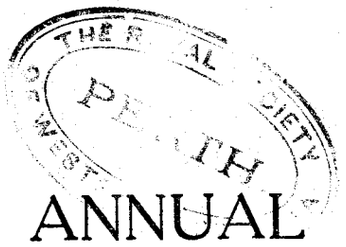
1929.

COMMONWEALTH OF AUSTRALIA.



THIRD ANNUAL REPORT

OF

THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

FOR THE

Year ended 30th June, 1929.

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COMMONWEALTH OF AUSTRALIA.

Council for Scientific and Industrial Research.

THIRD ANNUAL REPORT FOR YEAR ENDED 30th JUNE, 1929.

I.—GENERAL.

1. *Introduction.*—The First Annual Report of the Council (1926–27) dealt mainly with the steps taken for the reorganization of the former Institute of Science and Industry, consequent on the passing of the *Science and Industry Research Act* 1926, and with the policy which the Council decided to adopt for the development of the work and for concentration on certain special fields of activity. The Second Annual Report (1927–28) furnished an account of the progress that had been made in the various activities of the Council and in the planning and organization of research work and the collection of the necessary personnel and apparatus. During the second year, some progress in actual investigational work was recorded and important results of no little economic value were obtained, but—as was only to have been expected—these results were confined to mainly investigations which had been in progress over period of years and which had been initiated by the former Institute of Science and Industry. The third year (1928–29) has seen further substantial progress in the organization and work of the Council, which has now created, at any rate in regard to the certain of the major branches of its activities, a strong and effective organization capable of dealing efficiently with many of our pressing national scientific research problems. It is also satisfactory to be able to report that already beneficial results in the direction of increased production and the elimination of waste are being achieved in various directions as a result of the researches which the Council itself initiated.

Another very satisfactory and marked development during the year now under review, is the increased interest which has been evinced in the work of the Council. Evidence of this has been forthcoming in various ways and particularly from the closer relations which are being established with associations of persons engaged in pastoral and agricultural pursuits, with other institutions and Government Departments, both Commonwealth and State, and from the offers which have been received to co-operate with the Council and to provide funds for the erection of laboratories for the Council. In this connexion, special mention should be made firstly, of the generous gift of £10,000 made to the University of Adelaide by Mr. Harold Darling, on behalf of the Darling family, for the purpose of erecting a Soils Laboratory at the Waite Agricultural Research Institute in order to enable the Council to extend and develop its soils investigations with headquarters at that place, and secondly, of the munificent gift of Mr. F. D. McMaster of a sum of £20,000 for the erection of an Animal Health Laboratory to be staffed and maintained by the Council.

The Council is in touch with certain other individuals and authorities who are favorably disposed to contributing towards the Council's investigations, either by grants of money or by the provision of buildings, and it is possible that further material assistance in this direction will be forthcoming at an early date. There is thus strong evidence of the appreciation by the persons directly concerned of the value of the Council's work and of the important part which scientific research should play in the development and more efficient utilization of our natural resources.

2. *Organization of Work of Council and Formation of Divisions.*—In regard to the major sections of work on which the Council is concentrating, it has adopted the policy of establishing "Divisions", each under the control of an eminent authority in the sciences concerned, to direct the work in the capacity of Chief of the Division. In some fields of work this policy has led to delay, for the services of highly qualified officers of the calibre required for Chiefs of Divisions are not always readily available. Despite such delays, however, it is considered to be better to refuse to develop or even initiate the investigations than to run risks of building up the work on foundations which may be insecure. An analogous policy has been adopted in the case of minor and more or less independent investigations.

Up to the present, four Divisions have been formed, viz. :—

The Division of Animal Nutrition—Professor T. Brailsford Robertson, Ph.D., D.Sc. (Chief).

The Division of Economic Entomology—Dr. R. J. Tillyard, F.R.S., D.Sc., &c., (Chief).

The Division of Economic Botany—Dr. B. T. Dickson, Ph.D., &c. (Chief).

The Division of Forest Products—Mr. I. H. Boas, M.Sc. (Chief).

The Council hoped that during the year 1928–29, it would have been able to establish a fifth Division, viz., that of Animal Health under the charge of Sir Arnold Theiler, who visited Australia in 1928. Unfortunately, he was unable to accept the offer made to him to undertake the organization of the Division and the Council has accordingly been obliged to make other arrangements. During the year 1928–29, initial steps were taken for the establishment of a Division of Soils Research.

In this report, general information is furnished regarding the various investigations in progress and the results obtained. Details of the scientific work are not discussed, since information of that nature is furnished in the various publications of the Council, namely, its Bulletins, Pamphlets, and quarterly Journal.

3. *Shortage of Trained Investigators.*—The admitted shortage of scientific personnel adequately trained in the directions necessary for the study of Australian problems is another factor militating against rapid progress. The problems of Australia most likely to be solved by the application of scientific methods belong mainly to the agricultural and pastoral industries. The sciences involved are those of entomology, applied botany, pathology and physiology (animal and plant), bacteriology, &c. Even so short a period as a decade ago, the demand for research workers trained in such sciences was slight, and the inducement to the individual to take up such work was small as compared with that offering in engineering, chemistry, &c., upon which secondary industries so largely depend. The effect of the world-wide movement for the greater application of science to all industry, whether primary or secondary, that has taken place since the termination of the world war, has therefore been particularly noticeable in the consequent acute shortage of research workers trained in those sciences that may be broadly classified as biological. This shortage will quite probably be made up in the not distant future, but at the present time it is most certainly a severe handicap to progress.

4. *The Council.*—Since the previous report was made, two meetings of the full Council have been held, one in December, 1928, and the other in March, 1929. Unless special circumstances arise, two meetings will be held each year, of which the first will be sufficiently early to allow of consideration of draft estimates of expenditure for the following financial year. The Council meetings that have been held to date have each extended over three days. The present constitution of the Council is given elsewhere in this report. (*see* Appendix).

5. *Executive Committee.*—Under the Act constituting the Council, in between full meetings of the latter, all its powers and functions are vested in the Executive Committee. During the period under review, 31 meetings of the Executive Committee, allowing one meeting per day, have been held. The 126th meeting of the Committee was held on 13th June, 1929.

6. *State Committees.*—The various State Committees of the Council, whose main functions are to advise regarding the general business of the Council, and regarding any particular matter of investigation and research, have now been in existence for a sufficient time to give indications of the way in which they may most usefully develop. The constitution of the Committees provides for representatives of the scientific sections of State Departments and of different branches of science and industry. Provision for the co-option of additional members enables each Committee to be so constituted that all the major industrial and scientific activities in each individual State may be given a voice on the local body.

In practice, it has proved that the State Committees have provided the Council with a facile and rapid means of obtaining complete information on different aspects of particular problems. They have also ensured that any important information obtained from State sources is a well-balanced statement of the position, viewed from all aspects. The State Committees, especially those far distant from headquarters of the Council, have also served on occasions to draw attention to problems previously little known or whose importance and potentialities had not been fully realized.

They have also proved most helpful instrumentalities in connexion with the introduction of eminent visitors to individuals and organizations interested in the objects with which the visitors are concerned. The Council itself has been responsible for several visits of eminent authorities, who have been invited to Australia in order to advise on various activities or on the most suitable lines of future work.

7. *Co-operation with State Organizations.*— One of the duties of the Council is to co-operate with State organizations with a view to the utilization of facilities and staffs available in the States, and the prevention of unnecessary overlapping. Further attention to the matter has been given during the period under review. The more important investigations in which this co-operation has been established are stated below. Further details are given in the sections relating to each particular research. In addition to this co-operation in major investigations, mutual help has been given on numerous occasions in connexion with many minor matters.

(i) *Co-operation with State Departments.*—In Western Australia, co-operation has been continued with the State Department of Agriculture in investigations concerning bitter pit in apples, Kimberley horse disease and a braxy-like disease in sheep, and with the State Department of Forests in work on tannin extracts. The authorities of the Pathological Laboratory of the Adelaide Hospital are affording valuable facilities in connexion with work on haematuria in cattle and on caseous lymphadenitis in sheep. In Victoria, the State Department of Agriculture and the Department of Railways are co-operating in investigations on the storage, preservation and transport of citrus fruit. The former is also helping in the work on the freezing of meat. The State Rivers and Water Supply Commission has made valuable facilities available from time to time in connexion with the Research Station at Merbein. In New South Wales, co-operation has been continued with the Department of Agriculture in investigations on poison plants, on the blowfly problem, on the flying fox problem, and on paralysis in pigs. The Water Conservation and Irrigation Commission is closely associated with the work on the production of citrus fruit being carried out at the Council's Research Station, Griffith. In Queensland, the Department of Agriculture is co-operating in the work on the flying fox problem, in cattle tick dips investigations and, through the Committee of Direction of Fruit Marketing, in the investigations on the storage, maturation and transport of bananas. The co-operative work of the Commonwealth Prickly Pear Board is mentioned in greater detail later. The Mines Departments in all the States are co-operating with the Council in the work of the Imperial Geophysical Experimental Survey.

(ii) *Co-operation with Universities.*—In Western Australia, the University has afforded valuable co-operation in the work on tannin extracts. The University of Adelaide is associated with the Council in several important investigations. It has made available the land on which the Laboratory of the Division of Animal Nutrition has been erected. Very close links have been made with the Waite Agricultural Research Institute of the University. In co-operation with the Council and the Empire Marketing Board, the Waite Institute is carrying out extensive investigations of the mineral deficiencies of animal pastures. The Institute is the centre of the soils work of the Council and co-operative investigations on virus and soil-borne fungous diseases of plants, notably tomato wilt, are also being carried out there. The University has passed over to the Council its work on the regeneration, in eaten-out pastoral areas, of native vegetation, and is continuing to afford facilities for the investigation. In Victoria the University of Melbourne is co-operating with the Council in the investigations of pleuro-pneumonia in cattle, tuberculosis in cattle, braxy disease in sheep, on the transport, maturation and storage of bananas, and on the freezing of beef. It is also one of the active parties in the operations of the Radio Research Board and the Imperial Geophysical Experimental Survey. The University of Sydney is co-operating with the Council in the investigation of poison plants, of parasitological pests of sheep and stock, braxy disease and caseous lymphadenitis in sheep, and in the activities of the Radio Research Board and the Geophysical Survey. The University of Queensland has joined with the Council in the investigations on the study of storage, maturation and transport of bananas.

8. *Co-operation with Commonwealth Bodies.*—Very close relations have been established with all the scientific organizations of the Commonwealth. The Department of Defence and the Postmaster-General's Department are intimately associated with the Radio Research Board, and the former also with the Committee on the Maintainance of Standards. An agreement has been reached with the Inspector-General of Forests and the authorities of the proposed Federal Forestry Bureau whereby the Council will undertake researches connected with the utilization of forest products, and the Bureau will assume responsibility for researches in problems relating to the growing tree. Both bodies will co-operate in other forestry researches that may prove necessary and that may involve such sciences as entomology, plant pathology, &c., a staff experienced in which the Council has already obtained for other purposes. In paragraph 10 of this part of the report, reference is made to the close connexion which has been established between the Development and Migration Commission and the Council. In particular, the two bodies are associated in the work of the Imperial Geophysical Experimental Survey and the Australian Tobacco Investigation.

9. *Imperial Co-operation in Research Work.*—An important function of the Council is that of acting as a means of liaison between the Commonwealth and other countries in matters of scientific research. Co-operative arrangements have been completed with several institutions

in Great Britain and satisfactory relations, particularly for the interchange of information and publications, have been established with a large number of scientific bodies throughout the world. The Council attaches great importance to the carrying out of investigations in certain fields of work on an Imperial basis.

In Great Britain, scientific research on national problems falls into two main classes, namely, that connected with the agricultural industry and that connected with the secondary industries. Research work in the former category is subsidized on an extensive scale by the Development Commissioners, the actual work being carried out by independent organizations, such as the Rothamsted Experiment Station for soils work and the growth of plants, the Rowett Research Institute for animal nutrition, the East Malling Research Station for horticulture, &c., each institute specializing in a particular aspect of agricultural problems. With many of these organizations, touch has already been established, and all have been particularly ready to afford the Council their help, both in the direction of furnishing advice on particular problems and in making the results of their own research work freely available. In addition, in several instances, arrangements have been made for the British organization to house an Australian investigator for a period sufficient to enable him to obtain full information as to the methods of research adopted, and experience in details of technique, &c. There is no doubt whatever that this help will be of considerable value to the Australian agricultural and pastoral industries in the future.

The research needs of the secondary industries of Great Britain are largely the concern of the British Department of Scientific and Industrial Research, and, in general, the Department's main activities relate to those industries. Here again, the relations that have been established between the Council and the Department are proving most valuable. The major investigations of the Department of most interest to Australia are those of its National Physical Laboratory and its Boards dealing with researches in fuels, forest products, and the preservation of foods. The Department is carrying out very fundamental work on these matters, the results of which it has freely made available to the Council. It is difficult to assess the great value of the aid so offered. Moreover, it places the Council in the most fortunate position of being able to leave matters covered by the British Department very largely alone and to concentrate its limited energies and funds on the attack of other urgent problems. Were the Council not in that position, there would be a much more pressing need for it to spread its energies over a wider field with a consequent risk of failure owing to lack of concentration. In addition to help in the above major activities, the Department has, on numerous occasions, been of no little service in connexion with the many minor matters that arise from time to time.

The Empire Marketing Board is another body with which most fruitful relations have been established. The constitution and aims of this body were outlined in the first report of the Council. It has been most generous in contributing towards the cost of Australian investigations. Details of the various co-operative arrangements entered into by the Board are mentioned in the appropriate sections that follow.

In addition to the organizations in Great Britain mentioned above, close relations have been established with bodies corresponding to the Council in the other parts of the Empire. In Canada the counterpart of the Australian Council is the Advisory Council of Science and Industry. Parliament has already provided a sum of £150,000 as an initial vote for the erection of National Research Laboratories in Canada, and it is expected that the buildings will be completed before the end of 1930. The Canadian Council is engaged in many investigations of interest to Australia, notably in connexion with forest products and with problems connected with the production of cereals. It also proposes to establish the nucleus of a National Physical Laboratory or Bureau of Standards.

10. *Visit of British Economic Mission.*—The Economic Mission, nominated by the British Government at the request of the Commonwealth Government, visited Australia during parts of 1928 and 1929. The report of the Mission contains several appreciative references to the work of the Council and some of the conclusions and recommendations bear on matters which are of direct interest and importance to the Council. The Mission recommended that closer co-ordination should be effected between the Development and Migration Commission and the Council for Scientific and Industrial Research. The Government has accordingly appointed a Co-ordinating Committee, with the Minister as Chairman, and consisting of representatives of the Commission and the Council, together with a representative of the Department of Markets and Transport. The Committee meets at intervals of approximately one month.

Other matters concerning the Council and dealt with in the report of the British Economic Mission are referred to in appropriate places in later parts of this report.

11. *The Science and Industry Investigation Fund.*—In the previous reports of the Council, mention was made of the creation of this fund. By the Act constituting the Council in 1926, an amount of £250,000 was appropriated from revenue to form the fund. In 1928 an additional amount of £250,000 was appropriated for the same purpose. The total contributions to the fund therefore amount to £500,000. Up to 30th June, 1928, the sum of £106,981 was spent from the fund, the expenditure during the year 1928–29 being £94,345. This gives a total expenditure from the fund of £201,326, leaving a balance on the 30th June, 1929, of £298,674. Particulars of expenditure during 1928–29 on the various investigations, &c., are given in Part XIII. of this Report.

II.—AGRICULTURAL RESEARCH IN GENERAL.

1. *Imperial Agricultural Research Bureaux.*—As a result of recommendations made by the first Imperial Agricultural Research Conference, which met in London in 1927, arrangements have been made for the organization of eight Imperial Agricultural Research Bureaux whose principal function will be to act as effective clearing houses for the interchange of information of value to research workers in agricultural science throughout the various parts of the Empire. An account of the scheme of organization and work of the Bureaux was published in the Council's quarterly *Journal*, Vol. 2, No. 2. Arrangements have been made for the following six Bureaux to be opened on the dates and at the places specified, respectively :—

IMPERIAL AGRICULTURAL RESEARCH BUREAUX.

Date of Opening.	Bureau.	Location.	Director.
1st April, 1929	Animal Nutrition ..	Rowett Research Institute, Aberdeen	Dr. J. B. Orr
	Animal Genetics	Animal Breeding Research Department, Edinburgh University	Professor F. E. Crew
	Fruit Production ..	East Malling Research Station, Kent	Mr. R. G. Hatton
	Soil Science	Rothamsted Experimental Station, Herts	Sir John Russell
1st May, 1929	Plant Genetic (Herbage Plants)	Welsh Plant Breeding Station, Aberystwyth	Professor R. G. Stapledon
1st June, 1929 ..	Agricultural Parasitology	Institute of Agricultural Parasitology, St. Albans	Professor R. T. Leiper

It is expected that the following two Bureaux will be opened during the summer of 1929 :—

Animal Health ..	Veterinary Research Laboratory, Weybridge	Dr. W. H. Andrews.
Plant Genetics (Plants other than Herbage) ..	Plant Breeding Institute, Cambridge	Sir Rowland Biffen.

2. *Imperial Agricultural Research Conference, Australia, 1932.*—In accordance with an invitation given by the Prime Minister of Australia (the Rt. Hon. S. M. Bruce, P.C., M.P., &c.), it has been decided that the next Imperial Agricultural Research Conference shall be held in Australia in 1932. As a result of discussions which the Secretary of the Council (Mr. G. Lightfoot) had during a visit to England in 1928, an outline of the proposed work and organization of the Conference has been prepared and approved by the Council. An organizing Committee consisting of the permanent heads of the six State Departments of Agriculture and the members of the Executive Committee of the Council, with power to add to their number, has been appointed. It is intended also to establish an organizing Sub-Committee in England. It is anticipated that the meeting of the Conference in Australia will be an event of particular importance to agricultural research in the Commonwealth.

3. *Standing Committee on Agriculture.*—The Council's Standing Committee on Agriculture was appointed in 1927 and consists of the permenent heads of the six State Departments of Agriculture and of representatives of the Council. The principal object of creating the Committee was to ensure that there should be intimate collaboration between the Council and the State Departments of Agriculture. It has been found that two meetings of the Committee per annum will probably suffice, one of them being held concurrently with the meeting of the State Ministers of Agriculture, and the other some six months later. The fourth and fifth meetings of the Committee were held at Melbourne in December, 1928, and June, 1929, respectively. The more important matters considered at these meetings were the plans for the development of the work

of the Council's division of Economic Botany; plans for the development of the Council's soils investigations; the work of the Council's Division of Economic Entomology; investigations on problems of animal health; agrostological investigations; dairy research; the work of the Council's Division of Animal Nutrition; tobacco investigations; the Imperial Agricultural Research Conference (Australia) 1932; and seed testing.

At the meeting of the Committee held in June, 1929, attention was directed to the fact that the Council desired to develop the potentialities of the Committee so that it might take its place as an authoritative body to which all proposals affecting the scientific research side of agriculture in the Commonwealth would be naturally and spontaneously referred. Under present conditions, the Committee acts as a body to which the Council submits for discussion its proposals for agricultural research. This arrangement alone is not satisfactory because it is not sufficient to enable all the Commonwealth and State Governmental activities in agricultural research to be brought under review. It was, therefore, suggested to the Committee that it would become a very much more effective body if the heads of the State Agricultural Departments would also bring before it their proposals regarding agricultural research so that they could be discussed with representatives of the Council and with one another at the meetings of the Committee. It was agreed that the closest contact with regard to agricultural research was desirable, and it was decided that suggestions should be formulated which would enable the Standing Committee to fill a dominant place in deciding policies for agricultural research throughout the Commonwealth.

4. *Register of Agricultural Research.*—The compilation of a Register containing details of agricultural research work in progress throughout the Commonwealth was completed in 1928.

Copies of the Register were forwarded to the principal organizations and institutes concerned with agriculture and agricultural research, both in Australia and in other parts of the Empire. In this way the collection of information desired by such bodies has been facilitated, and so far as Australia is concerned, undesirable overlapping will be prevented. In accordance with a recommendation of the Standing Committee on Agriculture, supplementary sheets of the Register bringing it up to date have been compiled and issued in 1929.

III.—PLANT PROBLEMS.

1. *General.*—In 1927 the Council decided to establish a Division of Economic Botany and in February, 1928, Dr. B. T. Dickson, B.A., Ph.D., took charge of the work. Plans for the erection of Laboratories at Canberra were prepared, the estimated cost being £52,000, including the cost of an administrative block, with Museum and Library, which it is proposed to share with the Division of Economic Entomology.* In the meantime, the University of Sydney courteously arranged for accommodation to be provided in the Botany School for Dr. Dickson and certain other officers of the Division of Economic Botany, and whilst the fact that the Division has as yet no properly equipped laboratories of its own has inevitably handicapped the Division in the prosecution of a large part of its programme, satisfactory progress has been made in several branches of the work. The erection of laboratories at Canberra will not, of course, mean that all the investigational work of the Division of Economic Botany will be carried out at that place. On the contrary, much of it will be undertaken in the localities in which the problems exist. Such work will be housed in general in existing laboratories, e.g., those of other organizations co-operating in the investigations, although in some cases it may prove necessary to erect small and temporary sub-stations.

Dr. B. T. Dickson, the Chief of the Division, has prepared for the Council an annual report on the work of his Division, and has included in it a proposed programme of work for the Division showing the various branches of investigation it is proposed to undertake as the Division develops. Dr. Dickson's report, together with similar annual reports of the Chiefs of other Divisions, is being published by the Council as one of its pamphlets. During the financial year 1928–29, work had already been initiated in the sections of Plant Pathology, Plant Breeding, Plant Introduction, Agrostology, Noxious Weed Control and Herbarium, although in most cases under considerable handicaps owing to lack of inadequate laboratory facilities and staff.

In accordance with the announced policy of the Council, the Division will engage in such studies of plant problems as call for fundamental and long-time investigation, and which are of importance to more than one State of the Commonwealth. In several of these problems, the co-operation of the scientists in the State Departments has been sought and secured as in the case of studies in bitter-pit of apples, spotted-wilt of tomatoes, and water blister of pineapples.

* The proposal to erect this laboratory was enquired into by the Parliamentary Committee on Public Works and the approval of Parliament for the scheme was given in September, 1929.

2. *Plant Diseases.*—A matter of prime importance is that of improvement in our present crop plants, and such improvement may be in yield or quality or both. One of the chief factors in reducing yield is disease, and consequently efforts must be made to prevent or minimize loss from that cause. Usually it is only when disease occurs in epidemic severity that definite attention is focussed upon it and estimates of loss are available. Every year in every crop, however, a toll is taken which is generally regarded as reaching about 10 per cent. of the crop. A loss of £50,000 per annum is estimated as a result of bitter-pit in apples and £7,500 per annum by water-blister of pine apples, two diseases which are being investigated. Blue-mould of tobacco is so serious in some years that almost total loss occurs, and that disease, coupled with unattractive aroma, constitute limiting factors in the development of supplies for the Australian market, which is worth £2,000,000 per annum. Rust in wheat gave rise to a loss of £2,000,000 yearly in New South Wales alone. In 1924 at Cowra it was found that Waratah wheat gave 48 bushels per acre when free from "take-all", and only 11 bushels per acre diseased. Bunchy top of bananas and spotted-wilt of tomatoes are limiting factors with those crops.

(i) *Bitter-pit in Apples.*—In the investigations on bitter-pit, which are under the direct control of Mr. W. M. Carne, Senior Plant Pathologist, assisted by Messrs. Pittman and Elliott of the Plant Pathology Branch, Western Australia Department of Agriculture, very important results have been obtained, and at least a definite indication as to the cause of bitter-pit and a practical means of avoiding it have been discovered. The results of the work done during 1928 were published in the Councils' Bulletin No 41, "Bitter-pit of Apples." The investigations were continued during 1929. The results show that bitter-pit is due to apples being picked before they have reached a certain stage of maturity, that a simple iodine test for starch is a guide to maturity, and that bitter-pit may thus be avoided by picking apples after they have arrived at a stage of maturity at which they are no longer susceptible. While there are certain details connected with varietal and seasonal differences yet to be investigated, the general principle holds good for all apples, that later picking is essential for the elimination of bitter-pit and that a shorter picking season is necessary to avoid over-maturity. An immediate and much needed improvement can be effected in exported apples by picking them on a basis of maturity. This complete change in picking methods cannot probably be brought about suddenly, but it is obvious that a reduction in the amount of immaturity, bitter-pit, and breakdown, may be obtained next season by those controlling the industry.

(ii) *Spotted-wilt of Tomatoes.*—These investigations are being carried out at the Waite Agricultural Research Institute under the immediate control of the Institute's Plant Pathologist, Mr. G. Samuel, M.Sc., assisted by an officer of the Council, Mr. J. G. Bald, B.Agr.Sc. It has been ascertained that spotted-wilt is a virus disease and that it is normally spread, at least in South Australia, by a species of thrips, *Frankliniella insularis*. The information already obtained is of much value in planning further experiments on control. Since the thrips, *Frankliniella insularis*, is a widespread inhabitant of both cultivated and wild flowers, the control of spotted-wilt on outdoor tomatoes may prove to be particularly difficult unless a resistant variety can be bred. On the other hand, it should be practicable to develop methods of control for commercial glass-houses. The results of the investigations to date are being published as one of the Coumcil's Bulletins.

(iii) *Tobacco Diseases.*—In January, 1929, arrangements were made with the Australian Tobacco Investigation Committee whereby the investigation of the blue-mould disease of tobacco was undertaken by the Council's Division of Economic Botany. The problem was accordingly assigned to Dr. H. R. Angell, Senior Plant Pathologist of the Division. Blue-mould is one of the principal factors limiting the development of the tobacco-growing industry in Australia. It does not occur in North America, Europe, or most other tobacco-growing countries, but in Australia is most destructive, especially when the plants are in the seedling stage. Under weather conditions favorable to the spread of the causal organism, whole beds of seedlings may be entirely destroyed in a few days.

The investigations were directed towards the discovery of the origin of primary infection, and it has been concluded tentatively that the disease is seed-borne. Should further confirmation of these results be obtained from experiments now in progress, it is obvious that the most important, easiest, and least expensive method of control will be the sowing of seed free from disease. For the present, farmers have been advised as to the methods to be followed so as to minimize the risk of infection. An article on the investigations was published in the Council's quarterly Journal, Vol. 2, No. 3.

Preliminary observations and investigations have also been made on certain other tobacco diseases, notably basal stem-rot and two virus diseases, mosaic and ring-spot.

(iv) *Pineapple Diseases.*—At the request of the Queensland Government, the Chief of the Division of Economic Botany (Dr. B. T. Dickson) undertook investigations in January, 1929, on water-blister of pineapples, which was ascertained to be a soft-rot due to *Thielaviopsis paradoxa.* After a series of spore germination and other tests, it was found that while treatment with formalin was effective in controlling the rot, it could not be used as a practical method of control since it discoloured the tissues of the fruits to a depth of half an inch below the surface. Other disinfectants have been tried, but so far without successful results. Owing to the shortness of the season—end of February to middle of April—available for experimental consignments, there was little opportunity for adequate convenient tests of methods of control. The experimental consignments will be continued next season with the object of finalizing control measures. In the meantime it has been shown that care in cutting, handling, and packing materially reduces the loss from water-blister.

3. *Plant Breeding.*—Yield may also be improved by the breeding of higher yielding types. Farrar's development of Federation and other wheats in Australia, and Saunders' work on Marquis wheat in Canada illustrate this, the former being worth many hundred thousand pounds to wheat growers in Australia. Another phase of possible improvement in yield is that involved in nutrition. Much is yet to be done with respect to deficiencies in nutrition and the role of infinitesimals or minimals.

An area of approximately three acres (at Canberra) has been fenced in, partly cultivated, and water laid on. Some 300 varieties or strains of wheat, 30 of barleys and 20 of oats from different sources have been planted, and 200 strains of maize are to be planted as soon as danger of frost is over. This small area is merely sufficient to carry over the essential material and it will be necessary to obtain an area of between 50 and 100 acres of suitable land as near as possible to Canberra even to cope with immediate developments in breeding work.

Arrangements have been made to carry on the maize improvement work at Gatton College, Queensland, under the direction of Mr. McMillan, Senior Plant Geneticist. It is planned that studies on disease resistance with this crop will begin in the near future. Plans are under consideration concerning investigations into experimental plot technique under Australian condftions.

4. *Plant Introduction.*—Plans are being developed for initiating work on plant introduction and efforts will be made to find, test, and introduce valuable additions for the benefit of the pastoralist and agriculturist. The introduction into Australia of subterranean clover (*Trifolium subterraneum*), Kikuyu grass (*Pennisetum clandestinum*), and lucerne (*Medicago sativa*), are illustrations of what has been done in the past in this respect. The United States Office of Foreign Seed and Plant Introduction of the Department of Agriculture has tested over 65,000 species and varieties of plants since its inception, and many valuable additions to American agriculture have been selected. Steps have already been taken to secure the co-operation of the United States of America Plant Introduction Service and of the Royal Botanic Gardens, Kew.

5. *Weed Pests.*—Yet another source of loss, either in the crop itself or in the depreciation of agricultural lands, is the presence of weeds. In the former case it calls for the use of clean seed and of proper cultural operations, but in the latter the problem is more difficult. The infestations by prickly pear, Noogoora burr, Bathurst burr, hoary cress, St. John's wort, &c., are cases in point. It is too much to hope for unqualified success in every case, but each pest plant will be investigated and efforts made to ascertain possible control measures. To this end, co-operative measures or co-ordinated studies between the Division of Economic Botany, as that concerned with plants, and the Division of Economic Entomology are projected.

(i) *Prickly Pear Pest.*—During the year 1928–29 the investigations into the biological control of the prickly pear pest were continued by the Commonwealth Prickly Pear Board, towards which the Council for Scientific and Industrial Research is contributing £9,000 per annum and the Governments of New South Wales and Queensland £4,5000 per annum each. An account of the Board's operations was given in the Council's Bulletin No. 34, published in 1927. The Board is publishing a further Bulletin summarizing its work up to date in a more popular form. The scientific work of the Board is under the charge of Mr. Alan P. Dodd.

Several species of insects which attack the pear in different ways have been introduced, acclimatized, and distributed in large numbers. These include *Cactoblastis cactorum*, which belongs to a group of gregarious or social tunnelling caterpillars and from which remarkably destructive results are being obtained; *Chelinidea tabulata*, a plant-sucking bug; the small red spider *Tetranychus opuntiae*; and several species of cochineal (*Dactylopius*). The work of the Board ceases with the establishment of the various introduced insects and with the demonstration that they can be safely and profitably used to destroy the pear. The large-scale distribution of the insects does not, therefore, come within the Board's functions, but is a matter for State

action. The Board has accordingly entered into very close co-operative arrangements with the responsible State authorities, viz., the Queensland Prickly Pear Land Commission and the New South Wales Department of Agriculture and the Prickly Pear Destruction Commission. The Board is also carrying out investigations on the destruction of the pear by fungous and bacterial diseases. Mr. H. K. Lewcock, M.Sc., has made a survey of fungous diseases and bacterial rots attacking the pear in America, and on his return to Queensland in 1929 brought with him a large number of cultures of organisms isolated from diseased prickly pear. These cultures are being maintained by the Council's Division of Economic Botany for the purposes of the comparative study of organisms which occur in Australia. Mr. Lewcock is engaged on a survey of prickly-pear diseases in Australia, and is particularly inquiring into certain diseases which follow the partial destruction of the pear by *Castoblastis cactorum*.

There is no doubt that the introduction of *Cactoblastis* has completely changed the outlook for prickly pear eradication. The Board and its scientific officers, although satisfied with the success of the other established insects, were of the opinion that the control and eradication of the pest would prove a very slow undertaking. However, the advent of *Cactoblastis* and the demonstration of its remarkable destructive powers, have given rise to greater optimism.

It would be dangerous because of present indications, to attempt to prognosticate the end of the prickly pear menace. The effect of the insects is too recent to permit indulgence in prophecies, however pleasing the prospect. Nevertheless, with the wider distribution of the insect agencies, more particularly *Cactoblastis*, and with their ever-increasing numbers, the promise of eventual success is most hopeful. Yearly the density of the pear infestation and the area under its occupation should diminish, and the land be reclaimed for pastoral and agricultural purposes. Indeed, on present promise it is reasonable to expect that the pear will be eradicated from vast areas within the next few years.

(ii) *Noogoora Burr.*—Arrangements were made for an investigation to be undertaken of this pest which is spreading at a somewhat alarming rate, particularly in Queensland. In February, 1929, Dr. Jean White-Haney, an officer of the headquarters staff of the Council, was seconded to the Division of Economic Botany in order to carry out the investigation. A thorough examination is being made of the life-history of the plant, its rate of spread and present distribution, its economic importance and possibilities of control. Arrangements have also been made with Professor G. A. Dean, Manhattan, Kansas, for an investigation to be made of insect enemies which attack species of *Xanthium* (Noogoora burr is probably *Xanthium strumarium*).

(iii) *Control of Bracken.*—Bracken (*Pteridium acquilinum*) is cosmopolitan in distribution and is a pest wherever it occurs. To eradicate it by cutting requires from three to seven years, and consequently, cost is an almost prohibitive factor on large areas. Any means of natural control is, therefore, worth investigating. During the last two or three years, a curious dying back of bracken has been noticed in Ayrshire, Scotland, particularly near Maybole. In the summer of 1928, the same condition was observed on the slopes of the Logan Valley and it was reported from many separated areas distributed practically over the south of Scotland. The evidence is so far circumstantial, but it looks as though a fungus is affecting the bracken and gradually killing it out.

Dr. E. J. Butler, Director of the Imperial Bureau of Mycology, was communicated with and he arranged for cultures to be made available to the Division of Economic Botany. These have been received and are being studied under controlled conditions in the hope that they may be of value where bracken is a pest, as in Victoria and Tasmania. The organism suspected as the cause of the disease is *Rhopographus pteridis*.

6. *Regeneration of Pastures.*—A considerable portion of the pastoral activity of Australia is in regions where the annual average rainfall is less than 10 inches. In many of the dry regions the effect of continued grazing of the natural vegetation is very marked. Many areas have been over-grazed, and little knowledge is available as to the nature of the re-growth of plant life under such conditions. A study of the regeneration of native vegetation in such areas thus becomes of importance. Investigations of this nature have been made in progress at Koonamore (N.E. South Australia) for some time. They were commenced by the University of Adelaide on an area of 1,000 acres of eaten-out salt-bush country, vested in the University as a vegetation reserve for research work. The main objects of the investigations are :—

(*a*) the study of the regeneration of natural vegetation,

(*b*) the study of the effect of grazing of known intensity on the process of regeneration, and

(*c*) the study of the ecology of the area.

The original investigations were carried out under the direction of Professor T. G. B. Osborn, late of the University of Adelaide, but now of the University of Sydney. Subsequent to Professor Osborn's transfer, it was arranged that the investigations at Koonamore would be undertaken by the Council, in co-operation by the University of Adelaide. Funds have been provided by the Council for capital expenditure, and for the salary of a full-time investigator, Mr. T. B. Paltridge, B.Sc., who is located at Koonamore.

As a result of three years' records, a body of data is accumulating on the effect of total protection, checked by the effect of commercial grazing in the surrounding areas. Experiments on artificial regeneration of mulga (*Acacia aneura*) after fire, have given promising results. Experimental sowings of native and introduced fodder plants are being made, but this and other work have been hampered by the drought conditions which have prevailed during the past three years in the north-east of South Australia.

A description of the work at the Koonamore Vegetation Reserve was published in the Council's Journal, Vol 1, No. 6.

7. *Other Investigations.*—Various other investigations received attention by the Division of Economic Botany during the year 1928–29.

(i) *Mould in Sultanas.*—In 1928 heavy losses were threatened to the dried fruits industry in the Nyah district of Victoria owing to an unusual development of moulds, which are present to a limited extent every season when rain falls at the time of ripening of the fruit, but which ordinarily give rise to practically no loss. As a result of examinations of fruit and of inspections of packing plants, followed by experimental work, it was found that a marked improvement could be effected both in the reduction of the proportion of mouldy sultanas and in the general appearance of the fruit.

(ii) *Leaf-spot in Bananas.*—In Queensland in 1928 there was a serious outbreak of leaf-spot disease in bananas, and at the request of the Queensland Government, the Chief of the Division of Economic Botany paid a visit to their southern banana-growing areas in order to advise on the disease. Mr. J. H. Simmonds, of the Queensland Department of Agriculture, is making a careful study of the disease, but until more is known about the causal organism, recommendations are based on hygienic precautions.

(iii) *Plant Disease Survey.*—At a meeting of Plant Pathologists held in Melbourne in 1927, it was decided that a plant disease census should be prepared which should indicate the occurrence, distribution and severity of plant diseases in the respective States.

Reference has been made to this survey in the Council's Journal, Vol. 2, No. 2, page 97. The Plant Disease Survey of the Division of Economic Botany aims at organizing this information on a Commonwealth basis and at maintaining records available to all workers. Mr. C. C. Brittlebank is working up the records from Victoria made available through the courtesy of Dr. S. S. Cameron, Director of Agriculture, Victoria.

(iv) *Poison Plants Committee.*—The Division of Economic Botany is co-operating in the work of the Poison Plants Committee which was established in 1927 as a joint undertaking by the University of Sydney, the New South Wales Department of Agriculture and the Council. It was established by the Council primarily to assist the pastoral and farming industries by co-ordinating and amplifying work already being done, particularly at Glenfield, New South Wales, in the investigation of the known and reputedly poisonous plants which sometimes cause serious losses of stock by poisoning. Feeding tests are carried out at the Glenfield Veterinary Research Station near Sydney, botanical identification at the Botanic Gardens, Sydney, and chemical and physiological tests at the University of Sydney. The Committee has already carried out a number of valuable investigations, the results of which have been disseminated through the State Departments of Agriculture. An account of the Committee's work was published in the Council's Journal, Vol. 2, No. 1.

IV.—IRRIGATION SETTLEMENT PROBLEMS.

In its first annual report, the Council emphasized the importance of carrying out investigations on the many problems which affect fruit-growers in the Murray River settlements, extending from the Murrumbidgee irrigation area in the east to Renmark and other places in the west. The economic importance of the industries concerned and the large sums of money which have been expended in the construction of dams, channels, &c., fully warrant the initiation of extensive research work in order to ensure that cultural and irrigation methods will give the most economic results and that they will cause no permanent damage to the areas, e.g., by "salting." In addition to the investigations which the Council is carrying out on soil problems, referred to in a later part of this report, it is carrying out work on other problems affecting the settlements at its two research stations, one at Merbein in Victoria, the other at Griffith in New South Wales.

1. *Viticultural Problems.*—Work on the production problems of vine fruits has been continued at the Council's research station at Merbein, under the general control of a technical committee consisting of Dr. B. T. Dickson (Chairman), Professor T. G. B. Osborn and Professor J. A. Prescott. The Station is under the immediate direction of Mr. A. V. Lyon, M.Agr.Sc.

During the 1928–29 investigations were carried out on variability of yield in order to determine the number of vines necessary in each experimental plot to give results of statistical reliability; on the relation between the size of the fruiting shoot and the bunch borne; on practices of treating frosted vines; and on vine growth, bud development, rate of growth of berries, and pruning reactions. Investigations have been commenced on root developments in relation to irrigation. A detailed botanical map has been completed in connexion with an ecological survey of about 26 acres of virgin land on which additional field experiments are to be undertaken in order to study the effect of irrigation on salt movement in the soil.

Investigations have also been made on various methods and processes for the prevention of infestation of dried fruits by insect pests, and an article on the efficacy of the ethylene dichloride-carbon tetrachloride fumigation process was published in the Council's Journal, Vol. 2, No. 3. In co-operation with the Division of Economic Entomology, arrangements have been made to carry out tests with various types of insect proof packages and to determine the extent of the occurrence of the principal insect pects at critical periods of the year. Assistance is also being given to the Department of Markets and Transport in the steps which are being taken to improve the conditions of packing houses and to decrease sources of insect infestation.

2. *Sulphuring of Dried Fruits.*—Arrangements have been made for investigations to be carried out, in co-operation with the New South Wales, Victorian and South Australian Departments of Agriculture, on the sulphuring of dried fruits. The British Health Regulations do not permit the importation into Great Britain of dried apricots, peaches, pears, &c., containing more than fourteen grains of sulphur dioxide per lb. It has been found that some samples of such fruit produced in Australia contain more than the prescribed amount of sulphur dioxide. As a result of a conference convened by the Council in June, 1929, arrangements have been made for investigations in the three States concerned to be carried out on a co-ordinated basis. The report of the conference and the decisions reached were published in the Council's Journal, Vol. 2, No. 3.

3. *Citricultural Investigations.*—During the year 1928–29 the work at the Council's Murrumbidgee Irrigation Area Research Station at Griffith, New South Wales, has given a clearer indication of progress towards the successful elucidation of the problems upon which the experiments were designed to concentrate than has been possible during its earlier stages of development. It is gratifying to find that the growers, to whom these problems are of such importance, are showing a great deal of interest in the work at the Station, and that they now more fully realize the necessity for the adoption of scientific methods in the conduct of irrigation horticultural practice. The investigations, which have now been in progress for about five years, are beginning to yield results which prove that they have been planned and carried out in a highly satisfactory way which will be of very material value to the growers. During the year a new laboratory at the Station was completed and has afforded increased facilities permitting of enlargement of the scope of the investigations. In the previous reports of the Council, it has been stated that the investigations are being financed jointly by the Council and the Water Conservation and Irrigation Commission of New South Wales. The latter body is contributing £1,500 per annum towards the expenses of the Station, and is supplying all water free of charge.

The most important questions to be considered in relation to irrigation in agriculture are those concerning (*a*) the method of applying water to the land, and (*b*) the moisture relationships of the soil. The dominating subject of both popular and scientific literature relating to irrigation is the problem of the failures due to "alkali", high-water table and the dying-out of orchards. It is not improbable that in the majority of cases all these troubles are traceable to the methods of application of the water, and so a study of the soil water relationships is a matter of great importance. Investigations are being carried out at the Station to determine:—

(*a*) The effect of different soil treatment on the structure, yielding capacity and other properties of the soil.

(*b*) The most profitable fertilizer treatment for citrus fruit under local conditions.

(*c*) The effect on soil and citrus trees of various methods of green manuring.

An overhead spray irrigation system has been installed at the Station and is being extended. By its use, water can be applied very evenly and in measured quantities, and definite information will thus be obtained as to whether the cost of installing and operating the system is such as to make its use economically practicable. Field experiments are being carried out to determine the best methods of irrigation with reference to frequency of irrigation periods, and quantities of water applied, while complete records regarding percolation and the effect of growing vegetation

on the water-table are being obtained from the system of test-wells at the Station. Investigations are also in progress on growth of trees under different conditions of green manure, frost precaution, salt accumulation, the effect of a soil mulch on the evaporation of water, and control of soil moisture. An account of the work of the Station was published in the Council's Journal, Vol. 1, No. 6.

4. *Proposed Imperial Irrigation Research Station.*—The Empire Marketing Board has had under consideration a proposal that an Imperial Irrigation Research Station should be established in some suitable locality within the Empire. An Irrigation Research Sub-Committee of the Committee of Civil Research has been constituted to investigate the proposal in detail and to recommend a site, &c. Until a decision has been made as to the locality in which this Station will be placed, and as to the lines of work it will undertake, the Council considers it undesirable to make definite arrangements for the enlargement of its own programme of irrigation research. Consideration of that enlargement is, accordingly, being held in abeyance for the time being.

V.—SOIL PROBLEMS.

1. *Co-operative Investigations with Waite Agricultural Research Institute.*—In 1927 the Council entered into a co-operative agreement with the University of Adelaide for investigations to be carried out at the Waite Agricultural Research Institute on soils problems, particularly in the Murray River Valley Irrigation Settlements. The investigations were placed under the control of Professor J. A. Prescott, who was appointed as adviser to the Council on soil problems. This action was taken as a result of the realization of the importance of greater co-ordination in the investigation of soil problems throughout the Commonwealth, and of the urgent necessity for a more complete understanding of the soil problems associated with the development and subsequent practical difficulties in the irrigation settlements in the Murray Valley.

The development of laboratory technique and the application of modern methods to Australian problems had already become part of the policy of the Department of Agricultural Chemistry of the Waite Institute when action was taken by the Council in 1927 for the study of soil problems in co-operation with that Institute. The development of internationally recognized methods under the auspices of the International Society of Soil Science and the creation of the Imperial Bureau of Soil Science have made the present time singularly opportune for securing co-ordination throughout the Commonwealth. As a basis for discussion in reaching such standardization, a Pamphlet (No. 8) on "Methods for the Examination of Soils" was published by the Council in 1928 and this was followed by another Pamphlet (No. 13) on "The Mechanical Analyses of Soils" in 1929.

Before similar co-ordination is possible on the field side, much investigation remains to be done, but the work already carried out in the irrigation settlements has enabled a field technique to be developed on a satisfactory basis and will lead the way for similar detailed work in other parts of Australia.

2. *Development of Work.*—In April, 1929, a laboratory for soils investigation was opened at the Council's Research Station on the Murrumbigdee Irrigation Area at Griffith, New South Wales. At the Waite Institute the Melrose Laboratory was completed from funds made available by Sir John Melrose for the building of a chemical laboratory. In June, 1929, it was announced that Mr. Harold Darling had made a generous gift to the University of Adelaide, on behalf of the Darling family, of £10,000 for the erection of another laboratory at the Waite Institute. The University of Adelaide has agreed that the latter sum shall be used for the erection of a soils laboratory to be utilized by the Council for the purpose of establishing on a co-operative basis a joint Division of Soils Research. The details of the co-operative arrangements and the plans for establishing the new Division are being prepared. These developments will render practicable in the near future a considerable extension of the Council's investigations on soil problems.

3. *Investigations in Irrigation Areas.*—Since the beginning of the investigations in 1927, attention has been directed primarily to the survey of the more closely settled and more valuable lands, namely, irrigation settlements, the work of survey having been divided into convenient units each involving about six months' work for a surveyor with twelve months' associate laboratory work for a chemist. The first unit, the survey of Block E and the Ral Ral Division of Chaffey, both at Renmark, has been completed by Mr. J. K. Taylor, Senior Soil Survey Officer, and the results have been published in the Council's Bulletin No. 42. The laboratory work was carried out mainly by Mr. H. N. England, then at the Waite Institute, but now Soil Chemist at the Council's Laboratory at Griffith, New South Wales. The field work of the second unit, Woorinen Settlement (Victoria), has also been completed and the laboratory work is being carried out by the Chemists' Branch of the Victorian Department of Agriculture. The third unit comprises the swamp soils of the Lower Murray, of which sixteen individual swamps have been surveyed with a total area of 10,500 acres.

As part of the soil survey work, an aerial photographic survey of the whole of the Renmark Settlement has been carried out by officers of the Royal Australian Air Force with a view to ascertaining whether the known differences of soil types can be indentified in the photographs If so, it is intended to make use of the information thus obtained in completing the survey of the Renmark Settlement.

Systematic soil survey work began in the Murrumbidgee Irrigation Area in 1928. A soil survey chemist has been attached to the Council's Research Station at Griffith, New South Wales, and a detailed study of the heavier soils has been commenced. Soil studies of immediate importance to the Council's viticultural Research Station at Merbein (Victoria) are also in progress. As part of a scheme of re-organization of the work at this Station, an experimental area has been reserved for the study of the redistribution of salt in the soil as a result of irrigation, starting from virgin soil conditions. The preliminary work carried out in co-operation with the Council's Division of Economic Botany, has included a vegetation survey and a detailed soil examination of the area.

So far the soil survey work carried out by the Council in co-operation with the Waite Institute has been limited to the more valuable settled areas where horticultural experience of the local soils has already been obtained and where important fertility problems need to be defined. It is hoped that this work will form the basis for surveys intended for the investigation of future developmental projects.

4. *Survey Work in Other States.*—During the year 1928–29, a beginning was made in soil survey work in Tasmania, where the Council is co-operating with the State Department of Agriculture and the University of Tasmania in an investigation of the orchard soils of the Huon Valley. Up to the present progress has necessarily been slow, but it is hoped that the experience gained during the first year will enable a suitable organization to be developed for the purpose of undertaking systematic investigations of Tasmanian soils on an extensive basis.

Possibilities of co-ordination in broader aspects of soil survey work in Queensland and Western Australia have also been explored, but no definite steps have yet been taken. A progress report on the soils investigations of the Council was published in the Council's Journal, Vol. 2, No. 2.

VI.—ANIMAL PROBLEMS.

1. *Development of Investigations.*—Sir Arnold Theiler, who was for many years Director of Veterinary Research and Professor of Tropical Veterinary Medicine in South Africa, where he established the well-known Veterinary Research Institute at Onderstepoort, and carried out research work on many animal problems, especially on certain deficiency diseases in stock, reached Australia on a six months' visit in April, 1928. Arrangements were made for him to visit every State of the Commonwealth, and to obtain information on problems affecting the health of animals of economic importance. In addition to informing himself generally on the whole question of veterinary problems and research in Australia, with a view to closer Empire co-operation in the study of such matters, Sir Arnold advised the Council as to the immediate development of plans for research in those matters, and as to the organization of a Division of Animal Health. His report was published in the Council's Pamphlet No. 10. In it he reviewed the whole position regarding diseases already under investigation and new problems recommended for investigation and he outlined the policy which he thought should be followed in the establishment by the Council of a Division of Animal Health. The Council hoped that it would have been able to secure Sir Arnold Theiler's services to undertake at any rate the preliminary organization and direction of the Division, but unfortunately, owing to ill-health, he was unable to return to Australia and undertake these responsibilities.

The Council therefore decided, after the fullest consideration and consultation with various authorities, to postpone for the present the creation of a Division under the direction of a highly qualified and experienced officer and to endeavour to develop its animal health investigations mainly at two or three centres, viz., Sydney, Melbourne and Brisbane. The prosecution of this plan has fortunately been facilitated very greatly by the generous gift of Mr. F. D. McMaster. of Dalkeith, Cassilis, New South Wales, of a sum of £20,000. In his deed of gift Mr. McMaster states that at a meeting of the Sheep Breeders' Association of New South Wales at which the Prime Minister (the Rt. Hon. S. M. Bruce, P.C., M.P., &c.) stressed the need for scientific research on the problems confronting pastoralists in Australia and intimated that the Commonwealth Government was willing to provide men and equipment to conduct such research if suitable buildings were provided, he (Mr. F. D. McMaster) agreed to pay to the Council the sum of £20,000 for the erection of a building. The Council has conveyed to Mr. McMaster its most cordial appreciation of his gift and is preparing plans for the erection of the laboratory adjacent to the Department of Veterinary Science of the University of Sydney.

The Council has under consideration certain plans for the development of its work at the Veterinary Research Institute of the University of Melbourne and hopes also that, with the financial assistance of pastoralists in Queensland, it will be able to establish a third research centre on animal health problems in or near to Brisbane. Pending these developments, the Council has continued and augmented the investigations which were referred to in its last Annual Report.

2. *Braxy Disease in Sheep.*—Very satisfactory progress has been made in the Council's investigations into braxy-like diseases which affect sheep in several of the States and which were again very prevalent in certain districts during the past year. The investigations are in progress both in Victoria and Western Australia.

(i) *Victoria.*—In Victoria, Mr. A. W. Turner is engaged at the Melbourne Veterinary Research Institute under the supervision of Professor H. A. Woodruff. The work was commenced by him in March, 1928, after his return from the Pasteur Institute, Paris, where he was able to identify the causal organism of the so-called black disease in Victoria and to show that it was really a race of *Bacillus oedematiens*, an anaerobic spore-bearing bacillus which first came into prominence as one of the most important causes of gas-gangrene during the war. It is now proved that the braxy disease in Victoria is identical with the black disease of sheep of New South Wales and that it is probably identical with the disease to which the same name has been applied in Tasmania.

As a result of the laboratory investigations and of the field work carried out by Mr. D. Murnane, a preventive vaccine has been made by Mr. Turner and has been shown to be quite harmless when injected into healthy sheep and at the same time to have a very considerable protective value. Nearly 8,000 sheep have been treated and the results have been so beneficial that the owners concerned have been desirous of having all their sheep vaccinated. The question of manufacturing supplies of the vaccine for large-scale tests and observations has been taken up with the Commonwealth Department of Health.

The investigations have indicated that fluke infection may have a direct effect in making possible the entrance of the braxy microbe. This has opened up a very important line of investigation, but owing to the difficulty in obtaining an adequate supply of fluke cercariae it has been impracticable up to the present to carry it very far. A brief article on the investigations was published in the Council's Journal, Vol. 1, No. 6. A later report by Mr. Turner will be published in a future issue of the Journal.

(ii) *Western Australia.*—In this State investigations are being carried out with a primary view to determine whether the so-called braxy or Beverley disease has any relation to the braxy of Victoria and New South Wales. The Council, for an intensive attack on the problem, entered into a co-operative arrangement with the Western Australian Department of Agriculture, under which Mr. H. W. Bennetts, Veterinary Pathologist in that Department, has been seconded to the Council for a period of two years from April, 1928. It has already been established that the disease is quite distinct from the braxy disease of Victoria and New South Wales and strong evidence has been adduced to incriminate *Bacillus welchii* as the cause of death. This bacillus is known to be very widely distributed in nature, being found in soil and in the intestines of man and animals. The present conception of the disease is that certain predisposing factors favour the excessive growth and toxin production of *Bacillus welchii*, and that death is caused by the absorption of that toxin. A progressive report on the investigations was published in the Council's Journal, Vol. 2, No. 2.

The work has now reached a stage where its scope must be considerably extended to include nutritional as well as pathological studies. An arrangement has accordingly been reached between the Western Australian State Department of Agriculture and the Council under which the Department is to make available the Avondale State Farm near Beverley for further investigations, to provide a field laboratory, sub-divisional fencing, water service and stalls for experimental animals. The Council will continue to pay the salary of the investigator, Mr. H. W. Bennetts, and his assistant, Mr. R. Harley. It will also provide a chemist and laboratory equipment and apparatus. The study of the nutritional aspect of the problem will be conducted in close association with Professor Brailsford Robertson's Division of Animal Nutrition in Adelaide. The disease has proved to be a much more difficult problem than was anticipated at first, but it is hoped that the extensive team work now being initiated will lead quickly to a discovery of some method of control.

3. *Haematuria in Cattle (Endemic Redwater).*—The investigations on haematuria in cattle, particularly the condition occurring in the Mount Gambier district of South Australia, have been continued at the Government Laboratory of Bacteriology and Pathology of the Adelaide

Hospital. The work is being carried out by an officer of the Council, Mr. C. G. Dickinson, B.V.Sc., under the direction of Dr. Lionel Bull. The initial work included a survey of the distribution and incidence of the disease in the Mount Gambier district and the collection of specimens and their examination at the Laboratory at Adelaide. Investigations in other countries indicated that oxaluria was the cause of the disease, and, in considering oxalic acid as a possible factor in the Mount Gambier district, it became necessary to carry out a botanical survey and to make an examination of various plants. A large amount of data has been collected and a chemist, Mr. A. T. Dann, M.Sc., has been appointed for the purpose of carrying out the necessary chemical work.

Thorough attention is being given to the clinical diagnosis of the disease and, in view of the possible relation between mineral deficiency and the occurrence of the disease, investigations of the soils have been carried out by Professer J. A. Prescott. In addition numerous pathological samples of the various organs of affected cattle have been collected and examined. A great deal of very valuable information has been obtained and the whole of the material available is being examined. It is is not possible at present to make any definite statement of the results of the investigation, but they will be made available for publication from time to time, when full details will be given and their significance discussed.

4. *Parasitological Problems.*—The veterinary parasitologist of the Council, Dr. I. Clunies Ross, who was stationed at the Department of Veterinary Science, University of Sydney, left Australia in June, 1929, in order to undergo a short course of training in post-graduate research under Professor Miyagawa at the Japanese Institute of Infectious Diseases, Tokio.

Prior to his departure the investigations on liver fluke in sheep, referred to in the last Annual Report of the Council, were continued. Tests in Australia of the efficacy of the carbon tetrachloride treatment confirmed the results obtained in other countries and this method of treatment, recommended in the Pamphlet (No. 5) published by the Council, has been widely adopted throughout Australia with satisfactory results. A Bulletin (No. 43) giving the results of further investigations carried out on the life-cycle of the fluke and of its intermediate host, a species of snail (*Limnea brazieri*) is in the press and will be published at an early date.

During the year a Bulletin (No. 40) on the hydatid parasite and the control of hydatid disease in Australia was also published. The main portion of this work was carried out by Dr. Ross prior to his appointment as an officer of the Council. Investigations regarding the possible association of liver fluke with braxy disease have been partially suspended during Dr. Ross's absence abroad.

Work has also been carried out on stomach and intestinal worms in sheep and on the varieties of lice and tick which infest sheep. As a result of a survey in Central Queensland, it was found that the worm parasite of the greatest importance in the area was the large stomach worm or wire worm, *Haemonchus contortus*, and that the smaller worms commonly found in New South Wales and the southern States were of very minor importance. Experiments were carried out, with very satisfactory results, on the control of the worm by the use of carbon tetrachloride, and in consequence graziers are adopting the method of treatment on an extensive scale. An article on this subject was published in the Council's Journal, Vol. 2, No 2.

A report on co-operative investigations on the treatment of parasitic gastro-enteritis of sheep by Dr. H. R. Seddon, of the New South Wales Department of Agriculture, and Dr. Clunies Ross is being published by the Department.

A survey of the more serious diseases which affect each class of live-stock in Australia reveals the fact that none are of greater importance than those caused by, or spread through, the agency of parasites. The Council, therefore, proposes to extend this branch of investigation and in particular to develop it at the laboratory which is to be erected from the funds made available by Mr. F. D. McMaster. An article on the importance of parasitological research in relation to the prosperity of Australia's live-stock industry was published in the Council's Journal, Vol. 1, No. 4.

5. *Paralysis in Pigs.*—The investigations on pig paralysis were continued at the Glenfield Animal Research Institute of the New South Wales Department of Agriculture until March, 1929, when the Council's investigator (Mr. Carr Fraser) left Australia, under a research studentship awarded to him by the Trustees of the Science and Industry Endowment Fund, for the purposes of making certain inquiries in the United States of America and later of proceeding to Great Britain in order to gain further experience in veterinary research work particularly from the point of view of animal nutrition.

Prior to his departure, Mr. Carr Fraser continued his work on paralysis in pigs, under the supervision of Dr. H. R. Seddon, the immediate objects of the investigations being (*a*) to induce the condition experimentally, and (*b*) to ameliorate the naturally occurring condition or at least to observe the effect of certain therapeutic measures. Whilst satisfactory progress has been made, the work has not yet passed beyond the purely experimental stage.

6. *Tuberculosis and Pleuro-pneumonia in Cattle.*—Mr. T. S. Gregory, B.V.Sc., who was carrying out investigations on these problems under the direction of Professor H. A. Woodruff at the Melbourne University Veterinary Research Institute resigned his position in 1928, in order to join the University staff. A report on the investigation on pleuro-pneumonia was published in the Council's Journal, Vol. 1, No. 2, and showed that a test for diagnosis of the disease had proved satisfactory for use under field conditions. The test should, therefore, be of value for testing animals before allowing them to pass from an infected locality to a clean herd or area.

A preliminary report on the work on tuberculosis was published in the Council's Journal, Vol. 1, No. 2, and was followed by a further report in Vol. 2, No. 3 of the Journal. The results showed that the B.C.G. (Bacillus Calmette-Guerin) vaccine is innocuous and that it confers some degree of resistance towards infection with virulent tubercle bacilli. Arrangements are being made by Professor Woodruff and Mr. Gregory to continue the work and to test the power of the vaccine for protecting against virulent infection under field conditions. A number of herds known to be highly infected with tuberculosis have been chosen and the majority of calves will be vaccinated shortly after birth and revaccinated annually. A number will be left unvaccinated as controls.

7. *Caseous Lymphadenitis.*—The problem of caseous lymphadenitis is of considerable importance in connexion with the export of frozen mutton from Australia, since the British Health authorities have prohibited the importation of mutton having glands affected by the disease and since the percentage of animals affected is in some cases high. At the present time little is known as to the cause of the condition. In 1927, the Meat Industry Board of New South Wales seconded one of its veterinary officers, Mr. R. C. Cramp, B.V.Sc., to the Council in order that he might carry out some investigations under the direction of Professor J. D. Stewart of the University of Sydney. Mr. Cramp's studies were largely of a statistical nature, and concerned the incidence of the condition in carcasses at abattoirs in New South Wales and the distribution of lesions in the affected animals. Some bacteriological examination of affected glands was also carried out with a view to distinguishing between the various kinds of infection some of which, it is suspected, are not true caseous lymphadenitis due to the action of the Preisz-Nocard bacillus.

Mr. H. R. Carne, of the Veterinary Department, University of Sydney, is undertaking a study of serological methods of diagnosis, supported by a grant from the Science and Industry Endowment Fund. Mr. T. S. Gregory, up to the time of his resignation, was also studying at the Veterinary Research Institute, University of Melbourne, serological methods of diagnosis, as well as the identification of types of the bacillus. In addition to the work of these investigators, arrangements were made by the Council in 1928 for some preliminary observations on the production of immunity to the disease in laboratory animals (by use of vaccines) to be carried out by Mr. C. G. Dickinson, under the direction of Dr. Lionel Bull, of the Bacteriological and Pathological Laboratory of the Adelaide Hospital.

In view of the widespread occurrence of the disease and of the fact that the British Health authorities have prohibited the importation into Great Britain of affected carcasses, the Council attaches great importance to a systematic attack on the problem. It has arranged for the investigations under Dr. Bull at Adelaide to be extended, and he is carrying out a study of certain factors concerned in the susceptibility and resistance of animals to infection. Intensive work on these investigations was started in April, 1929, but it has not yet reached a stage at which results can be indicated. The Council had intended to arrange for a concentrated attack on the problem to be made under the control of Sir Arnold Theiler as part of the plan of reorganization and development which it was hoped he would have been able to undertake. As soon as it was ascertained that he could not return to Australia in order to undertake the direction of the Council's animal health work, other plans were made and Dr. J. A. Gilruth has recently been appointed for the purpose of co-ordinating the various investigations in progress and of developing an intensive attack on the problem. One of the primary objects of the attack is to ascertain the means by which the disease is spread. It is hoped that once this is definitely proved it will be possible to devise preventative methods.

8. *Cattle Tick Dips Committee.*—As a result of the recommendations made by a special Committee on Tick Eradication, which met in Sydney in 1916, experiments were initiated for investigating the possibilities of obtaining a dip for the eradication of cattle tick, economically superior to the standard dip regularly used in Queensland and New South Wales.

A special committee, consisting of representatives from what was then the Institute of Science and Industry and the Departments of Agriculture in New South Wales and Queensland, was formed in 1918 to undertake the work. Arrangements were made for the expenses to be defrayed by equal contributions from the Commonwealth, New South Wales and Queensland Governments. The Committee commenced work in 1918, and is still in operation.

The initial experiments were designed to ascertain with certainty the action of standard arsenical dips on ticks during the moulting stage, the extent of the protective action, if any, of medicaments against reinfestation by larval ticks, and the effect of subsequent rainfall on the efficacy of treatment. Later, further experiments were planned varying the composition of the arsenical dip and investigating the possibilities of other parasitological substances as cattle dips. An amount of valuable information was gathered as a result of these experiments, but it was found that a great deal still remained to be learned, and therefore during the past year the Committee recommended that an isolated area be procured, where experiments could be carried out under natural conditions. Accordingly a property at Samford was selected, and rented for a period of two years, and experiments are now in progress on this area. The cattle which have been purchased and placed there are considered for all practical purposes to be in quarantine, and trespassing on the area is strictly prohibited. The main purpose of the experiments is to discover the most suitable interval between dippings, and the composition of dipping fluids resulting in the optimum economic results. It was hoped that these experiments would have been completed last year, but the work was seriously interfered with by floods. A report on the work of the Committee has been published in the Council's Pamphlet No. 12.

VII.—ANIMAL NUTRITION INVESTIGATIONS.

1. *Division of Animal Nutrition.*—The Division of Animal Nutrition was established early in 1927 and placed under the direction of Professor T. Brailsford Robertson to carry out an extensive and fundamental investigation into problems associated with the nutrition of stock. For many years to come, the work will be confined to the study of sheep. The ultimate aim of the investigation, which is being carried out in co-operation with the University of Adelaide, is to obtain information whereby sheep reared in various localities and climates of Australia may be so fed as to yield the best economic results.

The laboratory of the Division was completed in October, 1928, and officially opened by the Prime Minister (The Rt. Hon. S. M. Bruce, P.C., M.P., &c.), on 22nd October of that year. A description of the building and their equipment occurs in the Journal of the Council, Vol. 1, No. 6, November, 1928. As mentioned in the previous reports the building has been erected on an area made available by the University of Adelaide. This laboratory is the focus of the Division to which every problem met with in the field ultimately gravitates and from which everything done by the Division in the field radiates.

Particular attention is being given by the Division to the protein and mineral contents of fodders. The principal investigations in progress at present relate in the main to the utilization and availability of phosphoric acid and of the particular proteins required by the sheep. The soils of very large areas of Australia are notoriously deficient in phosphoric acid. and these areas embrace many of the most important pastoral districts. In addition, the quality of the feed available to animals in many pastoral districts undergoes remarkable variation at different periods of the year, and for this reason the carrying capacity of the land is often far less than would be possible at the best season of the year, despite the apparent abundance of fodder during the period of low carrying capacity. It seems probable that in the majority of such cases the chief deficiency in the season of least abundance is protein. In any case, the losses arising are often serious, for a large amount of feed is never utilized, the feed that is consumed is of lower nutritive value than it would be if the pastures were kept closely cropped, and finally the seeds, burrs, &c., produced by the ripened plants constitute a serious handicap to the welfare of the sheep and cause reduction in the value of the wool.

As a result of an extensive series of analyses of wool, the Division has shown that wool fibre is a protein of unusual composition containing a high proportion of the sulphur-containing amino-acid cystine. Reports on this matter have been issued as the Council's Bulletins Nos. 38 and 39. No animal can synthesize cystine and the sheep must therefore obtain it pre-formed in the proteins of the fodder. Consequently, the production of wool must impose a very special demand on the nutrition of sheep unless cystine containing fodders are plentiful. In the laboratory, grasses and other fodder plants are being analysed for their protein and cystine contents. This survey, so far as cystine is concerned, is also being extended to other plants as will be discussed in greater detail later.

In addition, a search has been made in many directions for proteins which are available, or which might become available, on the market and which would relieve the sheep of some of the strain of wool production by conveying to them an exceptionally high proportion of cystine. Unfortunately, proteins of this nature are not as yet available in large quantities. Blood meal is an instance of such a material and a product formed by the hydrolysis of waste wool, hair, horns or hooves is another. Experiments on the feeding of these materials as supplements to the normal diet have been carried out on two of the Division's field stations and very encouraging results obtained. The analysis for cystine of plant materials not at present in common use as fodders is thus of much significance.

Another matter to which the Division is giving considerable attention is that of the distribution of the three forms—phosphates, phospho-lipins and nucleic acid—in which phosphorus occurs in the tissues of sheep of different ages. The ultimate object of this work is to investigate the efficacy of various licks for remedying phosphoric acid deficiencies encountered in the pastures. The investigations have been delayed somewhat owing to the previous lack of a satisfactory method for the qualitative determination of nucleic acid. A satisfactory procedure for such determinations has, however, been recently evolved at the Adelaide Laboratory, and it should now be possible to carry out a phosphoric acid balance and to determine the proportions of phosphoric acid utilized by sheep for various purposes. With this end in view, arrangements are in train for the carrying out of analyses on whole carcasses of lambs reared and given various treatments by licks at "Dismal Swamp," the field station of the Division located in a phosphoric acid deficient area in South Australia.

In addition to the above lines of investigation, other studies are being made. A comprehensive collection of bones of sheep has been obtained from a variety of pastoral areas in Australia. These will be analysed in the hope of obtaining an idea of the correlation between bone composition and the geology and soils of the districts from which the bones were obtained, and the physical characteristics of the bones themselves. In view of the known influence of the thyroid gland on the production of hair on animals, it has been thought desirable to make a survey of the iodine content of the thyroid glands of sheep from different parts of Australia. In addition to the thyroids, a staple of wool has been obtained friom each animal with a view to determining whether there is any correlation between the iodine content of the glands and the condition and the quality of the wool. Much of the analytical work on the thyroids has already been completed. The results obtained indicate that the greater part of the pastoral areas of Australia are abundantly supplied with iodine, in contrast to the United States, where large areas are deficient in iodine and where striking results have been obtained by the use of iodine in licks. The use of iodine in licks in Australia has been discussed by the Chief of the Division in *The Pastoral Review*, dated the 16th May, 1929.

Another somewhat minor matter to which attention has been given is that of "break" in wool, by which is meant a sudden change in the diameter of the wool fibres usually resulting from the thinning down of the fibre due to drought conditions followed by a sudden thickening due to the springing up of a quantity of fresh herbage following on rain. Methods of producing "break" at will have been evolved and with them a means of possibly overcoming on a commercial scale any sudden change of diameter has been devised. This involves the use of a cystine rich supplement.

Another aspect of the Division's activities is that of its studies of the metabolism of sheep by means of the calorimeter erected at the Waite Institute. By this instrument the minimum requirement of food for the maintenance of the sheep is measured. Such a measure is obviously of great importance as a guide in the making up of recipes for hand feeding in droughts.

In previous reports, mention has been made of the field stations of the Division. These are quite simple establishments which consist essentially of a weighing machine with a few sheep pens attached. They are established on sheep stations in various localities and very valuable co-operation has been obtained from the owners of the stations. In all cases the sheep employed in the investigation, now numbering some 1,200 all told, have been lent to the Division by the owners. Field stations have now been established at "Kolendo," near Port Augusta, South Australia; at "Dismal Swamp," near Mount Gambier, South Australia; "Buln Gherin," now "Niawanda," near Beaufort, Victoria; "Keytah," near Moree, New South Wales; and "Meteor Downs," Springsure, Central Queensland.

The general object of the field stations is to obtain data on the relationship between weight and age of sheep in various typical pastoral districts and at the same time to correlate these results with the production and quality of the wool. In addition data on at least one

special problem are also obtained from each station. Thus at "Keytah" the object is to compare the growth of lambs in receipt of a lick containing iodine with others in receipt of a lick containing no iodine. At "Meteor Downs" the use of blood meal as a cystine rich supplement is under investigation, and at "Dismal Swamp" a comprehensive study is being made of the effects of various licks containing phosphorus in different forms.

2. *Mineral Deficiencies of Pastures.*—Progress has been made in the work on mineral deficiencies being carried out as a co-operative enterprise by the Empire Marketing Board, the University of Adelaide and the Council. As practically the entire sheep and cattle population of the Commonwealth is maintained on the indigenous pastures, and as in consequence grass must be regarded as Australia's principal crop and an outstanding source of wealth, the importance of this work is obvious.

The investigations are centred in the Melrose Laboratory of the Waite Agricultural Research Institute and are there carried out under the direction of Professor A. E. V. Richardson. Although the work was commenced in July, 1927, it was not possible to appoint the full staff contemplated under the agreement until early in 1929 when the permanent laboratory was opened. The full staff engaged now consists of three chemists, two agrostologists, one agronomist and two botanical assistants.

The general object of the work is to investigate the mineral content of pastures with a view to determining the grassland areas in which deficiencies exist and the most economical methods of correcting such deficiencies. As very little scientific work has hitherto been carried out on the indigenous pastures of Australia, much attention has been given to the working out of a technique adapted to the investigation. Satisfactory methods have now been developed to measure the productivity, grazing value, botanical composition, and ecological succession of indigenous pastures.

In the laboratory considerable attention has been devoted to a study of the factors affecting the mineral content of pastures, such as the stage of growth, the effect of phosphates, the soil type, the rate of growth, and the effect of soil moisture. A survey of the composition of pasture plants collected from various areas in Australia where mineral deficiencies may exist is also in progress. As to the effect of the stage of growth on the mineral content, it has been found that the absorption of mineral matter and nitrogen is extraordinarily rapid in relation to the amount of water transpired and dry matter synthesized from tillering to flowering. Thus with gramineous plants, 86 per cent. of the total nitrogen, 82 per cent. of the potash, and 60 per cent. of the phosphoric acid had been absorbed in one series of experiments, before 40 per cent. of the total dry matter had been synthesized and before 34 per cent. of the total water used had been transpired. It has also been found that grasses and clovers produce dry matter at a relatively low water cost during the early stages, but in the final stages the water cost of dry matter is relatively high. This result, taken in conjunction with the high protein and mineral content of young grass, is of great economic significance in pasture management in some arid areas.

In the field, studies are being made of the effects of varying intensities of grazing on the yield and botanical and chemical composition of indigenous pastures, of the effect of applying soluble phosphate to natural pastures, and of the value of phosphatic licks fed to sheep when grazing on unmanured pastures, and the effect of various phosphatic fertilizers on the productivity and grazing value of indigenous grasses.

3. *Memorandum by Dr. J. B. Orr.*—In the previous Annual Report, mention was made of the visit to Australia of Dr. J. B. Orr, Director of the Rowett Research Institute, Aberdeen. Subsequent to his departure, Dr. Orr furnished the Council with a memorandum on research in nutrition in Australia. It has been published in the Council's Pamphlet No. 10, and deals with the nutrition not only of sheep, but of other animals of economic importance as well.

VIII.—ENTOMOLOGICAL PROBLEMS.

1. *Division of Economic Entomology.*—In the last Annual Report of the Council, an account was given of the action taken for the establishment of a Division of Economic Entomology under the control of Dr. R. J. Tillyard, F.R.S., and of the main lines of research to be undertaken. During the year 1928–29 progress was made with the erection of the Laboratories at Canberra for the Division, and it is expected that they will be completed towards the end of 1929. A brief description of the laboratory buildings was published in the Council's Journal, Vol. 2., No. 3. Behind the laboratory building an area has been provided for the erection of four large insectaries, and during the year 1928–29 two of these were completed and put into commission.

A scheme for the development of entomological research was prepared by Dr. Tillyard and published in the Council's Journal, Vol. 1, No. 4. Apart altogether from financial considerations, the immediate development of the full scheme is impracticable owing to the shortage of trained entomologists. For the present the investigations undertaken come mainly under the head of entomological control of pests and include :—

(*a*) the control of noxious weeds by their natural insect enemies, and

(*b*) the control of insect pests by parasites or predators.

The noxious weeds which have already received attention are St. John's wort, Noogoora burr, ragwort, skeleton weed, and saffron thistle. The main subjects of investigation on the side of insect pests are the sheep blow-fly, the buffalo fly, orchard and fruit pests, and field crop and pasture pests.

2. *Co-operation with other Bodies.*—In developing the work of the Division, the policy has been adopted of co-operating, whenever practicable, with other organizations already in existence in Australia. Thus the Division is co-operating with the Queensland Department of Agriculture and Stock on the buffalo-fly problem, and with the New South Wales Department of Agriculture on certain aspects of the sheep blow-fly problem. The National Museum, Melbourne, and the Australian Museum, Sydney, are both giving valuable help in systematic work. Negotiations are also in progress with the Waite Agricultural Research Institute, South Australia, with a view to close co-operation on the problem of the lucerne-flea.

In the last Annual Report of the Council, reference was made to the fact that the Empire Marketing Board was very generously making substantial contributions towards the cost of the Council's entomological work and that it was providing on a £ for £ basis with the Council a sum of up to £25,000 for capital expenditure and sums of £9,275 per annum for the first two years, £6,895 per annum for the next two years, and £4,710 for the fifth year towards annual expenditure; and further, that as a result of funds made available by the Empire Marketing Board, a laboratory for breeding beneficial parasites had been established at Farnham Royal in Buckinghamshire. The Council has been able to arrange for part of its work in connexion with the investigation of parasitic insects to be centred at Farnham Royal, where three of the Council's junior entomologists have been working during the past year.

3. *Noxious Weeds.*—The position regarding investigations on noxious weeds problems may be summarized as follows :—

(i) *St. John's Wort* (*Hypericum perforatum*).—This weed covers an area estimated at from 250,000 to 400,000 acres in Victoria and also small areas in New South Wales and South Australia. A survey of these areas has been carried out and has disclosed the fact that the weed is not controlled at all in Australia by natural enemies. At Farnham Royal an officer of the Council, Mr. S. Garthside, has been studying the life histories of insects which are known to attack the genus *Hypericum* in Europe. Various insects which attack the plant in various ways are being studied, the most important being a group of species of beetles of the genus *Chrysomela*. Tests are being carried out in order to ascertain definitely whether the insects will live on any plant of economic value. So far the results with *Chrysomela* have been entirely negative, and it is anticipated that supplies of that insect will be available for testing at Canberra at an early date. As the investigations have shown that in Europe St. John's wort is attacked by a considerable number of different species of insects, the possibility of control by their introduction into Australia appears to be promising.

(ii) *Bathurst and Noogoora Burrs* (*Xanthium spp.*).—Arrangements have been made with Professor G. Dean, Department of Entomology, State Agricultural College, Manhattan, Kansas, for research to be carried out on the native North American insects that attack species of the genus *Xanthium*. This work is being undertaken by Mr. Samuel Kelly during the 1928 summer in America.

(iii) *Ragwort* (*Senecio jacobaeae*).—In view of the importance of controlling this weed in Victoria and Tasmania, arrangements are being made with the Cawthorn Institute, Nelson, for a supply of pupae of the cinnabar moth, *Tyria jacobaeae*, which was introduced into New Zealand by Dr. Tillyard in 1925 for the purpose of attempting to control this weed. An exhaustive series of tests since carried out in Nelson has shown that this insect causes very great destruction to ragwort and is harmless to all other economic plants. It is at present being liberated in ragwort-infested areas in New Zealand.

(iv) *Other Noxious Weeds.*—During a recent visit to Cowra, Bathurst, and Mudgee, an officer of the Council, Mr. G. A. Currie, carried out some preliminary work on skeleton weed (*Chondrilla juncea*) and saffron thistle (*Kentrophyllum lanatum*), both of which are serious weeds in certain areas of Australia. At the present stage the prospects of biological control of skeleton weed do not appear to be promising.

4. *The Buffalo-fly Pest.*—The serious menace which this pest constitutes to the cattle industry of Northern Australia, and the fact that it was reported early in 1929 that the fly had crossed the border between the Northern Territory and Queensland, led to the recognition of the problem as one of outstanding importance and urgency. The investigations are under the direct charge of Dr. Ian Mackerras, assisted by Mr. T. G. Campbell in Northern Australia and Mr. G. L. Windred in Java. At the end of February, 1929, Mr. T. G. Campbell was sent to Darwin to make a special duty of the fly in Northern Australia, to work out details of its life-history, to try to discover whether or not it could breed in the dung of native animals, and to follow the herds of cattle travelling towards the Queensland border with a view to discovering evidence upon which to determine how far any proclaimed buffer area might be effective in stopping the entry of the fly into Queensland. He has already collected a great deal of valuable information about the fly, and has also established the important fact that the two more southern stock routes into Queensland are still free from the pest.

In the last Annual Report of the Council reference was made to certain important investigations, directed to the discovery of parasites likely to be useful in the control of the pest in Australia, carried out on behalf of the Council by Dr. O. Nieschulz at the Veterinary Institute, Buitenzorg, Java. Owing to Dr. Nieschulz's return to Holland, it became necessary for the Council to make other arrangements for continuing and intensifying this work and in April, 1929, Dr. Mackerras and Mr. G. L. Windred left Australia for Java. It has been ascertained that, in spite of the fact that climatic and other conditions in the Dutch East Indies are apparently ideal for flies of all kinds, neither the buffalo-fly nor the blow-fly, nor even the ordinary house-fly is a pest there. Factors must, therefore, operate to control these pests, and the problem is to determine what these factors are and whether they can be applied to Australia. As the buffalo-fly has no parasites in Australia, but is known to be parasitized in Java, parasites must be one of the factors in control in the latter country. The investigations are still in progress.

5. *The Sheep Blow-fly Pest.*—Owing to the pressing importance of the buffalo-fly pest and Dr. Mackerras's consequent absence from Australia, the work on the blow-fly problem has been confined to two main lines of research, viz. :—(*a*) The introduction and acclimatization at the insectary at Canberra of the parasite *Alysia manducator*, which work has been carried out by Miss M. Fuller, who has also undertaken certain accessory lines of investigation ; (*b*) investigations at Farnum Royal by Dr. F. G. Holdaway who is studying the causal factors of " blowing " in wool and is making a search in Southern European countries for new parasites of blow-flies. The Council is also co-operating with the New South Wales Department of Agriculture in certain investigations at the latter's Experiment Farm at Nyngan and has made available to the Department the services of an investigator (Mr. C. R. Mulhearn).

6. *Orchard and Fruit Pests.*—Owing mainly to the difficulty in securing the services of suitably qualified officers, the work in this section has been limited mainly to investigations on the codlin-moth pest, which affects orchards in all the States. Mr. J. W. Evans has carried out the work at Farnham Royal on the control of the pest by means of the parasite *Trichogramma minutum*, the main difficulty in regard to which is its late emergence in the spring as compared with the earlier prevalence of the first brood of codlin-moth. Satisfactory progress has been made with the work and arrangements have been completed for a shipment of three distinct races of the parasite to be made for experimental purposes in Australia.

7. *Field Crop and Pasture Pests.*—During the year 1928–29, Mr. G. F. Hill completed a preliminary investigation of the Tasmanian grass-grub *Oncopera intricata*, to which reference was made in the last report of the Council. The results, which were published in the Council's Pamphlet No. 11, indicate that except on valuable land where chemical treatment may be justified the only hope of control lies in the discovery of a natural parasite. One of the insectaries at Canberra has been planted with plots of various grasses with a view to rearing *Oncopera* larvae preparatory to testing out possible parasites.

8. *White-Ant Problem.*—The Chief of the Forest Products Division (Mr. I. H. Boas), has furnished the Council with information regarding the large amount of damage caused to wood structures in Australia by white ants, borers, and fungal rots, and Mr. G. F. Hill, of the Division of Economic Entomology, has perpared a statement outlining proposed lines of investigation on Australian varieties of termites. Steps are being taken to give effect to these proposals, of which particulars were published in the Council's Journal, Vol. 2, No. 3.

IX.—FOREST PRODUCTS INVESTIGATIONS.

1. *Division of Forest Products Research.*—The investigation of certain forest products problems was initiated in 1919 by the former Advisory Council of Science and Industry, the main lines of work being the investigation of hardwoods for paper making, a survey of the tanning materials of Australia, attempts to make suitable tannin extracts from marri kino (redgum),

and a study of the Powell process for wood preservation. Of these the paper study was conducted for some years and proved very successful. It was carried on from the laboratory stage, through semi-commercial and up to commercial stages. Not only has it led to the introduction into Australia of the industry of paper making from hardwoods, but it has pointed the way to the rest of the paper making world, a fact that is not often acknowledged abroad.

In 1928 the Council decided to establish a Division of Forest Products and appointed Mr. I. H. Boas, M.Sc., to the position of Chief of the Division. Arrangements were made for him to visit the Research Station of the Forest Products Research Board of the British Department of Scientific and Industrial Research, at Princes Risborough, England, and the Forest Products Laboratory, Madison, United States of America, to enable him to obtain the most recent information regarding the work and organization of these institutions and to establish the closest co-operation between them and the Council's Division in Australia. After his return to Australia, he formulated definite plans for the operations of the Division and recommended that at first attention should be devoted to seasoning, preservation, identification of timbers, general wood technology and utilization, and chemical investigations. During the past year a beginning has been made in all these directions. The question of the most suitable location of the laboratory was a difficult matter to decide, and after a long and very careful examination of all the possibilities the Executive Committee decided to take advantage of an opportunity to erect the laboratories on the Defence Departments area at Maribyrnong, Melbourne.* The principal arguments in favour of this site were the nearness to a centre of wood utilization which provides essential close contact between the timber trade and the researches, and also the fact that there was at Maribyrnong general service departments that would enable a saving in capital expenditure and annual cost to be effected.

The timber strike, which lasted during the whole time under review, prevented any very effective work being done in interesting the timber industries in the propssed lines of investigation. Nevertheless the Chief of the Division and certain of his officers were able to visit a number of industrial establishments, and a great deal of information has been collected in regard to the present practice in utilization and the problems that await solution.

2. *Seasoning.*—It became evident very rapidly that the greatest demand was for help in seasoning problems. The position in this regard is unsatisfactory in all the States. The timber trade has awakened to this fact, and urgent requests for advice and assistance were received by the Division from four States. It was found possible to obtain the services of Mr. Stanley Clarke, on loan from the Western Australia Forest Department for this work. Mr. Clarke, in addition to surveying seasoning practice in South Australia and Victoria, has initiated work in the drying of *Pinus radiata* (*insignis*) for the South Australian Forest Service. Plans for co-operative work are well advanced in Tasmania, New South Wales and Queensland. It is probable that in all these cases, the State Governments, Timber Associations, or private companies will co-operate in the work and will contribute towards its cost.

The urgency of the demand has necessitated attention being devoted to relief work of this nature, rather than to consideration of specific fundamental investigations in this section. It is proposed to place the initiation of good seasoning practices in air and kilns before research, as it is held that practice is so far behind in the application of existing knowledge that the search for new knowledge is for the present of secondary importance.

3. *Preservation.*—The losses caused in Australia by the destruction of timber by white ants, fungi, teredo and other marine organisms amounts to a very large sum annually. The first step taken was to endeavour to collect data to indicate the extent of these losses and a questionnaire was prepared and sent out to various large timber using organizations, including railways, public works departments, and post offices. This information is being received and tabulated. It is sufficient to say that present indications are that the problem of preservation of our hardwoods is one of pressing importance. Plans have been prepared for a plant for pressure and open tank treatment, and it has been designed in such a way that all the known methods can be tested out.

A preliminary test of fence posts in Western Australia has been carried out and a project for an extensive investigation has been laid down for next summer. Steps are being taken for the preparation and seasoning of the posts. This work is being carried out in conjunction with the Western Australian Forest Department.

Field tests of various timbers preservatized by different methods at the Forest Products Laboratory, Madison, Wisconsin, United States of America, are being carried out in conjunction with the Division of Economic Entomology. This forms part of a world-wide scheme organized by Madison, and the Council's Division is co-operating for Australia.

* Since the end of the period covered by this report it has been found necessary to bring this whole matter further under notice.

Tests of powellized karri for telephone cross arms which were being carried out for the Postmaster-General's Department had failed to yield results owing to the destruction of the specimens by bush fires. The work is being repeated by the Forest Products Division in co-operation with the Division of Economic Entomology and the Victorian State Forest Commission.

A survey of the "fluarising" plant at Pemberton, Western Australia, for the Western Australia Forests Department has been made and the working of the plant brought up to date. In addition a scheme of records has been worked out which will enable a closer control to be maintained than was possible in the past.

Mr. J. E. Cummins is in charge of the preservation work and Mr. G. F. Hill, of the Division of Economic Entomology, is co-operating with him. It is hoped shortly to initiate co-operative work with the Mycologist of the Division of Economic Botany.

4. *Indentification and Technology.*—In co-operation with the Federal Forestry School at Canberra, a scheme for the identification of Australian woods is being worked out. The work is under the direction of Mr. C. E. Carter, of the Forestry School, and the Council has supplied the services of Mr. W. Leslie. The work planned is a complete microscopic examination of sections of timbers and the working out of a key for identification. The microscopic work is being supplemented by a chemical examination of the timbers with a view to finding constant chemical characteristics which can be applied to differentiate timbers where microscopic structure is insufficient for this purpose. At the same time the work is designed to obtain a knowledge of the chemical nature of the timbers and especially of those which seem to offer prospects of commercial value as sources of oils or other materials of value. Particular attention will be given to differences between durable and non-durable species, with the idea of developing the ideal preservative. This section of the work is in the hands of Mr. H. E. Dadswell.

5. *Tannin Extract.*—The tan survey initiated by the former Advisory Council of Science and Industry grew into work on the manufacture of a commercial extract from Australian materials and a semi-commercial plant was established in Perth, under the supervision of a local Committee. This has now been taken over by the Division of Forest Products.

Up to February, 1929, work had been concentrated on tuart (*Eucalyptus gomphocephala*), but this proved to be of no commercial value. Attention has since been given to karri bark, and the work indicates that this material has definite commercial possibilities. The extract made is being tested out practically by tanners. It is hoped that this work will lead to the establishment of a small industry utilizing one of the numerous waste products of the forest. The work is under the direction of Mr. W. E. Cohen, who has associated with him Messrs. C. R. Kent and A. L. Baldock.

6. *Utilization.*—So far work in this section has been restricted to the collection of data and assisting inquirers in the selection of timbers for specific purposes. The number of inquiries reaching the Division is rapidly growing.

7. *General.*—Plans for the building and equipping of a Forest Products Laboratory are in hand and it is hoped that the Laboratory will be ready for occupation in 1930. A large library of publications has been collected from every forest products centre. It is now being classified and catalogued. Visits to every State Forestry Service except Tasmania have been made by the Chief of the Division and satisfactory arrangements made for co-operation. Owing to the projected appointment of a new Conservator in Tasmania, the matter of co-operation with that State has been postponed until his arrival.

A committee to deal with standards for timber testing, grading and selection has been formed by the Standards Association of Australia and the Chief of the Division has been appointed as Chairman.

8. *Imperial Forestry Conference,* 1928.—The third British Empire Forestry Conference was held in Australia and New Zealand from August to October, 1928, the Council being represented by its Chairman, Sir George Julius, and the Chief Executive Officer, Dr. A. C. D. Rivett. The question of forest products was discussed by the Conference and a number of papers relating to various aspects of that matter were contributed. The Conference emphasized the importance of research on forest products problems and of close co-operation between institutions in different parts of the Empire engaged on such research.

X.—COLD STORAGE PROBLEMS.

1. *General Organization.*—In the previous Report it was stated that, largely by reason of the lack of the necessary personnel, it had not yet been possible to give effect to many of the recommendations made in the report of Dr. F. Kidd and Dr. W. J. Young, nor to proceed very far with the organization of any Division of Cold Storage Research that might be proposed. That position still remains and work in the field of cold storage has been limited to the isolated investigations on citrus fruits, bananas, and meat reported on last year.

2. *Co-operation with British Food Investigation Board—Proposed Expedition.*—The Council has continued to keep in close touch with the authorities of the British Food Investigation Board especially as some of the work done in Australia and in England deals with identically the same material. The Board is desirous of having further investigations made of all the factors concerned in the successful carriage of meat and fruit to England. For that reason it proposes to carry out surveys of all such factors (environmental conditions of production, temperatures of storage, ventilation in storage, conditions of the voyage, treatment after landing, &c.) right from the points of production in the various Dominions to the retail markets in Great Britain. Some work of this nature was carried out in Australia some years ago in connexion with the export of apples. The Board has now arranged to send an expedition to New Zealand to study problems relating to the preservation, transport and marketing of meat. It is proposed to attach two Australian investigators to the expedition largely for the purpose of special training in work of this nature. Eventually the investigators will devote themselves to food preservation work in Australia.

3. *Problems in Preservation of Citrus Fruit.*—Actual investigational work under the co-operative arrangements outlined in the previous annual report was commenced in August, 1928, when the effects of preliminary washing with various solutions on the storage life of Navel oranges were studied. The solutions used contained either bicarbonate of soda or borax. The effect of treating the skins of such washed oranges with small amounts of paraffin was also studied. A similar experiment was commenced some months later with Valencia oranges. In both series, investigations were made into the nature of the moulds to which the fruit was exposed from the orchard to cool store, and into the moulds which caused the wastage.

It has been decided to carry out another series of experiments on Navel oranges during the forthcoming season. The programme to be followed has been prepared in the light of the information obtained in the first two series of tests. In this third series the effects of degree of maturity of the fruit (as determined by acidity-sugar ratios) and of various temperatures of storage will be investigated.

4. *Banana Investigations.*—Mr. G. Williams, Director of Fruit Culture, Queensland Department of Agriculture and Stock, has been added to the committee controlling this work. The small experimental ripening chambers at the Universities of Melbourne and Queensland have proved quite satisfactory and have been in operation fairly continuously. They have been so constructed that the temperature and humidity of the fruit they contain can be altered at will.

In Queensland, the object of the preliminary experiment was to establish a definite ripening procedure for the Cavendish banana. To this end the American ripening procedure for the Gros Michel was tried out, but it soon became evident that while for the Cavendish the procedure, or slight modifications of it, gave excellent results, the average time taken was excessive for commercial purposes. Investigations are now being commenced with a view to hastening this time of ripening. Indications have already been obtained that the time can be cut down considerably by the use of suitable atmospheres. In Melbourne, bananas of different origin have shown very great differences in rate and evenness of ripening. Experiments are now in progress on the rate of respiration and changes in the sugar content of bananas during ripening.

Another important side of the investigations on bananas is that of the conditions of transport between Queensland and the southern markets. The State Railway Departments of Queensland, New South Wales and Victoria have agreed to co-operate in the investigation of this phase. The scope of this inquiry is (i) to investigate the conditions under which the fruit is being conveyed at the present time, and (ii) to conduct experiments with a view to improving these conditions. The Railway Departments have also agreed to fit a heating apparatus, known as Stone's apparatus, which is used extensively in Europe for heating banana vans, to an insulated wagon in each of the three systems. Initial experiments with these wagons have already been conducted.

It is hoped as a result of the investigations outlined above to develop a technique both of ripening and of transport whereby Queensland fruit may be landed on southern markets in a much more satisfactory condition than at present.

5. *Meat Problems.*—The Committee mentioned in the previous report continued its investigations throughout the year. It has now been appointed as a joint body of the Council for Scientific and Industrial Research and of the Australian National Research Council. Its name has also been altered and it is now known as the Meat Preservation Committee, its constitution having been considered such that it could furnish advice on the storage of all varieties of animal flesh. An Annual Report of the Committee (for the year ending 30th June, 1929) was published in full in the Council's Journal, Vol. 2, No. 3.

Attention has been given to the rapid freezing of fish and the results have been published. Work on the freezing of beef has also been continued. Towards the end of the period under review, a previous proposal of the Committee, namely, that a small experimental consignment of prime beef be sent to Great Britain in the frozen condition, was revived. Steps have been taken to obtain two young prime bullocks from each of three breeds, namely, Polled Angus, Shorthorn and Hereford. These animals will become available to the Committee in September. They will then be slaughtered and portions frozen and chilled. Inspections and tests of their appearance, eating qualities, &c., will then be carried out both in Australia and in England. It is hoped by this means to demonstrate that there are distinct possibilities in the export trade in frozen beef provided that the material exported is young and of prime quality.

XI.—OTHER INVESTIGATIONS.

1. *Geophysical Prospecting.*—The Imperial Geophysical Experimental Survey has now completed a considerable amount of investigational work in the field, and by the time it comes to an end (February, 1930) a mass of valuable information and data will have been obtained. As indicated in the previous report, the Survey is financed from equal contributions of the Empire Marketing Board and the Commonwealth, the contributions of the latter having been appropriated under a special Act, the *Geophysical Prospecting Act* 1928. The Survey is under the control of an Executive Committee consisting of representatives of the Council, the Development and Migration Commission, the Australasian Institute of Mining and Metallurgy, the various State Departments of Mines and the Institute of Physics. The actual details of the administrative work are largely attended to by officers of the Council.

The initial two field parties or sections have now been expanded into four. The gravimetric section has completed its work in the Gelliondale district, Victoria, where it investigated the underground delineation of a bed of brown coal. The deductions drawn from the measured variations of gravity agreed to a reasonable degree of accuracy with the information obtained from bores. The overburden in this case was approximately 100 feet. Following on its work at Gelliondale, the section was sent to an area near Lakes Entrance, Victoria. The object of the work in this particular area was to determine, if possible, the underground extension of a granite mass outcropping to the north. The information would have been of value in connexion with the search for oil and would have been checked by bores being put down in that connexion. After a few weeks' work, however, no indications of the existence of the granite underground were found. The electrical section has now been split into two in order to expedite the work. Field investigations have been concluded at the following localities :—Anembo and Captain's Flat, near Lake George, New South Wales ; Leadville, New South Wales ; Woods Point, Victoria ; and several areas in the Zeehan and Renison districts of Tasmania. In all the areas studied, indications have been obtained of the existence of ore bodies. In some cases, these indications have been quite definite and those obtained by more than one method have agreed. As the result of the valuable co-operation of State Departments of Mines, arrangements are now being made for these indications to be tested by bores. The electrical parties are now at Northampton, W.A., and Moonta-Wallaroo, South Australia, respectively. In addition to the search for ore bodies, some attention has also been given to the application of the Gish and Rooney method to the search for underground water. This work was carried out in the Victorian Mallee, but the results obtained to date have been somewhat inconclusive.

Towards the close of 1928, it was decided to establish a new section for the purpose of investigating the possibilities of the application of the seismic method of prospecting. It was realized that neither the time nor the funds available would be sufficient for a comprehensive investigation, but nevertheless it was felt that results of value would be obtained by an investigation on a somewhat smaller scale. The seismic section was accordingly established and field work commenced at Gulgong, New South Wales, early in 1929. The section is mainly confining its attention firstly to certain apparatus developed by Major E. H. Booth and the late Professor Pollack, of the Sydney University, and secondly to Askania seismometer equipment as used in seismic prospecting in Europe and other places.

Shortly after the close of the period under review, the survey suffered a very severe loss by reason of the most regrettable death of its Deputy-Director, Dr. E. S. Bieler. He was on a visit to the field party at Northampton, Western Australia, but on the way contracted acute pneumonia and died at Geraldton on the 25th July, 1929.

2. *Dairy Research.*—The Council has experienced considerable difficulty in initiating a programme of research on dairying problems. It is aware of the great importance of the dairying industry to the national welfare and realizes that the application of scientific knowledge to the industry must inevitably lead to a material increase in production. One of the difficulties met with, however, has been the reconciliation of conflicting views hitherto held as to the part which the Council might take in any organized scheme of dairy research.

At a meeting of the Standing Committee on Agriculture held in March, 1928, it was resolved :—

> "That this Committee is in accord with the suggestion that the Council for Scientific and Industrial Research should undertake research on problems affecting the dairying industry. It is considered that not more than one bacteriologist and one chemist would be required in the immediate future."

The Council accordingly invited applications for the positions of dairy bacteriologist and dairy chemist. In view, however, of subsequent developments and particularly of the practicability of bringing the Council's work on dairy research under the proposed Division of Animal Health and also of the further conflicting opinions which the Council received regarding the whole question of dairy research in Australia, it was decided not to make any appointments for the present. It was felt that in order to enable the Council to plan effectively any work undertaken in dairy research, a more intimate knowledge should be obtained of the general position of the dairying industry and that the facts underlying the extraordinarily diverse claims made by those associated with the industry, must be sought by a competent unprejudiced investigator. For this purpose, the Council was able to secure the services of Professor S. M. Wadham, School of Agriculture, University of Melbourne. His report has been received and the matter is still under consideration.

In the report of the British Economic Mission, to which reference has already been made, attention was directed, in referring to the work of the Development and Migration Commission and of the Council for Scientific and Industrial Research, to the importance of the more intensive use of, and increased productivity in, the already partially developed resources of Australia. The Mission stated that it had been struck by what had been seen and heard of the comparatively small degree to which intensive use is made of the land already in occupation in Australia. The more intensive use of land already settled or partially settled, might, at least cost, be productive of a greater increase in wealth and population than extensive schemes involving the construction of new railways, roads and other developmental works. The Mission suggested that the scope of the £34,000,000 Agreement should be enlarged to permit of the funds available under it being used in other ways and, in particular, to assist the work of scientific research through subsidies to appropriate institutions, by facilitating large scale experiments and the like.

The Commonwealth Government resolved to pursue inquiries in the directions recommended by the Economic Mission and decided that the dairy industry should be the first branch to be investigated. An economic and technical survey of the dairy industry is accordingly being undertaken jointly by the Development and Migration Commission, and the Council for Scientific and Industrial Research, and is under the control of a Committee of which Professor A. E. V. Richardson is Chairman.

The Council has welcomed proposals made by the Empire Marketing Board for the publication of an Empire Journal of Dairy Research and arranged for an article by Professor S. M. Wadham to be contributed to the first number of the Journal.

3. *Fuel problems.*—No change has been made in the policy of the Council towards research work relating to the important national problem of liquid fuels. It has therefore continued to watch the course of developments in other countries. Research in connexion with the production of liquid fuels from coal, either by low tempreature distillation or by hydrogenation, &c., involves the provision of complicated plant and is, therefore, costly. Moreover, large sums have been spent on such researches by private and public interests in various European and American countries. The British Fuel Research Board is in close touch with all the developments that have arisen in regard to such matters, and, as is well known, it itself has been engaged for many years on an extensive programme of liquid fuel research. As a result of the close liaison that exists between the British Department of Scientific and Industrial Research and the Council, and also the further development of team spirit in bodies interested in research throughout the Empire, Australia is in the fortunate position of knowing information concerning any important developments in the field of liquid fuel research will be made available to her. During the year 1928–29 two of the Council's officers, Messrs. J. R. Duggan and L. J. Rogers, who had previously been research students under the Science and Industry Endowment Fund Act, continued to work at the Research Station at Greenwich of the British Fuel Research Board. It is probable that both these officers will be taken over in the near future by industrial enterprises in Australia.

4. *Australian Radio Research Board.*—The annual report of the Radio Research Board for the period ended 30th June, 1929, was published in a very slightly condensed form, in the Journal of the Council for Scientific and Industrial Research (Vol. 2, No. 3, August, 1929).

The main investigation carried out under the aegis of the Board during the period under review was the field intensity work at the Universities of Sydney and Melbourne. The distribution of the field intensities of the larger (A Class) stations in Melbourne, Sydney and Hobart, has now been determined up to a distance of about 100 miles from the point of broadcasting. Some interesting and valuable results have been obtained. In Victoria, for instance, it has been found that the one millivolt per metre contour line is distant from Melbourne some 100 miles to the north, west and south, but that in the east where the country is broken and heavily timbered, it is much closer to the broadcasting stations, approaching to as close as 30 miles. It is thus believed that the well-known poor reception in Gippsland and further still to the east, is due to attenuation of the waves as they pass over the tall trees and hills which are to be found between that district and Melbourne. Results of a similar nature have been obtained in New South Wales, where it has been found that going north from Sydney rapid absorption takes place over the broken and wooded country that occurs in that area, whereas to the south there is little absorption until the watershed is reached, when rapid attenuation takes place. This field strength work is obviously of considerable importance in connexion with the location of further broadcasting stations in Australia and it is being continued.

The erection of the atmospherics recorder loaned by the Board to the Watheroo Magnetic Observatory, Western Australia, was completed towards the end of the year 1928. Continuous recording was commenced on the 1st November of that year, but owing to various delays in the arrival of measuring instruments and in the necessarily slow progress in the early stages of the work, little has yet been done in the direction of the reduction of the records obtained and their interpretation.

Early in 1929 arrangements were made for the Board to carry out an enlarged programme of research. Four additional investigators will be appointed to the staff of the Board, and of these, two will be located at the University of Sydney and two at the University of Melbourne. The programme provides for a continuation of the field intensity work at Melbourne, and also for an investigation aimed at the determination of the best methods of making practical measurements of modulation. Field intensity measurements will also be continued at Sydney. The programme also provides for work on fading and distortion and atmospherics at both places. A qualitative study of fading and distortion, to be followed by an investigation on the lines adopted by Appleton and his co-workers, will be undertaken. As regards atmospherics, a study will be made of (i) the regions of origin of such disturbances affecting various portions of Australia, (ii) the variation of their number and intensity both diurnally and seasonally, (iii) their predominant characteristics. It has been estimated that the above programme involves some three years' work. It has also been estimated that the programme will require the expenditure of about £16,500. The Postmaster-General's Department has agreed to provide £8,000 of this amount and the Council the remainder.

5. *Maintainance of Standards.*—The question of Commonwealth control of weights and measures has been brought before the Council and the former Institute of Science and Industry on several occasions. In 1926 the Council convened a representative Conference in order to obtain advice as to the action it should take in the matter. The Conference advised that the progress of Australia, its efficiency in industry, and the effectiveness of its defence system would be handicapped if some of the facilities which other countries possess in the way of national physical laboratories were not provided in Australia. The Council accordingly appointed a Committee to go thoroughly into the whole question of the provision and maintenance of legal physical standards on a uniform basis throughout the Commonwealth.

In 1927 the Chairman of the Committee, Professor J. P. Madsen, took the opportunity of a visit abroad to obtain first-hand information regarding ultimate standards and their maintenance in England, the United States, Canada and certain European countries. Valuable assistance was rendered by the British National Physical Laboratory, which prepared a report setting out the details of apparatus necessary for the provision of suitable Commonwealth standards and the approximate cost. The National Physical Laboratory, with the approval of the British Department of Scientific and Industrial Research, generously offered to carry out, free of charge, the whole of the initial standardization and verification of the standard apparatus which would be required by the Commonwealth, and to carry out the necessary reverification for a period of five years, also free of charge.

The final report and recommendations of the Committee have been received and transmitted to the Commonwealth Government. The Committee recommended that as a first step the Commonwealth Government should, under its constitutional powers, pass a Weights and Measures Act defining standards for the whole of Australia and adopting those standards which are legalized or recognized in Great Britain. It also recommended that the work should be carried out by the Council for Scientific and Industrial Research under the direct control of a Standards Board, and that it should be sub divided under the following headings :— (i) metrology, (ii) physics, (iii) electricity and wireless, and (iv) electro-techn cs and photometry.

It considered that suitable arrangements could be made for the work to be carried out at the Universities of Sydney and Melbourne and at the Laboratories of the Munitions Supply Board of the Defence Department.

The report and recommendations of the Committee were approved by the Council and were transmitted to the Commonwealth Government, which has decided that in view of the present financial position of the Commonwealth no action is to be taken to deal with the recommendations at present. The Commonwealth Attorney-General has given his opinion that the Commonwealth Parliament has full power to legislate on the subject of weights and measures on the lines indicated in the Committee's report. The report has been published in full in the Council's Journal, Vol. 2, No. 3.

6. *Standards Association of Australia.*—In its report, the British Economic Mission suggested that it would be greatly to the advantage of commerce and manufacture in Australia, if there were added to the present activities of the Council for Scientific and Industrial Research, the sphere of work which deals with the standardization and simplification of manufacturing processes. As a result of this suggestion, the Australian Engineering Standards Association and the Australian Association for Simplified Practice have been re-organized and combined under the title of the Standards Association of Australia, and the Commonwealth Government has decided that the Council shall be the means of liaison between the new Association and the Government. The Chairman of the Council (Sir George Julius) is also Chairman of the Standards Association.

7. *Flying Fox Problem.*—In the last Annual Report of the Council, it was stated that in view of the serious menace confronting fruitgrowers in New South Wales and Queensland through the depredations of flying foxes and of the failure of such suggested methods of control as poisoning, shooting, &c., it had been decided to approach the problem from a fundamental basis and to collect full information regarding the life-history and habits of the animal. The Council and the New South Wales and Queensland Departments of Agriculture accordingly agreed to contribute £500 each towards the cost of an investigation over a period of two years. Applications were invited for the position of investigator, and Mr. F. N. Ratcliffe was appointed to the post in March, 1929. He is carrying out a systematic biological study of the various species of flying fox and is collecting quantitative evidence of the losses caused in various districts to the fruit industries in New South Wales and Queensland, and of the distribution of the different species of flying foxes. A preliminary survey has been completed in Queensland and will be extended into New South Wales when the animals begin their southerly migration. There are four species in Australia, the commonest being *Pteropus poliocephalus*. The investigations will be concentrated mainly on that species as it is responsible for by far the greater part of the loss suffered by fruitgrowers. A progress report on the work has been received from Mr. Ratcliffe and will be published in the Council's Journal.

8. *Tobacco Investigations.*—The Australian Tobacco Investigation was initiated in July, 1927, as a result of a co-operative agreement between the Commonwealth Government, the five mainland State Governments, and the British-Australasian Tobacco Company. The Development and Migration Commission and the Council for Scientific and Industrial Research are responsible for carrying out the investigations. An Executive Committee has been appointed to control the finance and general policy of the investigation and an Advisory Committee, composed of the permanent heads of the five mainland State Departments of Agriculture, is consulted from time to time. Later, a Research Committee was also created, the objects being to relieve the Executive Committee of the necessity of deciding on technical details and to facilitate more effective supervision of the co-operative research. A staff of workers has been secured and an organized scheme of procedure has been planned and put into operation. A series of 24 separate projects are either already under way, or will be started during the financial year 1929-30.

In each of the five mainland States, the experimental work is being carried out in co-operation with the State Departments of Agriculture. Research work on the blue mould of tobacco has been assigned to the Council's Division of Economic Botany and reference to these investigations has already been made in this report.

The aim of the Australian Tobacco Investigation is the improvement of the tobacco industry. It is hoped to improve the quality and increase the quantity of Australian grown tobacco until at least the major part of the cured leaf used in Australian tobacco factories will be grown in Australia. Exploratory and general agronomical field tests are in progress in each of the five mainland States. Warehouse and factory tests have been made in Melbourne, Sydney and Perth.

9. *Mineragraphic Investigations.*—During parts of the years 1927 and 1928, Dr. F. L. Stillwell, who is the investigator engaged on this work, was seconded to the Development and Migration Commission in order that he might carry out some special geological investigations

on the Kalgoorlie mining field. On completion of that work, he returned to Melbourne, where he is pursuing the mineragraphic investigations which were inaugurated by the Council in January, 1927, in co-operation with the Australasian Institute of Mining and Metallurgy. The present field of work comprises the unusual telluride minerals which occur in abundance in the auriferous lodes of Kalgoorlie. It is hoped that the direct microscopic examination of these minerals will lead to results of economic value.

10. *Research in the Field of Secondary Industries.*—The Council has adhered to its policy, outlined in its previous report, in regard to investigations in the field of secondary industries. It is of the opinion that, in general, research work in the secondary industries may well be carried out by these industries themselves. They are more favorably placed to investigate their own specific problems than are the primary industries. The latter face many problems which possess a broad national character, and the investigation of them may legitimately be regarded as a function of the Government. Individual farmers, or even groups of them, cannot be expected to undertake the investigation of complex biological problems of continental significance. On the other hand, in the application of science to problems not of so wide a national character, the responsibility for research may well rest mainly with the industries concerned rather than with the Government. The main operations of the Council are therefore confined to primary industries. As regards secondary industries, it is felt, however, that it may be advisable in time to aim at the establishment of Research Associations of a nature similar to those already in existence in Great Britain. If such associations be formed in Australia, the Council will explore the possibilities of co-operation with the corresponding bodies in Great Britain. It is known that some of the latter would welcome such co-operation and would also welcome Australian firms as members, although in other cases requests to be admitted would not be favorably considered.

XII.—MISCELLANEOUS.

1. *Publications of the Council.*—Consideration has been given to the question of responsibility for the accuracy of scientific work and conclusions recorded in the various publications of the Council. The attitude that has been adopted is outlined in the fifth issue of the Journal. Briefly, it is considered that while it is the Council's duty to secure the best men available under prevailing conditions to take charge of its several Divisions, these men and their colleagues must carry full responsibility for the work which they place on record. They, and not the official heads of the organization, are entitled to receive in enhanced reputations and in other ways the reward of the excellence of their work. Hence, too, they must accept responsibility for errors if any occur.

The following publications were issued during the period under review :—

(i) *Bulletins*—

No. 36.—Kimberley Horse Disease, by D. Murnane and A. J. Ewart.
No. 37.—Paper-pulp and Cellulose from the Eucalypts by the Sulphite Process, by L. R. Benjamin and J. L. Somerville.
No. 38.—The Chemical Composition of Wool, by H. R. Marston.
No. 39.—The Utilization of Sulphur by H. R. Marston (with a preface by T. Brailsford Robertson).
No. 40.—Observations on the Hydatid Parasite, by I. Clunies Ross.
No. 41.—Bitter Pit of Apples in Australia, by W. M. Carne, H. A. Pittman and H. G. Elliot.
No. 42.—A Soil Survey of Block E (Renmark) and Ral Ral (Chaffey) Irrigation Areas, by J. K. Taylor and H. N. England.
No. 43.—The Bionomics of Fasciola Hepatica, by I. Clunies Ross and A. C. McKay.

(ii) *Pamphlets*—

No. 8.—Methods for the Examination of Soils, by J. A. Prescott and C. S. Piper.
No. 9.—A Forest Products Laboratory for Australia, by A. J. Gibson.
No. 10.—The Health and Nutrition of Animals, Reports by Sir Arnold Theiler and J. B. Orr.
No. 11.—The Tasmanian Grass Grub, by G. F. Hill.
No. 12.—The Cattle Tick Pest ; Report by Cattle Tick Dips Committee.
No. 13.—The Mechanical Analysis of Soils, by C. S. Piper and H. G. Poole.

(iii) *Quarterly Journal*—

Vol. I. No. 5.—August, 1928.
Vol. I. No. 6.—November, 1928.
Vol. II. No. 1.—February, 1929.
Vol. II. No. 2.—May, 1929.

In addition to these printed publications, the issue of a confidential Monthly Summary to members of the Council and of its State Committees, and to the principal scientific and technical officers, has been continued.

2. *Library.*—During the past year, 486 additional volumes have been placed on the shelves, of which number 280 are bound volumes of periodicals. As heretofore the number of special bulletins, pamphlets, and reports which have been catalogued and filed has been greater than the number of books and periodicals, and they perhaps form the more important part of the library.

An effort, which has met with some success, has also been made during the year to complete the sets of some of the more important periodicals by trying to obtain back volumes and missing numbers.

As the divisional libraries are formed, a good many of the works at present at the Headquarters library will have to be handed over to the Divisions. It is hoped, however, to maintain a nucleus of all the more important works on all subjects at the head offices of the Council, and to specialize more particularly in chemical technology and books relating to manufacturing processes.

In addition to its own functions, the Headquarters library will act as a co-ordinating body for the divisional libraries. A general catalogue of the contents of all the libraries will be maintained, and by this means the interchange of publications will be facilitated and overlapping prevented. The divisional libraries will contain mainly specialized works dealing with the subjects with which they are particularly concerned. They will be able to draw on the head office library for more generalised works and for publications on other subjects to which they need to make occasional reference.

3. *Catalogue of Scientific Periodicals.*—The publication of the catalogue of all scientific and technical periodicals in the public and semi-public libraries of Australia is nearing completion. The compilation, which has been carried out by Mr. E. R. Pitt, M.A., of the Melbourne Public Library, was greatly facilitated by the cordial co-operation afforded by the authorities of many libraries concerned. The object of the catalogue is to facilitate the work of scientific investigators in the Commonwealth. It is, for instance, particularly useful in a country of such large distances, for research workers to be able readily to ascertain which libraries contain particular periodicals they desire to see. Often such periodicals are comparatively rare in Australia. The value of the catalogue to librarians is also obvious.

Entries have already been received from 132 Australian libraries. In addition, some 213 publishing societies and departments have been asked for details as to works issued by them.

It is expected that copies of the catalogue will be available towards the end of 1929.

4. *Council Representation in Great Britain.*—Mr. F. L. McDougall, C.M.G., the Representative of the Council in Great Britain, and his officers have continued to furnish valuable reports on various matters and constitute a most useful means whereby the Council is readily able to obtain information on recent scientific developments in practically any subject whatever. Mr. McDougall maintains effective liaison between the Council and numerous research organizations and individual workers in Britain. In addition his services have been of particular value during the negotiations for co-operative investigations between the Empire Marketing Board and the Council. The promised contributions of the Board towards present and future scientific investigations of the Council have been most generous, and their total value is large.

5. *General Scientific Advice to the Government.*—The Council is coming more and more to be recognized as a source of general scientific advice to the Government, both on matters which it is itself investigating and on others also. Throughout the year a large amount of such advice was given on a wide range of subjects. In addition, advice was given as to Australian representation at a number of scientific congresses and other meetings of an international nature.

6. *Bureau of Information.*—The Council's Act provides that one of its functions shall be the establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters. Although a Bureau of Information has not yet been established as a special part of the Council's organization, a large amount of information on scientific and technical matters has been given to outside organizations and the general public.

The following list gives an indication of the varied nature of the inquiries dealt with during 1928–29 :—

(i) *Agriculture.*—Cape tulip weed ; wild chicory pest ; bee industry ; bunt in wheat ; drought resisting grasses ; weed destroyers ; storage of potatoes ; determination of flour strength ; damage to orchards by frost ; flax ; artificial farmyard manure ; vitamins in Australian butter ; sheep branding fluids ; coco nut fibre ; conservation of fodder ; potato by-products ; damage to orchards by frosts ; acidity of pineapple juice ; destruction of blackberry.

(ii) *Processing.*—Utilization of orchard waste ; chilling of beef ; blood albumen glue ; dehydration of fruit ; processing of dried fruit ; utilization of fruit waste ; writing inks ; " pearl essence " from fish scales.

(iii) *Minerals, Metals, &c.*—White clays ; stone ; pottery clays ; methods of analysis of phosphatic materials.

(iv) *Forest Products.*—Paper pulp ; essential oils ; beer barrel shives ; artificial silk ; grass-tree ; tanning materials ; baobab tree ; nitro-cellulose ; Huon pine oil.

(v) *Biological.*—Maize breeding ; sea lettuce ; dried fruit grubs ; cultivation of castor oil tree ; termites ; borers in timber ; mosquito pest ; poisoning of stock by saw-fly larvae.

(vi) *Miscellaneous.*—Utilization of fur of flying-fox ; paper mills in Australia ; plastic compositions ; wind-motor generators ; methods for examinations of preserved eggs ; production of radium in Australia ; power from tides.

7. *Research Work in Commonwealth Departments.*—In October, 1928, the Commonwealth Government asked the Council to undertake an inquiry regarding scientific research work carried out in Commonwealth Departmental Laboratories and to report on the questions of the prevention of any undesirable overlapping and of securing further co-ordination and efficiency by modification of existing arrangements. Statements were accordingly obtained from the several Departments concerned furnishing details of their research activities. A summary of the whole of the information thus received was prepared and copies of it were sent to the several Departments with an explanatory letter stating that in the opinion of the Council the results of the inquiry showed that there was no overlapping in research activities ; that the Council had already taken action to secure co-operation with Commonwealth Departments in all cases in which such Departments were concerned with researches initiated by the Council ; and that no further suggestion for co-ordination or closer co-operation could be made. The replies received indicated that all the Departments concurred with the views of the Council and a report was furnished to the Government accordingly.

8.—*Commonwealth Scientific Publications Committee.*—In the last annual report of the Council, it was stated that consideration had been given to the question of the publication of certain memoirs, reports, &c., embodying the results of special investigations on scientific matters in Australia, carried out by independent investigators or institutions. Frequently such memoirs and reports, though of great scientific value are not suitable, mainly on account of their length, for publication in any existing journals, or series of bulletins, &c., and no funds are available for their publication through any other channels ; nor are they attractive to commercial publishing houses. As a result, under circumstances that existed previously, there was a grave danger of the results of valuable investigations being lost to science and to subsequent workers in the same field.

On the advice of the Council, supported by the Meteorological Bureau, the Forestry Bureau and the Solar Physics Observatory, the Government has set up a Commonwealth Scientific Publications Committee, consisting of one representative of the Council, one of the Australian National Research Council and one of the Treasury. In addition, when any particular publication is being considered, a fourth member may be appointed in an *ad hoc* capacity, so that expert advice on the particular matter covered by the publication will be available. In 1928–29 a sum of £1,000 was made available to the Committee as a special appropriation.

The Committee has so far arranged for the publication of the following :—

Meteorological Observations of the First Shackleton (Nimrod) Antarctic Expedition, 1907–1909, by E. Kidson, O.B.E., D.Sc., &c., formerly of the Commonwealth Meteorological Bureau, now of the New Zealand Department of Scientific and Industrial Research.

Australian Rain Forest Trees, by W. D. Francis, Assistant Government Botanist, Queensland.

XIII.—FINANCIAL MATTERS AND STAFF.

1.—*Finance.* The statement of expenditure from 1st July, 1928, to 30th June, 1929, is as follows :—

			£
1. Salaries and contingencies			13,898*
2. Remuneration of Chairman and Members of Council			2,217†
3. Investigations—			
(i) Animal Problems—		£	
(*a*) Contagious pleuro-pneumonia and tuberculosis in cattle	414		
(*b*) Black disease	1,885		
(*c*) Parasitological	806		
(*d*) Paralysis in pigs	858		
(*e*) Sheep blow-fly	453		
(*f*) Haematuria in cattle	608		
(*g*) Braxy-like (Beverley) disease (Western Australia)	742		
(*h*) Cattle tick dips	£ 854		
Less contributions from Governments of New South Wales and Queensland	700		
		154	
(*i*) Flying fox pest		364‡	
(*j*) Visit of Sir Arnold Theiler		1,395	
(*k*) Miscellaneous		209	
			7,888
(ii) Plant Problems—Division of Economic Botany—			
(*a*) Central Laboratory—	£	£	
Salaries, &c.	2,605		
Capital	187		
		2,792	
(*b*) Tomato wilt		592	
(*c*) Bitter pit in apples		800	
(*d*) Arid flora		868	
(*e*) Poison plants		967	
(*f*) Noogoora burr		250	
(*g*) Miscellaneous		20	£
			6,289
(iii) Entomological Problems—Division of Economic Entomology—			
(*a*) Central Laboratory—			
Salaries, &c.	4,086		
Capital	1,1362		
		15,448	
(*b*) Noxious Weeds		494	
(*c*) Noxious insects		322	
(*d*) Sheep blowfly		686	
(*e*) Buffalo fly		746	
(*f*) Scouting work abroad (Farnham Royal &c.)		665	
(*g*) Miscellaneous		440	
			18,801§

* The main items of expenditure under this heading are salaries of the Administrative Staff at the Council's head office; staff and upkeep of State Committees; staff at Australia House; travelling expenses of head-office staff, members of the Council, &c., and printing and general office expenditure. The sum of £13,898 was provided as follows:—

From Consolidated Revenue Fund	£4,878
„ Science and Industry Investigation Trust Account	9,020
Total	£13,898

† Provided from Consolidated Revenue Fund.

‡ Contribution of £500 each have been received from the Governments of New South Wales and Queensland towards the cost of this investigation.

§ This expenditure will be reduced by half on receipt of contribution from Empire Marketing Board.

(iv) Animal Nutrition—Division of Animal Nutrition—			
(*a*) Central Laboratory—			
Salaries, &c.	6,056		
Capital	5,447		
		11,503	
(*b*) Field work, Waite Institute ..		1,718	
(*c*) Field Station, Beaufort, V.		365	
(*d*) Field Station, Kolendo, S.A. ..		134	
(*e*) Field Station, Moree, New South Wales		284	
(*f*) Field Station, Springsure, Queensland ..		553	
(*g*) Miscellaneous		107	
At Waite Institute in co-operation with E.M.B. and Adelaide University—			
(*h*) Mineral deficiencies in pastures ..		2,518	
			17,182
(v) Horticultural Problems of the Irrigation Settlements—			
Citricultural—			
(*a*) Research Station, Griffith—			
Salaries and incidentals	3,480		
Capital	3,448		
	6,928		
Contributions by New South Wales W.C & I.C.	1,500	5,428	
Viticultural—			
(*b*) Research Station, Merbein—			
Salaries and incidentals	3,477		
Capital	318	3,795*	9,223
(vi) Soil Problems—			
(*a*) Investigations at Waite Institute and Irrigation Areas—			
Salaries, &c. ..	2,345		
Capital	792		
		3,137	
(*b*) Miscellaneous		57	
			3,194
(vii) Food Preservation and Cold Storage—			
(*a*) Maturation and transport of bananas ..		1,510	
(*b*) Cold storage of meat and fish ..		428	
(*c*) Citrus preservation		672	
(*d*) Miscellaneous		445	
			3,055
(viii) Dairy Research—			
(*a*) Professor S.M. Wadham's investigations		299	
(*b*) Miscellaneous		3	
			302
(ix) Prickly Pear—			
(*a*) Grant for Investigations—			
Capital		1,000	
Maintenance		8,901	
			9,901
(x) Forest Products—			
(*a*) Forest Products Division		2,973	
(*b*) Tannin extracts		2,068	
(*c*) Wood technology		140	
			5,181

* £561 was received for sale of produce and credited to Trust Fund receipts.

(xi) Mining and Metallurgy—	
(*a*) Mineragraphic Investigations	194
(xii) Fuel Investigations—	
(*a*) Hydrolysis of hardwoods	439
(xiii) Radio Research	631
(viv) Maintenance of Standards	42
(xv) Library	1,503
(xvi) Catalogue of Scientific Periodicals	651
(xvii) Miscellaneous	1,849
Total of Item 3	£86,325

Grand Total of Expenditure.

From Science and Industry Investigation Trust Account	£95,345
From Consolidated Revenue	7,095
	£102,440

2. *Staff.*—The following is a list of the staff of the Council as at the 30th June, 1929. The list does not include typistes, laboratory assistants, and labourers, &c.

1. Head Office Staff.

Chief Executive Officer—A. C. D. Rivett, M.A., D.Sc.
Secretary—G. Lightfoot, M.A.
Assistant Secretary—G. A. Cook, M.Sc., B.M.E.
Chief Clerk and Accountant—H. P. Breen.

Library—

Librarian and Scientific Assistant—Miss E. Archer, M.Sc.
Assistant Librarian—Miss K. Ramsay.

Accounts, Staff, Stores—

M. G. Grace.
J. Derum.

Orders—

R. W. Constable.

Records—

P. Domec Carre.
H. T. Chadwick.

Clerical Assistant to Chief Executive Officer—Miss A. Slattery, B.A.
Clerical Assistant to Chairman—Mrs. N. Roberts.

2. Secretaries of State Committees.

New South Wales—

Brigadier-General I. G. Mackay—University of Sydney.

Victoria—

G. A. Cook, M.Sc., B.M.E.—314 Albert-street, East Melbourne.

Queensland—

Miss H. Todd, Cr. Ann and Edward streets, Brisbane.

South Australia—

E. V. Clark, B.Sc., University of Adelaide.

Western Australia—

L. W. Phillips, M.Sc., Box K.766, G.P.O., Perth.

Tasmania—

F. J. Carter, Box U.B., G.P.O., Hobart.

3. Australia House, London.

Representative in Britain—F. L. McDougall, C.M.G. (part time).
Scientific Assistant—A. S. Fitzpatrick, M.Sc. (part time).
Clerical Assistant—A. W. Stuart Smith (part time).

4. Division of Economic Botany.

At Botany Department, University of Sydney—
Chief—B. T. Dickson, B.Sc. (London), B.A. (Ontario), Ph.D. (Cornell).
Senior Plant Pathologist—H. R. Angell, B.Agr.Sc., Ph.D.
Laboratory Assistant—W. H. Wilson.

At Canberra—
Senior Plant Geneticist—J. R. A. McMillan, B.Agr.Sc., M.Sc.

At Head Office, Melbourne—
Mycologist—C. C. Brittlebank.

At Waite Agricultural Research Institute, South Australia—
Junior Plant Pathologist—J. G. Bald, B.Agr.Sc.

At Department of Agriculture, Western Australia—
Senior Plant Pathologist—W. M. Carne, F.L.S.
Junior Plant Pathologist—H. A. Pittman, B.Sc.Agr. (Resigned 28th February, 1929).

At University of Sydney, under direction of Poison Plants Committee—
Assistant Research Officer—C. B. Cox, B.Sc.
Chemist—A. A. Luciano, B.Sc. (resigned 13th March, 1929).
Chemist—E. H. Kipps, B.Sc. (*vice* A. A. Luciano, resigned).

At Koonamore Vegetation Reserve, South Australia (under part-time direction of Professor T. G. B. Osborn)—
Research Officer—T. B. Paltridge, B.Sc.

In Queensland—
Investigator—Jean White-Haney, D.Sc. (seconded from Head Office).

5. Irrigation Settlement Problems.

Commonwealth Research Station, Griffith—
Liaison Officer—F. K. Watson, M.A., B.Sc., A.M.Inst.C.E. (part time).
Officer-in-Charge—E. S. West, B.Sc., M.S.
Accountant—D. Chalmers (part time).
Orchard Superintendent—B. H. Martin.
General Assistant—W. B. Robson (ceased duty 18th June, 1929).
Field Assistant—E. F. Mackenzie.
Clerical Assistant—Miss E. A. E. Smith.

Commonwealth Research Station, Merbein—
Officer-in-Charge—A. V. Lyon, M.Agr.Sc.
Agricultural Officer—J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.
Botanical Assistant—C. Barnard, B.Sc.
Secretary and Field Officer—J. E. Giles.

6. Soil Problems.

At Waite Agricultural Research Institute—
Soils Advisor—Professor J. A. Prescott, M.Sc. (part time).
Soil Survey Officer—J. K. Taylor, M.Sc., M.Agr.Sc., B.A.
Assistant Field Officer—T. T. Marshall, B.Agr.Sc.
Assistant Chemist—H. G. Poole, M.Sc.

At Commonwealth Research Station, Griffith—
Assistant Soil Chemist—H. N. England, B.Sc.

At University of Tasmania—
Assistant Soil Chemist—C. G. Stephens, B.Sc.

7. Animal Problems.

At University of Sydney—
Parasitologist—I. Clunies Ross, D.V.Sc. (Proceeded to Japan on 1st June, 1929, to undertake post-graduate work in parasitology).

At Glenfield Research Institute, New South Wales—
Veterinary Officer—W. A. Carr Fraser, B.V.Sc. (on loan to the New South Wales Department of Agriculture, until 23rd March, 1929, when proceeded abroad for post-graduate work in animal nutrition).

At Nyngan Experimental Farm, New South Wales—
Veterinary Officer—C. R. Mulhearn, B.V.Sc. (on loan to the New South Wales Department of Agriculture).

At Melbourne University Veterinary Research Institute—
Advisor—Professor H. A. Woodruff, M.R.C.V.S. (resigned 31st December, 1928).
Veterinary Officer—A. W. Turner, B.V.Sc.
Veterinary Officer—T. S. Gregory, B.V.Sc. (resigned 16th February, 1929).
Veterinary Officer—D. Murnane, B.V.Sc.
Laboratory Assistant—A. E. Wright.

At Adelaide Hospital Pathological Laboratory—
Veterinary Officer—C. G. Dickinson, B.V.Sc.

At Department of Agriculture, Western Australia—
Veterinary Officer—H. W. Bennetts, M.V.Sc. (seconded from Department of Agriculture, Western Australia).
Assistant Veterinary Officer—R. Harley, M.R.C.V.S.

8. Division of Animal Nutrition.

At the University of Adelaide—
Chief—Professor T. Brailsford Robertson, Ph.D., D.Sc.
Chief Assistant—J. Ward Walters.
Biological Officer—H. R. Marston.
Chemist—R. G. Thomas, B.Sc.
Assistant—J. D. O. Wilson.
Statistical Recorder—G. W. Bussell.
Typiste-Secretary—Mrs. E. V. Wilson.
Cadets—D. Graham, H. J. Lee, R. Trowbridge.

At the Waite Agricultural Research Institute—
Field Officer—E. W. Lines. B.Sc.
Assistant Field Officer—A. W. Peirce, B.Sc.

At "Buln Gherin" Sheep Station, Beaufort, Victoria—
Field Assistant—A. R. Beggs.

At "Meteor Downs" Sheep Station, Springsure, Queensland—
Field Assistant—C. Brown.

At "Keytah" Sheep Station, New South Wales—
Field Assistant—O. K. Samuel.

9. Mineral Deficiency of Pastures Investigation.

At the Waite Agricultural Research Institute—
Agronomist—K. M. Fraser, B.Agr.Sc.
Analytical Chemist—R. E. Shapter, A.A.C.I.

10. Division of Economic Entomology.

At Canberra—
Chief—R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S.
Forest Entomologist—G. F. Hill.
Senior Entomologist—I. M. Mackerras, M.D.
Curator and Executive Officer—G. A. Waterhouse, D.Sc., B.E.
Entomologist—G. A. Currie, B.Sc., B.Agr.Sc.
Entomological Assistant—Miss M. Fuller, B.Sc.
Scientific Assistant—Mrs. H. Willings, B.A.
Field Assistant—H. Willings, B.A.
Entomological Assistant—Mrs. F. L. Benham, B.A.

At Farnham House Laboratory, England—
Junior Entomologist—F. G. Holdaway, M.Sc., Ph.D.
Junior Entomologist—S. Garthside, M.Sc.
Junior Entomologist—J. W. Evans, B.A.

At Buitenzorg, Java—
Junior Entomologist—G. L. Windred, B.Agr.Sc.

At Northern Australia—
Junior Entomologist—T. G. Campbell, B.Sc.

11. Division of Forest Products.

At Head Office Melbourne (temporarily)—
Chief—I. H. Boas, M.Sc.
Seasoning Officer—S. A. Clarke, B.E., A.M.I.E. (Aust.)
Preservation Officer—J. E. Cummins, M.Sc.

At Tannin Extract Laboratory, University of Western Australia—
Supervisor—Professor N. T. M. Wilsmore, D.Sc., F.I.C. (part time) resigned 15th October, 1929.

Officer-in-Charge—W. E. Cohen, B.Sc.
Chemist—D. Coghill (ceased duty 30th November, 1928).
Assistant Chemist—J. Baldock (temporary).

At Commonwealth Forestry School, Canberra—
Chemist—H. Dadswell, M.Sc.
Assistant Chemist—J. R. Leslie, B.Sc.

At Technological Museum, Sydney—
Chemist—W. G. Arneman, B.Sc. (temporary).

12. Cold Storage Investigations.

At University of Melbourne—
Adviser and Investigator—Associate Professor W. J. Young, D.Sc. (part time).
Assistant Biochemist—W. A. Empey, B.V.Sc.
Biological Assistant—E. W. Hicks, B.Sc.

At University of Queensland—
Biological Assistant—F. E. Huelin, B.Sc.

13. Other Investigations.

Mineragraphic Investigations—
Investigator—F. L. Stillwell, D.Sc.

Flying-fox Investigation—
Investigator—F. N. Ratcliffe, B.Sc.

Radio Research—
At University of Melbourne—
Investigator—R. O. Cherry, M.Sc. (part time).
At University of Sydney—
Investigator—W. G. Baker, B.Sc. B.E. (part time).

Fuel Research—
At Fuel Research Station, East Greenwich, England—
Investigator—J. R. Duggan, B.Sc. B.E. (seconded to British Fuel Research Board).
Investigator—L. J. Rogers, B.E. (seconded to Btitish Fuel Research Board).

XIV. ACKNOWLEDGMENTS.

The Council desires to acknowledge the very valuable assistance so freely afforded by many organizations and individuals. The close co-operation that has been maintained with the Development and Migration Commission has continued to lead to valuable results.

It is also desired to make special reference to the various State Departments, particularly those of Agriculture, and to the Universities. The help these bodies have given in affording laboratory accommodation and the use of their other facilities has been invaluable. Other organizations, including Commonwealth Departments and independent bodies, have also been particularly helpful. Mention must also be made of many private individuals who have taken a keen interest in the work of the Council and afforded it much help.

G. A. JULIUS, Chairman,
A. C. D. RIVETT, Deputy Chairman and Chief Executive Officer,
A. E. V. RICHARDSON,
} Executive Committee.

G. LIGHTFOOT, Secretary.

APPENDIX.

A.—Personnel of the Council and of its various Committees.

COUNCIL.

Executive.

Sir George A. Julius, Kt. B.Sc., B.E. (*Chairman*).
A. C. D. Rivett, Esq., M.A., D.Sc. (*Deputy Chairman and Chief Executive Officer*).
Professor A. E. V. Richardson, M.A., D.Sc.

Chairman of State Committees.

Professor R. D. Watt, M.A., B.Sc. (New South Wales).
Sir David O. Masson, K.B.E., F.R.S., &c. (Victoria).
Professor H. C. Richards, D.Sc. (Queensland).
W. J. Young, Esq., C.B.E. (South Australia).
B. Perry, Esq. (Western Australia).
P. E. Keam, Esq. (Tasmania).

Co-opted Members.

Professor E. J. Goddard, B.A., D.Sc.
A. E. Leighton, Esq., F.I.C.
Professor H. A. Woodruff, M.R.C.V.S., &c.

Secretary,
G. Lightfoot, M.A.

STATE COMMITTEES (AS AT 30th JUNE, 1929).

New South Wales.

Professor R. D. Watt, M.A., B.Sc. (*Chairman*).
E. C. Andrews, Esq., B.A., F.G.S.
Professor Sir Henry E. Barraclough, K.B.E., V.D., B.E., M.M.E., M.Inst. C.E., M.I.Mech.E.
Professor H. G. Chapman, M.D., B.S.
G. P. Darnell-Smith, Esq., D.Sc.
C. H. Hoskins, Esq.
F. Leverrier, Esq., K.C., B.A., B.Sc.
F. D. McMaster, Esq.
J. Nangle, Esq., O.B.E., F.R.A.S.
Professor T. G. B. Osborn, D.Sc.
Professor J. D. Stewart, M.R.C.V.S., B.V.Sc.
G. D. Ross, Esq.

Victoria.

Emeritus-Professor Sir David O. Masson, K.B.E., M.A., D.Sc., LL.D., F.R.S. (*Chairman*).
Professor W. E. Agar, M.A., D.Sc., F.R.S.
W. Baragwanath, Esq.
W. R. Grimwade, Esq., B.Sc.
W. F. Cuming, Esq.
Associate-Professor W. N. Kernot, B.C.E., M.Mech.E., M.Inst.C.E.
Emeritus-Professor Sir Thomas R. Lyle, M.A., D.Sc., F.R.S.
H. A. Mullett, Esq., B.Agr.Sc.
F. J. Rae, Esq., B.Agr.Sc., B.Sc.
W. E. Wainwright, Esq., A.S.A.S.M., M.Aust.I.M.M., M.Am.I.M.M.
L. J. Weatherly, Esq., M.A.
Associate-Professor W. J. Young, D.Sc.

South Australia.

W. J. Young, Esq., C.B.E. (*Chairman*).
E. H. Bakewell, Esq.
Professor Kerr Grant, M.Sc., F.Inst.P.
W. A. Hargreaves, Esq., M.A., B.C.E., D.Sc., F.I.C.
W. J. Hill, Esq.
Professor T. H. Johnston, M.A., D.Sc.
Professor T. G. B. Osborn, D. Sc.
Professor A. J. Perkins.
F. T. Perry, Esq.
Professor J. A. Prescott, M.Sc.
L. K. Ward, Esq., B.A., B.E., D.Sc.

QUEENSLAND.

Professor H. C. Richards, D.Sc. (*Chairman*).
Professor H. Alcock, M.A.
J. D. Bell, Esq.
J. C. Brunnich, Esq., F.I.C.
H. T. Easterby, Esq.
E. Graham, Esq.
J. B. Henderson, Esq., O.B.E., F.I.C.
T. L. Jones, Esq.
A. J. B. McMaster, Esq.
Professor T. Parnell, M.A.
Professor B. D. Steele, D.Sc., F.R.S., F.I.C.
W. L. Payne, Esq.

WESTERN AUSTRALIA.

B. Perry, Esq. (*Chairman*).
F. G. Brinsden, Esq., M.I.M.M., M.Aust.I.M.M.
Professor E. de Courcy Clarke, M.A.
T. E. Field, Esq.
J. D. Hammond, Esq.
S. L. Kessell, Esq., M.Sc., Dip.For.
Professor G. E. Nicholls, D.Sc., A.R.C.Sc., F.L.S.
Professor A. D. Ross, M.A., D.Sc., F.R.S.E., F.Inst.P.
E.S. Simpson, Esq., D.Sc., B.E.
G. L. Sutton, Esq.
Professor H. E. Whitfeld, B.A., B.E., M.I.M.M., M.I.E.Aust.
Professor N. T. M. Wilsmore, D.Sc., F.I.C., M.I.Chem.E.

TASMANIA.

P. E. Keam, Esq. (*Chairman*).
Sir Alfred Ashbolt, K.B.
N. P. Booth, Esq., F.I.C.
Professor A. Burn, M.Sc., B.E.
H. A. Curtis, Esq., A.M.Am.I.E.E., A.M.I.E.Aust.
Professor A. L. McAulay, M.A., B.Sc., Ph.D., F.Inst.P.
D. O. Meredith, Esq., A.Inst.M.M., M.I.E.Aust., M.A.C.S.
A. K. McGaw, Esq.
A. McIntosh Reid, Esq., A.I.M.E.
R. O. Shoobridge, Esq.
F. E. Ward, Esq.

STANDING COMMITTEE ON AGRICULTURE.

S. S. Cameron, D.V.Sc., M.R.C.V.S., Director, Department of Agriculture, Victoria (*Chairman*).
E. Graham, Esq., Under-Secretary, Department of Agriculture and Stock, Queensland.
Professor A. J. Perkins, Director, Department of Agriculture, South Australia.
G. D. Ross, Esq., Under-Secretary, Department of Agriculture, New South Wales.
G. L. Sutton, Esq., Director, Department of Agriculture, Western Australia.
F. E. Ward, Esq., Director, Department of Agriculture, Tasmania.

COMMONWEALTH RESEARCH STATION, MERBEIN—COMMITTEE OF CONTROL.

B. T. Dickson, B.A., Ph.D., Chief, Division of Economic Botany (*Chairman*).
Professor T. G. B. Osborn, D.Sc., University of Sydney.
Professor J. A. Prescott, M.Sc., Waite Agricultural Research Institute, University of Adelaide.

COMMONWEALTH RESEARCH STATION, MERBEIN—ADVISORY COMMITTEE.

D. Gordon, Esq., Mildura Vineyards Protection Board (*Chairman*).
S. P. Bromfield, Esq., State Rivers and Water Supply Commission, Victoria.
A. Lever, Esq., Mildura Vineyards Protection Board.
A. V. Lyon, Esq., M.Agr.Sc., Commonwealth Research Station, Merbein.
S. Thompson, Esq., Citrus Growers' Association, Merbein.
F. K. Watson, Esq., M.A., B.Sc., A.M.Inst.C.E., Commonwealth Citrus Research Station, Griffith, New South Wales.
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