ..	..	..	..	..	..	15	3	18
Other States ..	..	..	..	..	..	28	6	34
Overseas ..	..	..	..	..	..	65	6	71
<b>Total</b> ..	..	..	..	..	..	<b>132</b>	<b>15</b>	<b>147</b>

NO. 9.—TERM RESIDENCE DISTRIBUTION OF ALL STUDENTS ENROLLED. (INSTITUTE OF ADVANCED STUDIES.)

Term Residence.							Males.	Females.	Total.
College	..	..	..	..	..	..	77	13	90
Lodgings	..	..	..	..	..	..	55	2	57
Total	..	..	..	..	..	..	132	15	147

NO. 10.—ASSISTED STUDENTS 1960. (INSTITUTE OF ADVANCED STUDIES.)

Nature of Assistance.	Government.		University.		Other.		Corrected Total.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
Australian National University Research Scholars .. .. .	..	..	100	15	..	..	100	15
General Motors-Holden's Fellows ..	..	..	..	..	4	..	4	..
Fulbright (United States Educational Foundation) .. .. .	..	..	..	..	4	1	4	1
Australian Atomic Energy Commission Scholars .. .. .	1	..	..	..	..	..	1	..
Total .. .. .	1	..	100	15	8	1	109	16

TABLE 11A.—DEGREES AWARDED IN 1960.\*

	1960.		Total.	Total Number up to and including 1960.		
	Males.	Females.		Males.	Females.	Total.
John Curtin School of Medical Research—						
Ph.D. .. .. .	3	..	3	10	1	11
M.Sc. .. .. .	..	..	..	..	2	2
Research School of Physical Sciences—						
D.Sc. .. .. .	..	..	..	1	..	1
Ph.D. .. .. .	6	..	6	18	..	18
Research School of Social Sciences—						
Ph.D. .. .. .	5	..	5	21	1	22
M.A. .. .. .	..	..	..	1	2	3
Research School of Pacific Studies—						
Ph.D. .. .. .	6	..	6	19	2	21
M.A. .. .. .	..	..	..	2	..	2
Total .. .. .	20	..	20	72	8	80

\* Does not include degrees of the University of Melbourne awarded to students in the former Canberra University College, now the School of General Studies.

## ENROLMENT IN THE SCHOOL OF GENERAL STUDIES ON 30TH SEPTEMBER, 1960.

	Full Time.	Part Time.	Total.
<b>Higher Degree Courses—</b>			
M.A. .. .. .	1	16	17
M.A. (Melb.) .. .. .	2	3	5
M.Ec. .. .. .	..	17	17
LL.M. .. .. .	1	..	1
M.Sc. .. .. .	5	2	7
	9	38	47
<b>Bachelor Degree Courses—</b>			
<b>Arts—</b>			
B.A. (Hons.) .. .. .	9	4	13
B.A. .. .. .	78	190	268
B.A. (Melb.) .. .. .	12	9	21
<b>Law—</b>			
LL.B. .. .. .	11	32	43
LL.B. (Melb.) .. .. .	1	3	4
<b>Economics—</b>			
B.Ec. .. .. .	39	203	242
B.Com. (Melb.) .. .. .	6	9	15
<b>Education—</b>			
B.Ed. (Melb.) .. .. .	..	1	1
<b>Science—</b>			
B.Sc. .. .. .	54	27	81
	210	478	688
<b>Diploma Courses—</b>			
Public Administration .. .. .	..	7	7
Public Administration (Melb.) .. .. .	..	1	1
	..	8	8
<b>Miscellaneous (Single Units)—(Not for any purpose referred to above)—</b>			
Arts .. .. .	4	58	62
Law .. .. .	2	9	11
Economics .. .. .	7	26	33
Science .. .. .	1	9	10
	14	102	116
<b>Summary—</b>			
Higher Degree Courses .. .. .	9	38	47
Bachelors' Degree Courses .. .. .	210	478	688
Diploma Courses (Sub-Graduate) .. .. .	..	8	8
Miscellaneous Courses .. .. .	14	102	116
<b>Total</b> .. .. .	233	626	859
<b>Adjustments for Students in more than one category</b> .. .. .	4	6	10
<b>Corrected Grand Total</b> .. .. .	229	620	849
<b>Non Examination Students and Special Course Subjects</b> .. .. .	..	51	51

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(i.)

(Other than the School of General Studies.)

STATEMENT OF ASSETS AND LIABILITIES AS AT 31ST DECEMBER, 1960.

*General Funds.*

	£	£	£
<b>Current Assets—</b>			
<b>Cash—</b>			
Commonwealth Trading Bank of Australia, Canberra—			
General Account .. .. .	Cr. 229		
Interest Bearing Deposit—General Account .. .. .	88,858		
Restricted Funds .. .. .	61,142		
		149,771	
Held in Imprests .. .. .		1,434	
Sundry Debtors .. .. .			151,205
Advances and Prepayments .. .. .			30,750
Materials in Stores and Service Pools .. .. .			604,033
			213,028
			<u>999,016</u>
<b>Fixed Assets—</b>			
<b>Buildings—</b>			
Buildings and Service Installations .. .. .		3,453,325	
Dwellings .. .. .		1,301,466	
			4,754,791
<b>Research Equipment and Furniture—</b>			
Research Schools and Library .. .. .		1,949,869	
Administration and General Services .. .. .		105,386	
Residential Properties .. .. .		63,600	
			2,118,855
<b>Library—</b>			
Books and Publications .. .. .			316,451
<b>Hall of Residence—</b>			
University House (v)—Buildings .. .. .		959,186	
Equipment and Other Assets .. .. .		100,516	
			1,059,702
			<u>9,248,815</u>
<b>Liabilities—</b>			
Sundry Creditors .. .. .			46,502
			<u>9,202,313</u>
<b>Capital Accumulation (ii.) .. .. .</b>		9,141,171	
<b>Restricted Funds (vi.) .. .. .</b>		61,142	
			<u>9,202,313</u>
<b>Trust and Agency Funds (vii) .. .. .</b>			448,636

L. G. H. HUXLEY,  
Vice-Chancellor.J. RYAN,  
Accountant.

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 (other than the School of General Studies) as at 31st December, 1960.

(Signed) V. J. W. SKERMER,  
Auditor-General for the Commonwealth.  
27th June, 1961.

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(ii.)

*(Other than the School of General Studies.)*

## CAPITAL ACCUMULATIONS ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1960.

	£	£
Balance, 1st January, 1960 .. .. .	..	8,522,377
<i>Add—</i>		
Transfer from Income and Expenditure Account .. .. .	98,457	
Commonwealth Grant for Capital Works and Services .. .. .	585,866	
Assets Purchased from Restricted Funds .. .. .	6,701	
Profit on Sale of Houses to Members of Staff .. .. .	883	
Residences on Site taken over from Department of Interior .. .. .	22,040	
Sale of Library Duplicates .. .. .	1,561	
Gifts and Donations .. .. .	44	
	<hr/>	715,552
		<hr/> 9,237,929
<i>Less—</i>		
Adjustment of Inventory Account .. .. .	19,290	
Loss by Fire—		
(i) Building .. .. .	45,000	
(ii) Equipment and Stores .. .. .	32,468	
	<hr/>	77,468
		<hr/> 96,758
Balance, 31st December, 1960, as contra to assets in Statement of Assets and Liabilities (i.) .. .. .	..	<hr/> 9,141,171

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(iii.)

*(Other than the School of General Studies.)*

STATEMENT OF INCOME AND EXPENDITURE, FOR THE YEAR ENDED 31ST DECEMBER, 1960.

Income—			£
Commonwealth Grant for Running Expenses .. .. .			1,780,750
Rentals Received .. .. .			60,500
Students and Examination Fees Received .. .. .			1,352
Bank Interest and Sundries .. .. .			5,281
			<hr/> 1,847,883
Expenditure—	£	£	
The Research Schools ( <i>See analysis attached—iv.</i> )—			
The John Curtin School of Medical Research .. .. .	455,344		
The Research School of Physical Sciences .. .. .	546,890		
The Research School of Social Sciences .. .. .	166,850		
The Research School of Pacific Studies .. .. .	133,914		
	<hr/>	1,302,998	
Scholarships .. .. .		122,843	
The Library—			
Salaries and Wages .. .. .	29,066		
Pay Roll Tax .. .. .	732		
Provision for Superannuation .. .. .	2,662		
Binding Costs .. .. .	4,472		
Administrative Expenses .. .. .	4,832		
	<hr/>	41,764	
Administration—			
Salaries and Wages .. .. .	93,788		
Pay Roll Tax .. .. .	2,335		
Provision for Superannuation .. .. .	7,342		
Administrative Expenses .. .. .	31,412		
	<hr/>	134,877	
Miscellaneous—			
Council and Committee Meetings .. .. .	1,753		
Ceremonial Functions and Expenses .. .. .	1,195		
Subscriptions and Donations to Other Bodies .. .. .	4,135		
Bad Debts written off .. .. .	234		
University Calendar and Public Relations Material .. .. .	2,995		
Publications Section—Salaries and Expenses .. .. .	2,035		
Private Audit Expenses .. .. .	2,369		
Legal Expenses .. .. .	1,030		
University Film Subvention .. .. .	2,500		
Publications Fund Subvention .. .. .	6,000		
Subvention for Facilities Provided by University House for General Purposes .. .. .	5,000		
Sundries .. .. .	664		
	<hr/>	29,910	
Maintenance and General Services—			
Maintenance—Buildings .. .. .	58,691		
Maintenance—Other .. .. .	22,486		
Watchmen .. .. .	4,107		
Freight, Supply and Disposal Expenses .. .. .	3,709		
Telephone Exchange Costs .. .. .	11,136		
Pay Roll Tax .. .. .	2,195		
	<hr/>	102,324	
Hall of Residence—			
University House—			
Operating Loss .. .. .	412		
Estimated Depreciation on Equipment .. .. .	8,551		
Master's Stipend and Secretarial Assistance .. .. .	5,747		
	<hr/>	14,710	
		<hr/>	1,749,426
Transferred to Capital Accumulations Account (ii) .. .. .			<hr/> 98,457

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(iv.)

(Other than the School of General Studies).

ATTACHMENT TO INCOME AND EXPENDITURE STATEMENT (iii).—31ST DECEMBER, 1960.

	Expendable Research Materials.	Salaries.	Pay-roll Tax.	Provision for Super- annuation.	Field Research and Travelling Expenses.	Adminis- trative and Service Expenses.	Total.
	£	£	£	£	£	£	£
<b>John Curtin School of Medical Research—</b>							
Department of Biochemistry ..	11,926	28,951	..	..	..	..	40,877
Department of Physical Biochemistry ..	6,702	8,928	..	..	..	..	15,630
Department of Medical Chemistry ..	9,927	35,035	..	..	..	..	44,962
Department of Microbiology ..	19,442	38,529	..	..	..	..	57,971
Department of Experimental Pathology ..	10,109	24,606	..	..	..	..	34,715
Department of Physiology ..	7,333	33,766	..	..	..	..	41,099
Biological Inorganic Chemistry Unit ..	2,712	4,365	..	..	..	..	7,077
General Administration ..	..	47,260	6,982	26,289	1,226	60,179	141,936
Animal Breeding Establishment ..	..	16,395	..	..	..	5,199	21,594
Medical School Workshops ..	..	35,803	..	..	..	11,503	47,306
Electron Microscope Unit ..	712	1,465	..	..	..	..	2,177
	68,863	275,103	6,982	26,289	1,226	76,881	455,344
<b>Research School of Physical Sciences—</b>							
Department of Particle Physics ..	..	63,216	..	..	..	..	63,216
Department of Nuclear Physics ..	..	30,789	..	..	..	..	30,789
Department of Theoretical Physics ..	..	13,842	..	..	..	..	13,842
Department of Geophysics ..	..	50,738	..	..	..	..	50,738
Department of Astronomy ..	..	88,239	..	..	..	..	88,239
Physics School Expenses ..	72,972	..	8,581	41,513	9,686	84,326	217,078
Administrative and Technical Salaries ..	..	31,041	..	..	..	..	31,041
Workshop Salaries ..	..	48,347	..	..	..	..	48,347
Electronics Section ..	..	3,600	..	..	..	..	3,600
	72,972	329,812	8,581	41,513	9,686	84,326	546,890
<b>Research School of Social Sciences—</b>							
Department of Law ..	8	8,890	..	..	203	..	9,101
Department of Economics ..	244	29,242	..	..	430	..	29,916
Department of Political Science ..	97	12,242	..	..	795	..	13,134
Department of History ..	141	20,217	..	..	918	..	21,276
Department of Demography ..	300	17,191	..	..	2,440	..	19,931
Department of Statistics ..	8	8,409	..	..	..	..	8,417
Department of Social Philosophy ..	..	15,664	..	..	..	..	15,664
General Administration ..	..	12,301	3,159	12,289	860	20,802	49,411
	798	124,156	3,159	12,289	5,646	20,802	166,850
<b>Research School of Pacific Studies—</b>							
Department of International Relations ..	306	10,580	..	..	2,405	..	13,291
Department of Anthropology ..	384	23,430	..	..	3,492	..	27,306
Department of Pacific History ..	508	12,403	..	..	1,944	..	14,855
Department of Geography ..	473	16,999	..	..	3,916	..	21,388
Department of Far Eastern History ..	212	15,628	..	..	1,801	..	17,641
Department of Economics ..	9	5,814	..	..	986	..	6,809
General Administration ..	..	6,288	2,267	9,325	1,056	13,688	32,624
	1,892	91,142	2,267	9,325	15,600	13,688	133,914
	144,525	820,213	20,989	89,416	32,158	195,697	1,302,998

THE AUSTRALIAN NATIONAL UNIVERSITY.  
(Other than the School of General Studies.)

(v.)

## UNIVERSITY HOUSE.

## OPERATING STATEMENT FOR THE YEAR ENDED 31ST DECEMBER, 1960.

	£	
Income—		
Tariff Received—Residents .. .. .		61,150
Income for Casual Meals and Catering ..		12,054
Membership Fees .. .. .		1,973
Reimbursement of Board—House Staff ..		2,384
Subvention from University for Facilities provided for University Purposes ..		5,000
Beverage Sales—Net Proceeds .. .. .		2,072
Sundry Income .. .. .		1,069
		£85,702
Expenditure—	£	£
Operating Costs—		
Cost of Foodstuffs .. .. .	24,586	
Fuel, Light and Power .. .. .	12,328	
Cleaning, Laundry and Sundry Materials ..	3,191	
Domestic Staff Wages and Gratuities to Staff ..	33,278	
Losses, Breakages and Replacements .. .. .	906	
Local Transport, Freight and Supply Expenses ..	370	
	74,659	
Administrative Expenses—		
Administrative Salaries .. .. .	5,628	
Pay-roll Tax .. .. .	967	
Workmen's Compensation .. .. .	295	
Provision for Superannuation .. .. .	977	
Advertising and Appointment Expenses .. .. .	13	
Posts, Telegrams and Telephone .. .. .	246	
Stationery, Printing and Office Expenses .. .. .	258	
Newspapers and Periodicals .. .. .	125	
Master's and Fellow's Entertainment Expenses ..	1,290	
	9,799	
Property, Maintenance and Service Expenses—		
Rates and General Services .. .. .	349	
Building Maintenance .. .. .	532	
Sundry Repairs .. .. .	775	
	1,656	
		86,114
Net Operating Loss Transferred to University Statement of Income and Expenditure (iii.) .. .. .		412
Estimated Depreciation on Assets Transferred to University Statement of Income and Expenditure (iii.) ..		8,551
		8,963

## STATEMENT OF ASSETS AND LIABILITIES AS AT 31ST DECEMBER, 1960.

Assets—		
Sundry Debtors .. .. .		5,248
Stock on Hand .. .. .		8,743
Works of Art and Record Library .. .. .		1,477
Furniture and Equipment .. .. .	146,514	
Less Estimated Depreciation to Date .. .. .	58,059	
	88,455	
		103,923
Less—		
Sundry Creditors .. .. .		3,407
Included in University's Statement of Assets and Liabilities (i.) .. .. .		100,516

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(vi.)

(Other than the School of General Studies.)

## STATEMENT OF FUNDS GRANTED FOR RESTRICTED PURPOSES FOR THE YEAR ENDED 31ST DECEMBER, 1960.

	Subsidies and Donations Received During 1960.	Funds Disbursed or Transferred During 1960.	Net Amounts Transferred to Capital of Funds.	Fund Balances 1st January, 1960.	Fund Balances 31st December, 1960.
	£	£	£	£	£
The John Curtin School of Medical Research Reserve ..	..	..	..	1,840	1,840
The Research School of Physical Sciences Reserve ..	..	939	Cr. 939	4,168	3,229
The Research School of Social Sciences Reserve ..	..	..	..	5,000	5,000
The Research School of Pacific Studies Reserve ..	..	602	Cr. 602	5,000	4,398
The University Art Reserve ..	200	..	200	400	600
The University Film Reserve ..	2,500	313	2,187	1,013	3,200
The University Publications Reserve ..	6,000	1,447	4,553	7,939	12,492
Mount Stromlo Observatory Reserve for Accumulated Fur- lough ..	..	..	..	7,500	7,500
Rockefeller Foundation Grant for Visiting Fellows ..	1,112	1,112	..	..	..
Rockefeller Foundation Grant for Research in Microbiology ..	1,847	1,847	..	..	..
National Health and Medical Research Council Grants ..	2,970	2,970	..	..	..
Wool Research Committee Grant for Sheep and Wool Re- search ..	2,759	2,759	..	..	..
Wool Research Committee Grant for Department of Physio- logy ..	3,875	5,100	Cr. 1,225	1,225	..
C.S.I.R.O. Grant for Biological Inorganic Chemistry ..	3,223	3,223	..	..	..
C.S.I.R.O. Grant for Physical Biochemistry (Dairy Research) ..	..	1,069	Cr. 1,069	..	Dr. 1,069
Rural Credits Development Fund Grant for Tropical Sheep Research ..	2,980	3,336	Cr. 356	2,830	2,474
National Institute of Health Grant for Department of Micro- biology ..	221	221	..	..	..
Special Travel Fund for Department of Physiology ..	357	105	252	..	252
Commonwealth Government Grant for Accelerator Project ..	3,750	6,258	Cr. 2,508	2,508	..
U.S.A. Office of Naval Research Grant for Department of Astronomy ..	834	..	834	Dr. 834	..
Metropolitan Water Board and Snowy Mountains Hydro- Electric Authority Grant for Geophysics ..	2,000	1,487	513	475	988
Nuffield Foundation Grant for Research in Demography ..	..	598	Cr. 598	936	338
Department of Immigration Grant for Research in British Migration ..	730	6,407	Cr. 5,677	5,446	Dr. 231
Grant in Aid—W. M. Hughes Biography ..	..	..	..	1,934	1,934
Social Science Research Council Grant for Research in Economics ..	..	207	Cr. 207	207	..
Australian Banks Grant for Visiting Professor in Economics ..	..	1,574	Cr. 1,574	2,855	1,281
Goldsbrough Mort Grant for History of Wool Industry ..	250	..	250	..	250
Donation for Visitor in Law ..	100	100	..	..	..
Special Travel Fund for Research School of Social Sciences ..	1,774	..	1,774	..	1,774
Grant for Expenses—Australian Dictionary of Biography ..	1,500	..	1,500	..	1,500
Department of National Development Grant—Geography ..	..	..	..	50	50
Lady Isaacs Grant for Books—Anthropology ..	..	4	Cr. 4	4	..
Grant for New Guinea Research Unit ..	..	..	..	7,000	7,000
E. M. Symon Bequest—Department of Anthropology ..	..	..	..	752	752
Donation for Journal of Pacific History ..	..	..	..	268	268
Hunter Douglas Fund Grant for New Guinea Research ..	1,500	..	1,500	..	1,500
Grant for National Income Research Project ..	200	..	200	..	200
British Solomon Island Protectorate Grant for Census Analy- sis ..	300	..	300	..	300
General Motors Holden Ltd., Grant for Scholarships ..	6,000	6,924	Cr. 924	1,970	1,046
Australian Atomic Energy Commission Grant for Scholar- ships ..	..	265	Cr. 265	265	..
Australian Institute of Nuclear Science and Engineering Scholarship Grant ..	1,552	1,432	120	..	120
Commonwealth Post Graduate Scholarships Grant ..	9,050	9,050	..	..	..
Fund for Publication—Companion and Lucanian Pottery ..	579	63	516	542	1,058
Grant for Students' Association Lectures ..	50	37	13	..	13
Gifts for McDonald Collection ..	734	..	734	..	734
Gifts for Lady Hancock Memorial ..	351	..	351	..	351
	59,298	59,449	Cr. 151	61,293	61,142
Commonwealth Trading Bank of Australia—General Account ..	..	..	..	..	61,142

## THE AUSTRALIAN NATIONAL UNIVERSITY.

(Other than the School of General Studies.)

## STATEMENT OF TRUST AND AGENCY FUNDS FOR THE YEAR ENDED 31ST DECEMBER, 1960.

	Income Received.			Disbursements.	Transferred to Reserve.	Fund Balance 1st January, 1960.	Fund Balance 31st December, 1960.
	Subsidies, Donations and Subscriptions.	Interest and Capital Appreciation.	Total.				
	£	£	£	£	£	£	£
<b>University Funds—</b>							
Commonwealth Superannuation and Provident Account Fund .. .. .	78,010	16,006	94,016	1,949	92,067	270,442	362,509
The Australian National University Supplementary Superannuation Benefits Fund .. .. .	5,223	1,305	6,528	..	6,528	23,492	30,020
The Australian National University Superannuation Scheme—Members' Accumulations .. .. .	3,772	865	4,637	..	4,637	14,323	18,960
<b>Trust Funds—</b>							
The Lord Rutherford Memorial Trust Fund .. .. .	..	355	355	235	120	6,831	6,951
Morrison Oration Trust Fund .. .. .	..	32	32	31	1	598	599
Sir Littleton Groom Memorial Scholarship Trust Fund .. .. .	..	39	39	..	39	847	886
Norwegian—Australian Cultural Trust Fund .. .. .	..	118	118	100	18	2,274	2,292
Danish—Australian Cultural Trust Fund .. .. .	..	117	117	100	17	2,267	2,284
Swedish—Australian Cultural Trust Fund .. .. .	..	82	82	75	7	1,642	1,649
<b>Agency Funds—</b>							
The Saionji Memorial Scholarship Fund .. .. .	200	2	202	123	79	49	128
Mount Stromlo Observatory Fund .. .. .	..	351	351	..	351	8,225	8,576
The Vice-Chancellor's Discretionary Fund .. .. .	2,415	177	2,592	200	2,392	4,600	6,992
The Research School of Physical Sciences Faculty Fund .. .. .	55	6	61	72	Cr. 11	201	190
The Department of Biochemistry Fund .. .. .	..	..	..	..	..	16	16
The Research School of Social Sciences Faculty Fund .. .. .	..	..	..	..	..	11	11
The Research School of Pacific Studies Faculty Fund .. .. .	..	1	1	..	1	28	29
The John Curtin School of Medical Research Contingencies Fund .. .. .	..	115	115	..	115	6,429	6,544
	89,675	19,571	109,246	2,885	106,361	342,275	448,636

Investments—	Face Value.	Purchase Price Appreciated to Date.	
	£	£	£
Commonwealth Superannuation and Provident Account Fund .. .. .	363,540	..	355,184
The Australian National University Supplementary Superannuation Benefits Fund .. .. .	30,310	..	29,919
The Australian National University Superannuation Scheme—Members' Accumulations .. .. .	19,490	..	18,661
The Lord Rutherford Memorial Trust Fund .. .. .	7,230	..	6,854
Morrison Oration Trust Fund .. .. .	580	..	580
Sir Littleton Groom Memorial Scholarship Trust Fund .. .. .	910	..	882
Norwegian—Australian Cultural Trust Fund .. .. .	2,275	..	2,225
Danish—Australian Cultural Trust Fund .. .. .	2,250	..	2,206
Swedish—Australian Cultural Trust Fund .. .. .	1,625	..	1,596
Mount Stromlo Observatory Fund .. .. .	8,200	..	8,086
The Vice-Chancellor's Discretionary Fund .. .. .	2,100	..	2,009
	438,510		428,202
The Vice-Chancellor's Discretionary Fund—Loans .. .. .	..	..	5,157
Cash at Bank—Commonwealth Savings Bank of Australia—Account No. S.979 .. .. .	..	..	15,277
			448,636



## THE AUSTRALIAN NATIONAL UNIVERSITY.

## SCHOOL OF GENERAL STUDIES.

STATEMENT OF RECEIPTS AND PAYMENTS FOR THE PERIOD 30TH SEPTEMBER, 1960 TO 31ST DECEMBER, 1960.

	Receipts.			Payments.		
	£	s.	d.	£	s.	d.
Cash at Bank 30th September, 1960—						
General Funds .. .. .	33,360	3	3	..	..	..
Canberra Scholarship Funds .. .. .	5,274	1	0	..	..	..
G.M.H. Scholarship Funds .. .. .	723	14	2	..	..	..
Commonwealth Post-Graduate Scholarship Funds .. .. .	130	12	9	..	..	..
Social Service Research Council of Australia Funds .. .. .	561	19	8	..	..	..
Shell Co. Grant Funds .. .. .	85	8	4	..	..	..
N.C.D.C. Lake Biology Research Funds .. .. .	67	6	11	..	..	..
I.C.I. Chemistry Library Grant Funds .. .. .	100	0	0	..	..	..
Ampol Grant Funds .. .. .	196	13	2	..	..	..
Commonwealth Bank Research Funds .. .. .	1,350	2	10	..	..	..
Department of Botany Special Purposes Fund .. .. .	123	8	8	..	..	..
				41,973	10	9
Cash in Hand, 30th September, 1960	..	..	..	72	10	0
Government Grants—						
Prime Minister's Department—						
General Activities .. .. .	136,000	0	0	..	..	..
Commonwealth Post-Graduate Scholarships .. .. .	1,050	0	0	..	..	..
				137,050	0	0
Other Grants—						
A.P.M. Forests Pty. Ltd.—						
Botany Department Special Purposes Fund .. .. .	..	72	10	0	..	..
National Capital Development Commission—						
Grant for Furniture for New Buildings .. .. .	..	4,629	13	8	..	..
				4,702	3	8
Students' Fees—						
Lecture Fees .. .. .	..	Dr. 47	9	6	..	..
Matriculation Fees .. .. .	..	21	3	6	..	..
Other Fees .. .. .	..	20	10	0	..	..
Adult Education Courses .. .. .	..	4	10	0	..	..
Students' Association Fees .. .. .	..	2	0	0	..	..
				14	0	82
						0
Other Income—						
Bank Interest .. .. .	..	85	6	4	..	..
Sundry Income .. .. .	..	306	10	5	..	..
				391	16	9
Administration and Overhead Expenses—						
Salaries .. .. .	..	..	..	9,200	17	1
Superannuation Contributions .. .. .	..	..	..	1,245	8	6
Pay Roll Tax and Workers' Com- pensation .. .. .	..	..	..	276	1	8
Printing and Stationery .. .. .	..	..	..	2,049	9	2
Postages .. .. .	..	..	..	309	4	5
Telephones and Telegrams .. .. .	..	..	..	410	0	7
Advertising .. .. .	..	..	..	732	8	0
Travelling Expenses .. .. .	..	..	..	25	0	4
Furniture and Equipment .. .. .	..	..	..	Cr. 162	15	0
Sundry Expenses .. .. .	..	..	..	17	12	8
						14,103
						7
						5

## THE AUSTRALIAN NATIONAL UNIVERSITY.

SCHOOL OF GENERAL STUDIES—*continued.*STATEMENT OF RECEIPTS AND PAYMENTS FOR THE PERIOD 30TH SEPTEMBER, 1960 TO  
31ST DECEMBER, 1960—*continued.*

	Receipts.						Payments.					
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Teaching and Research Expenses—												
Salaries, Teaching (Full-time) ..	..	..	..	..	..	..	59,694	3	9			
Salaries, Teaching (Part-time) ..	..	..	..	..	..	..	1,849	10	2			
Salaries, Clerical and Typing ..	..	..	..	..	..	..	5,164	0	8			
Salaries, Technical and Laboratory ..	..	..	..	..	..	..	3,072	3	0			
Superannuation Contributions ..	..	..	..	..	..	..	23,810	13	10			
Pay Roll Tax and Workers' Com- pensation ..	..	..	..	..	..	..	2,005	0	10			
Travelling Expenses ..	..	..	..	..	..	..	644	11	0			
Living Expenses ..	..	..	..	..	..	..	943	0	6			
Research Expenses ..	..	..	..	..	..	..	1,164	12	3			
Appointment Expenses ..	..	..	..	..	..	..	678	18	9			
Financial Assistance Study Leave ..	..	..	..	..	..	..	650	0	0			
Apparatus (Teaching) ..	..	..	..	..	..	..	3,135	16	10			
Expendable Laboratory Materials ..	..	..	..	..	..	..	3,093	7	9			
Expenses of Visiting Lecturers ..	..	..	..	..	..	..	212	0	6			
Field Expenses ..	..	..	..	..	..	..	167	7	1			
Office Furniture and Equipment ..	..	..	..	..	..	..	189	8	8			
Sundry Expenses ..	..	..	..	..	..	..	344	19	4			
										106,819	14	11
Library Expenses—												
Salaries ..	..	..	..	..	..	..	6,541	17	5			
Pay Roll Tax and Workers' Com- pensation ..	..	..	..	..	..	..	158	14	2			
Superannuation Contributions ..	..	..	..	..	..	..	709	18	4			
Books, Periodicals and Binding ..	..	..	..	..	..	..	2,770	12	1			
Furniture and Equipment ..	..	..	..	..	..	..	4	2	0			
Sundry Expenses ..	..	..	..	..	..	..	92	17	0			
										10,278	1	0
Buildings, Services and Grounds—												
Maintenance of Buildings and Grounds ..	..	..	..	..	..	..	527	19	3			
Maintenance of Furniture and Equipment ..	..	..	..	..	..	..	215	0	2			
Power and Heating ..	..	..	..	..	..	..	3,041	0	8			
Cleaning of Premises ..	..	..	..	..	..	..	2,166	1	2			
Minor alterations and Additions ..	..	..	..	..	..	..	373	3	8			
Sundry Expenses ..	..	..	..	..	..	..	64	6	1			
										6,387	11	0
Pensions ..	..	..	..	..	..	..				357	14	7
Melbourne University Fees ..	..	..	..	..	..	..				17	12	6
Scholarships—												
Canberra ..	..	..	..	..	..	..	854	13	4			
General-Motors Holdens ..	..	..	..	..	..	..	569	13	2			
Oriental Studies ..	..	..	..	..	..	..	975	0	0			
Commonwealth Post-Graduate ..	..	..	..	..	..	..	557	12	4			
										2,956	18	10
Adult Education and Extension												
Courses Expenses—												
Salaries—Teaching (Full-time) ..	..	..	..	..	..	..	585	1	1			
Salaries—Teaching (Part-time) ..	..	..	..	..	..	..	403	0	0			
Salaries—Clerical and Typing ..	..	..	..	..	..	..	217	2	4			
Pay Roll Tax and Workers' Com- pensation ..	..	..	..	..	..	..	23	7	4			
Superannuation Contributions ..	..	..	..	..	..	..	126	11	1			
Advertising ..	..	..	..	..	..	..	2	0	0			
Car Running ..	..	..	..	..	..	..	35	5	10			
Travel Expenses ..	..	..	..	..	..	..	0	11	6			
Books and Periodicals ..	..	..	..	..	..	..	8	0	6			
Other Expenses ..	..	..	..	..	..	..	17	17	8			
										1,418	17	4

## THE AUSTRALIAN NATIONAL UNIVERSITY.

SCHOOL OF GENERAL STUDIES—*continued.*STATEMENT OF RECEIPTS AND PAYMENTS FOR THE PERIOD 30TH SEPTEMBER, 1960 TO  
31ST DECEMBER, 1960—*continued.*

	Receipts.						Payments.					
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
General College Services—												
Salaries and Wages .. ..	..			..			1,215	5	11			
Pay Roll Tax and Workers' Com- pensation .. .. .	..			..			177	17	2			
Superannuation Contributions .. ..	..			..			379	8	10			
Subscriptions .. .. .	..			..			15	10	0			
Furniture and Equipment .. .. .	..			..			170	10	8			
Other Expenses .. .. .	..			..			844	16	8			
										2,803	9	3
Hall of Residence—												
Sundry Expenses .. .. .	..			..			..			8	18	0
Capital Expenditure—												
Equipment for new Physics Building	..			..			774	5	0			
Telephone Installations — New Buildings .. .. .	..			..			92	4	3			
Alterations to Science Buildings ..	..			..			397	0	0			
										1,263	9	3
Special Purposes Funds—												
N.C.D.C. Lake Biology Research Project .. .. .	..			..			110	18	1			
N.C.D.C. Furniture for New Buildings .. .. .	..			..			12,243	0	1			
Sundry Trust Funds .. .. .	..			..		63	10	0	48	13	10	
										12,402	12	0
Cash at Bank, 31st December, 1960—												
General Funds .. .. .	..			..			31,337	8	10			
Capital Funds .. .. .	..			..			Cr.1,263	9	3			
General Motors Holdens Funds ..	..			..			154	1	0			
Commonwealth Post-Graduate Scholarship Funds .. .. .	..			..			623	0	5			
Ampol Grant Funds .. .. .	..			..			182	5	5			
Commonwealth Bank Funds .. .. .	..			..			1,023	0	7			
Social Sciences Research Council Funds .. .. .	..			..			522	19	8			
Shell Company Grant Funds .. .. .	..			..			77	7	10			
N.C.D.C. Lake Biology Research Funds .. .. .	..			..			Cr. 43	11	2			
I.C.I. Chemistry Library Grant Funds .. .. .	..			..			100	0	0			
Department of Botany Special Purposes Fund .. .. .	..			..			195	18	8			
N.C.D.C. Furniture Account Funds	..			..			Cr.7,610	0	5			
										25,299	1	7
Cash in Hand, 31st December, 1960 (Petty Cash Imprests) .. .. .	..			..			..			72	10	0
TOTALS .. .. .	..			..		184,271	17	8	..	184,271	17	8

L. G. H. HUXLEY,  
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*Acting Registrar,*  
*School of General Studies.*

## THE AUSTRALIAN NATIONAL UNIVERSITY.

## SCHOOL OF GENERAL STUDIES.

STATEMENT OF RECEIPTS AND PAYMENTS ON ACCOUNT OF SPECIAL FUNDS FOR THE PERIOD 30TH SEPTEMBER, 1960—  
31ST DECEMBER, 1960.

Name of Fund.	Balance as at 30th September, 1960.	Receipts.			Payments.		Balance as at 31st December, 1960.
		Interest On Investments.	Bank Interest.	Total.	Cost of Prizes.	Total.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
John Deans Prize .. .. .	7 16 0	5 0	..	5 0	..	..	8 1 0
University Trust Fund .. .. .	13 10 2	..	..	..	..	..	13 10 2
Lady Isaacs Prize .. .. .	5 7 7	9 6	..	9 6	..	..	5 17 1
Robert Ewing Prize .. .. .	17 5 9	4 13 0	..	4 13 0	..	..	21 18 9
Andrew Watson Prize .. .. .	2 5 5	1 5 0	..	1 5 0	..	..	3 10 5
Sir George Knowles Memorial Prize	15 2 6	5 0	..	5 0	3 3 0	3 3 0	12 4 6
Alliance Francaise Prize .. .. .	1 6 9	..	..	..	..	..	1 6 9
W. J. Lind Prize .. .. .	2 10 8	1 2 6	..	1 2 6	..	..	3 13 2
Australian Society of Accountants Lecture Fund .. .. .	11 3 1	..	..	..	..	..	11 3 1
Tillyard Prize .. .. .	8 1 6	5 5 0	..	5 5 0	..	..	13 6 6
J. B. Chifley Memorial Prize .. .. .	9 11 5	6 11 3	..	6 11 3	..	..	16 2 8
Totals .. .. .	94 0 10	19 16 3	..	19 16 3	3 3 0	3 3 0	110 14 1

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## THE AUSTRALIAN NATIONAL UNIVERSITY.

## SCHOOL OF GENERAL STUDIES.

## INVESTMENT ACCOUNT BALANCES AND LIST OF INVESTMENTS AS AT 31ST DECEMBER, 1960.

Investment Account Balances.				List of Investments.				
				Commonwealth Treasury Bonds.		Face Value.	Cost.	
				Rate.	Date of Maturity.			
	£	s.	d.	%		£	s.	d.
Superannuation and Provident Fund Reserve ..	7,097	0	0	3½	15.10.63	2,950	0	0
				3½	15. 8.64	1,850	0	0
				3½	15.11.65	1,010	0	0
				3½	15.11.65	300	0	0
				3½	15.12.65	1,000	0	0
John Deans Prize Fund .. .. .	70	0	0*	5	15. 9.74	100	0	0
	10	0	0	5	15.12.79	10	0	0
University Trust Fund .. .. .	18	0	0	..	..	..	..	..
Lady Isaacs Prize Fund .. .. .	124	0	0	4½	15.11.68	10	0	0
				3½	15. 8.64	100	0	0
				5	15.12.79	10	0	0
Robert Ewing Prize Fund .. .. .	216	7	0	4½	15.11.65	140	0	0
				4½	15.11.65	30	0	0
				5	15.10.82	20	0	0
				5	15.12.79	20	0	0
Andrew Watson Prize Fund .. .. .	50	0	0	5	15.12.79	50	0	0
Sir George Knowles Memorial Prize Fund ..	210	0	0	3½	15. 8.64	200	0	0
				5	15.12.79	10	0	0
W. J. Lind Prize Fund .. .. .	50	0	0	4½	15.10.67	50	0	0
Alliance Francaise Prize Fund .. .. .	100	0	0	5	15.10.82	100	0	0
Tillyard Prize Fund .. .. .	209	10	6	5	15. 4.63	150	0	0
				5	15. 4.63	40	0	0
				5	15.12.79	20	0	0
J. B. Chifley Memorial Prize Fund .. .. .	350	0	0	3½	15.12.65	350	0	0
<b>TOTAL</b> .. .. .	<b>8,504</b>	<b>17</b>	<b>6</b>			<b>8,520</b>	<b>0</b>	<b>0</b>

\* The remainder of this Bond is an investment of—

University Trust Fund .. .. .	..	..	..	..	..	18	0	0
Lady Isaacs Prize Fund .. .. .	..	..	..	..	..	4	0	0
Robert Ewing Prize Fund .. .. .	..	..	..	..	..	8	0	0
						<u>30</u>	<u>0</u>	<u>0</u>

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