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COMMONWEALTH OF AUSTRALIA.

FIFTH ANNUAL REPORT

OF

THE COUNCIL FOR SCIENTIFIC AND
INDUSTRIAL RESEARCH

FOR THE

Year ended 30th June, 1931.

S. Authority.

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I. SUMMARY OF WORK AND RESULTS.

1. *Introduction.*—The first part of this report (pages 5 to 12) is intended to furnish in a very brief summarized way information regarding the principal activities of the Council, and the nature and value of the work it is conducting, and to indicate some of the more economic results which have been achieved. Additional information regarding each of the branches of the Council's work is given in later parts of this report, while detailed results of its investigations are published in the Council's Bulletins, Pamphlets and quarterly Journal. Results of economic value cannot, of course, usually or even generally, be expected to follow from the majority of the Council's investigations within a relatively brief period. As will appear from this report many of the problems on which the Council has undertaken research are of a difficult and complex character, and it is only as a result of patient and painstaking efforts over a period of years that complete or even partial solutions of the problems can be obtained. In some cases the problems are of a relatively simple nature and direct methods of attack can be employed. In most cases, however, the problems are by no means simple, and a great deal of arduous fundamental work must be undertaken before there can be any hope of obtaining results which can be applied in industry. In spite of these difficulties, as the following records of achievement will show, the Council has made valuable progress in its work, and important results of great economic value, far exceeding the total expenditure of the Council, have already been achieved.

2. *Plant Industry.*—Until recently the Council's Division of Plant Industry suffered very serious disadvantages in carrying out its work inasmuch as it did not possess any properly equipped laboratories of its own. This was remedied towards the end of the year 1930 by the completion of the Division's Laboratories at Canberra. Moreover, the work of the Division could not be conducted with a maximum degree of efficiency in the absence of suitable plant houses, which were not available at Canberra until after the end of the year 1930-31. Further facilities originally provided for experimental plots adjacent to the Division's Laboratory at Canberra were for various reasons inadequate and unsatisfactory, but the Council has recently been able to obtain for these purposes part of the Duntroon Farm Area in the Federal Capital Territory, and it is, therefore, only quite recently that this important Division of the Council's work has been adequately equipped for the important and difficult work which it is undertaking.

One of the most important activities of the Division is in relation to plant diseases from which it is estimated that Australia suffers an annual loss of no less than £12,000,000. The results of the investigation on bunchy top in bananas completed a few years ago, and the recommendations made for the control of the disease, have been followed up by the New South Wales and Queensland Departments of Agriculture and by other interests concerned, and the banana industry has now been successfully re-established on large areas in these States. Further confirmatory evidence has been obtained between the relation of bitter pit in apples and immaturity at picking time, and it is now considered that a solution of the problem of the control of bitter pit has been found, and that the annual loss of £100,000 in Australian export apples may be reduced to negligible proportions. The investigations on blue mould in tobacco, a disease which is so serious a disability to the tobacco-growing industry in Australia, were continued during the year 1930-31, and results having an important bearing on the control of the disease have been obtained. Valuable progress has been made in the investigations on varieties of wheat resistant to flag smut, which cause an average annual loss of 3 per cent. In some districts losses of 10 per cent. are common, and losses of up to 50 per cent. have been known.

The object of the Division's work is the development of varieties resistant to the disease. Similarly, investigations are being pursued on foot rots, and progress has been made in the work which is being conducted for the purpose of ascertaining the susceptibility to the disease of different varieties of wheat. Spotted wilt of tomatoes is another disease which is frequently responsible for the total destruction of plantings. The transmission of the disease has been ascertained definitely to be caused by the bite of a thrips, and thus an important step has been taken towards the ultimate goal of economic control. Efforts are being made to develop resistant varieties of tomatoes. Further confirmatory experiments have been carried out on water blister of pineapples, which causes a loss of £12,500 per annum, and a simple method of control has been devised for commercial application. An important section of the Division's work is concerned with fundamental investigations on genetics and plant breeding. These investigations are concerned with the mode of inheritance of variations of plant characteristics with a view to facilitating the production of new types. Since wheat is the most widely cultivated crop for export purposes, and since the average yields for Australia are relatively low, the investigations are being concentrated on that cereal with the object of bringing about improvement in quality and yield. A carefully planned trial has been laid down on the Duntroon Farm Area. The Division is not, however, engaged in wheat breeding work along lines similar to those followed by the State Departments of Agriculture. Another important activity of the Division of Plant Industry is the introduction from abroad of new varieties of plants likely to be of value, particularly in the drier and drought affected areas of the Continent. Close co-operative arrangements have been made with various institutions abroad, particularly with the Bureau of Plant Industry at Washington, United States of America, for the exchange of plants of economic value, especially of cereals and forage crops. In order to make preliminary investigation of plants suitable for tropical and sub-tropical climates, arrangements have been made for the establishment of a small quarantine area at Gatton Agricultural College, Queensland, and about 140 new plants have already been planted at that place. In addition nearly 1,000 introduced plants have been established at Canberra, and there is reason to believe that about 40 at least of these are distinctly promising. Valuable progress has been made in the work on bud studies in fruit trees. This work is of very considerable practical importance since the adoption of the best methods of cultivation depends essentially on an accurate knowledge of the conditions regarding the development of fruit buds. Valuable work has also been carried out by the Division on a number of other problems including those of fluctuations in apple crops, biometrical studies, seed testing and regeneration of pastures.

3. *Entomology*.—An important section of the work of the Council's Division of Economic Entomology is devoted to the entomological control and eradication of weed pests. Satisfactory progress has been made in the investigations on the control of St. John's wort by insect enemies. Following on the discovery by the Council's investigations in Europe of certain species of insects (*Chrysomela*) which are destructive to St. John's wort, a number of consignments of the insects have been sent to Australia. The completion of the tests with these insects, both in England and Australia, proved conclusively that they are entirely confined to St. John's wort in their feeding habits, that they will not attack any plants of economic value, and that they are capable of destroying St. John's wort by causing successive defoliations. With the co-operation of the State authorities concerned, several thousand beetles and larvae have been liberated in selected localities at Myrtleford, Bright and Dargo in Victoria and near Tumbarumba in New South Wales. It is yet too early to state whether the colonies will spread by natural increase to such an extent as to effect any material destruction of the plant. In the United States of America, investigations made by an officer of the Council have resulted in the discovery of a fly which attacks the seed pods of Noogoora burr, a weed which already covers thousands of acres in Queensland and which is spreading at an alarming rate. Several consignments of the fly have been received in Australia, and as soon as the laboratory tests are completed, it is intended to take steps for liberation. When adequate supplies of the insects are available, the clearing of large areas of weed infested localities may be rendered possible at a nominal cost, and if this can be achieved the total increase in the value of the land thus made reproductive will amount to millions of pounds. Another weed pest in regard to which valuable progress has been made is ragwort which covers large areas in the Southern States. A consignment of larvae of the cinnabar moth, which attacks the plant and which was obtained from New Zealand, was liberated on ragwort in South Gippsland in December, 1930. Investigations are also in progress in connexion with the control of bracken fern and lantana.

During the year 1930-31 public attention was directed to the menace of the buffalo-fly pest to the cattle herds of Australia. The Council is not charged with the duty of attempting to control the pest by quarantine measures, &c., but it is investigating the problem with a view to the introduction and distribution of insect parasites and predators which attack the fly at

some stage of its life history. Work is being carried out by the Council both in the Netherlands Indies and in Northern Australia. As a result of the work in the former country, a great deal of light has been thrown on the problem, and twelve species of parasites have been discovered. Further investigations are necessary before any definite judgment can be given as to their suitability for the control of the fly in Australia, but arrangements are being made to introduce the most promising of the Javan parasites into Australia. In Northern Australia the work is centred at a Field Station at Burnside, where arrangements have been made for the rearing of parasites and for their distribution in the field. Surveys made by the Council's officers have shown that since 1929 the fly has spread some 60 miles eastward into Queensland, and that it has reached the east of the Leichhardt River beyond Burketown. The whole position has been the subject of several conferences, at which the advice of the Council was sought, particularly with reference to the question of setting up a buffer area. The recent spread of the fly indicates that a buffer area would have to be very considerably wider than previously anticipated. The expenditure necessary would be very great, and no guarantee could be given that it would be ultimately effective. It is considered that the eastward progress of the fly can probably be checked by the use of spray races at railheads and trucking yards and by control of stock routes. The Council is pressing on actively with its investigations on biological control in the hope that a suitable combination of parasites and competitors may be found which will reduce the intensity of the pest.

Probably no single problem is regarded by Australian primary producers as of equal importance, and no single source of loss as great as that caused by blow-fly attack in sheep. Whilst the quest for a means of adequate control of this pest is by no means hopeless, it is admittedly an exceedingly difficult problem. It involves slow and laborious investigations, and where so many able workers have failed in the past it cannot be expected that early spectacular results will follow the investigations which the Council is conducting. Although, therefore, progress must inevitably be slow, already very definite advances have been made in the Council's fundamental work on the problem. For example, accurate knowledge has now been obtained of the habits of the various species of blow-fly which attack sheep, and definite information has been acquired regarding the species which are "primary", i.e., which first attack uninjured sheep, and which are, therefore, responsible for the damage, and in the second place regarding those which will only "strike" the sheep after the way has been prepared for them by the attack of "primary" species. It has been established that there is a very definite series of the flies which arrive at successive stages in the process of decomposition. If these species responsible for "primary" strike can be controlled, the problem will be largely solved. During the year 1930-31 important progress was also made in investigations on the association of body strike with a stained condition of the wool. The organism responsible for one of the types of wool stain has been isolated and by artificially implanting cultures of it in the wool of sheep, it has been found that only the areas thus infected will be struck, the remaining parts of the fleece remaining untouched. This important line of investigation is being followed up closely. Experiments on control by trapping, carcase destruction, jetting and the application of curatives and preventatives are also being conducted.

Investigations on the clover springtail (lucerne flea) in Western Australia have resulted in the discovery of a predatory mite which it is hoped to establish in other parts of Australia where the springtail is a pest. Similarly, with respect to the grass grub which causes such serious damage and loss to pastures, particularly in Tasmania, a parasite has been discovered in New Zealand which destroys a grub closely related to the Australian species. This discovery has opened up a promising line of attack which is being pursued vigorously.

The difficult problem of the control of the apple thrips is being tackled mainly along the lines of investigations on repellents.

In co-operation with the Victorian Apiarists' Association, a research has recently been initiated on a nutritional disease of bees known as the "disappearing trick".

Progress is also being made in the tests which are being carried out on the efficiency of timber preservation processes against the attack of termites.

4. *Animal Health*.—At the end of the year 1930-31 the erection of the McMaster Laboratory in the grounds of the University of Sydney was nearing completion. The cost of building the laboratory is being paid from a gift of £20,000 made by Mr. F. D. McMaster, "Dalkeith," New South Wales. The laboratory will be ready for occupation in September, 1931, and the closest co-operative arrangements have been made with the Department of Veterinary Science of the University of Sydney.

In 1930-31 an agreement was reached with the Australian Pastoral Research Trust and the Empire Marketing Board to contribute funds on a £1 for £1 basis to enable several new investigations to be undertaken and certain other investigations, already initiated in a small way, to be enlarged. This work, which is being conducted by the Council, includes investigations on parasitological problems in Queensland, New South Wales and Tasmania, foot-rot and pizzle disease in Victoria, pregnancy disease of ewes and pulpy kidney of lambs in Tasmania, and field work in Victoria on vaccinations for black disease.

One of the outstanding achievements of the Division of Animal Health is the discovery and practical application of an effective vaccine against black disease of sheep. The economic value of this work will be realized when it is stated that the estimated annual loss from black disease in Australia is no less than £1,000,000 per annum. The Council has been informed authoritatively that the results of this work will lead to a saving of £100,000 per annum in Tasmania alone, with corresponding savings in other States affected. Satisfactory progress has been made in the work on the sheep disease in Western Australia known as braxy-like or Beverley disease. The organism responsible for this disease has been determined, and a vaccine against the disease has been evolved. Preliminary field tests have shown that the deaths from the disease may, by the use of the vaccine, be reduced to very small proportions. Investigations are also in progress in Western Australia, in co-operation with the State Department of Agriculture, on certain other diseases such as Gin-Gin disease, which is an obscure disease affecting young sheep, and Denmark cattle disease. The investigation of various parasitological diseases has been pursued actively and attended with a considerable measure of success. For some of them methods of control and eradication have been shown to be practicable. Similarly with regard to caseous lymphadenitis, a disease which causes such serious loss in the mutton export trade, much detailed information has been secured regarding the incidence of the disease, the methods of spread under natural conditions, means of prevention, &c., and good progress has been made in the work on the discovery of a suitable vaccine. Satisfactory progress has also been made in the Council's investigations on a number of other animal health problems.

Queensland and Northern Australia are responsible for practically the whole of the Australian exported beef and for many of the store cattle which are fattened in southern districts, and the Council has for some years past been urged by pastoralists in the north to undertake research work on conditions which militate against the success of their operations. During the year 1930-31 the Council was able to make definite progress in the arrangements for the investigation of these problems, owing to the offer of the Empire Marketing Board to contribute funds on a £1 for £1 basis with local contributions in Australia, and also the generous offer of the Queensland Government to place at the disposal of the Council its Stock Experiment Station at Townsville and to contribute a definite sum of money annually to match part of the funds offered by the Empire Marketing Board. (Since the end of the year 1930-31 the arrangements have reached finality and effect is being given to the co-operative agreement).

5. *Animal Nutrition.*—In the last Annual Report of the Council attention was drawn to the loss which had been suffered through the death of Professor T. Brailsford Robertson, Chief of the Council's Division of Animal Nutrition, which has its head-quarters at Adelaide. The Council has been fortunate in obtaining the services of Sir Charles Martin, M.A., D.Sc., F.R.S., formerly Director of the Lister Institute of Preventive Medicine, London, to take charge of the work of the Division. He took up his duties in Australia in March, 1931.

The work of the Division has been concentrated almost entirely on a fundamental study of sheep with a view to building up a body of knowledge which will enable definite guidance and advice to be given to pastoralists so as to enable them to overcome certain serious difficulties with which they are at present faced. During the year 1930-31 confirmatory evidence was obtained, as a result of field trials in Queensland, regarding the value of certain proteins as a supplementary feed to sheep. The results have shown that it is practicable under certain conditions to obtain an increase of over 30 per cent. in the weight of the fleece at a relatively small additional cost. Further work is necessary before the method can be made generally applicable, but the potentialities are promising and if the results can be applied widely they are likely to effect a material decrease in the cost of wool production.

The question of phosphorus deficiency is a very serious matter in many pastoral areas of Australia. Substantial progress has been made in the investigations of which the object is to determine the form of phosphorus with which the deficiency can be most economically combated.

Valuable progress has also been made in the investigations which are being conducted for the purpose of determining whether a deficiency of iodine exists in pastoral areas in Australia. So far the results have not given any evidence of such a deficiency, and it is evident that it is quite unnecessary for pastoralists in the areas investigated to use iodine licks.

During the year 1930-31 arrangements were made for the Division of Animal Nutrition to carry out part of the research work on sheep, initiated with funds made available by the Australian Pastoral Research Trust and the Empire Marketing Board. The object of this part of the work is to determine the best and most economical methods for the supplementary feeding of sheep during drought, and for combating the evils attendant upon insufficiency of phosphorus in the pastures. For this purpose a small building is being erected in order to test on a semi-large scale the results obtained in the laboratory. When this work is completed it will be practicable to give definite advice to pastoralists on this very important matter.

Work has been continued at the various small field stations which have been established in co-operation with several owners of sheep stations and which serve the dual purpose of enabling the results obtained in the laboratory to be tested on a practical scale and conversely of drawing the attention of the Council's investigators to practical problems in the field. Investigations on mineral deficiencies of pastures under the co-operative scheme initiated by the Empire Marketing Board and the University of Adelaide have been continued at the Waite Agricultural Research Institute. The general object of this 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 them. The nature of the pastures may be altered profoundly by the use of fertilizers, by the introduction of new pasture plants, and by varying the character of pasture management. Information on these very important matters is being accumulated, and since practically the whole of our sheep and cattle are maintained on indigenous pastures, and as in consequence grass must be regarded as Australia's most important crop and her outstanding source of wealth, the importance of these investigations is obvious.

6. *Soil Investigations.*—A new laboratory for the Council's Division of Soils Research was completed in September, 1930, at the Waite Agricultural Research Institute, Adelaide. The work of the Division has been confined almost entirely to investigations of the soils of our irrigation settlements with the main objects firstly, of advising settlers as to the methods to be adopted in order to make their areas more productive and to minimize the serious troubles with which many of them are faced, and secondly, to make investigations of the soils of virgin areas for future settlement and development, and thus to avoid costly mistakes similar to those which have been made in the past. Satisfactory progress was made during the year 1930-31 in the work on the Murray River Settlements, and it is anticipated that the whole of that work will be completed in about two or three years' time. The survey of the whole of the Renmark area and the work on the soils of the Lower Murray have been completed. The losses incurred in the settlements due to lack of soil investigations in the past, amount to very large sums of money, and the results of the work already carried out by the Council's Division indicate clearly not only that much of the loss could have been avoided had the necessary investigations been made, but also that future developments in irrigation settlement can be undertaken with a full knowledge, so far as suitability of soils is concerned, of the conditions essential for successful production. As an example of the practical importance and utility of the work of the Division, it may be mentioned that the investigation of the soils on the bed of Lake Albert at the mouth of the Lower Murray resulted in the abandonment of a project for reclamation, as it was shown that the project was likely to prove unsuccessful; in this way the saving of a very large sum of money, which would have been wasted, was effected. The Division is co-operating closely with the State Departments of Agriculture. Thus at the request of the Tasmanian Department a soil survey of King Island has been undertaken and is nearing completion. In the Murrumbidgee Irrigation Areas in New South Wales a great part of the survey of the rice soils has been completed, whilst in Victoria arrangements have been made for soil investigations to be conducted at Nyah and Tresco in co-operation with the Victorian Department of Agriculture and the University of Melbourne.

7. *Irrigation Settlement Investigations.*—The dried fruit industry of Australia has an annual turnover of nearly £3,000,000, and the viticultural and citricultural industries have led to the establishment of thousands of homes in the irrigation areas and to the expenditure of large sums of money on dams, channels, pumping stations, &c. Investigations have been undertaken by the Council on problems relating to dried vine fruits and to citrus fruits, which constitute the main production of these settlements. For these purposes research stations have in the past been established at Merbein and Griffith, respectively.

Since the establishment of the Viticultural Research Station at Merbein the yield of dried fruit per acre has been more than doubled and this increase has been accompanied by a substantial improvement in quality. It may, in fact, be claimed that the present satisfactory condition of the industry is in no small degree due to the results of the Council's work, which results are each year becoming more and more generally applied with consequent improvements in yields, processing methods and quality, and enhanced prices for the products. During the year 1930-31,

special attention was given to further improvement in processing methods, and investigations were initiated on the keeping qualities of dried fruit, a matter of much importance to the export trade. Irrigation investigations on the "duty" of water have been extended to the Renmark area, the work in the Mildura and Red Cliffs districts having resulted in an estimated saving of no less than £9,000 per annum. A great deal has been done by the Station in co-operation with the Department of Markets to reduce the extent of infestation of dried fruit by insect pests, and steps are being taken with a view to still further reducing the infestation to a minimum. The work of the Station has been materially assisted by a grant from the Australian Dried Fruits Control Board.

Steady progress has been made in the citricultural investigations at the Council's Research Station at Griffith. The citrus orchards at the Station have now reached the stage of bearing fruit and the results of the investigations in 1930-31 showed conclusively that certain practices and methods adopted at the Station must prove of substantial benefit throughout the areas. Already some of these practices and methods are being followed to an increasing extent by the settlers in the area.

8. *Forest Products.*—During the year 1930-31 the recently formed Division of Forest Products succeeded in establishing very close contact with timber organizations and individual millers, who have shown confidence in the work of the Division, and are now freely using its services. The policy adopted by the Division of devoting a large part of its activities to the application of existing knowledge with a view to the immediate improvement of the timber industries, and to the solution of pressing practical problems has continued to be successful, and is the basis of the confidence now placed by the industries concerned in the work of the Division. The Council has not yet been able, owing to financial considerations, to erect a properly equipped laboratory for the Division, but excellent use is being made of the limited facilities for experimental work which have been provided in the outbuildings at the Council's Head Office premises.

Although there have not yet been any further industrial developments as the result of the successful investigations on the manufacture of paper from Australian timbers, Mr. I. H. Boas, the Chief of the Council's Division, at the request of the Commonwealth Government, collaborated in preparing a report and recommendations on the position regarding the establishment of the paper-making industry in Tasmania. Further action for the establishment of that industry now depends mainly on economic and commercial factors with which the Council is not directly concerned. The investigations which were completed last year on the preparation of tannin extracts from certain Western Australian trees are being actively followed up by commercial interests, which propose to establish the industry on a large scale. Very satisfactory progress has been made in the Division's work on timber seasoning, and during the year 1930-31 a second experimental kiln was installed, the single kiln being unable to cope with the volume of work. A number of kilns and re-conditioning chambers have been installed in various parts of the Commonwealth in accordance with plans prepared by the Division. Definite seasoning schedules are being worked out for a number of the more important commercial timbers, and special attention is being given to *Pinus radiata* because of the very large operations in South Australia in the growth and utilization of that timber. Particularly valuable progress has been made in seasoning work on hardwoods for use for the manufacture of cases and boxes. In the experimental kiln $\frac{1}{4}$ -in. boards have been tried and re-conditioned in twelve hours with excellent results. In view of the difficulty in identifying certain Australian timbers merely by an examination of the sawn planks and of the importance to the timber industries of devising simple methods for identification, special attention is being given to that problem, and the results already obtained have proved to be of great assistance. Towards the end of the year 1930, a small experimental plant for work on timber preservation was completed; tests are being carried out with various methods of creosoting and valuable results have already been obtained. As an indication of the industrial importance of this branch of work, it may be mentioned that the various public utilities of Australia are faced with an annual bill of over £1,000,000 for necessary replacements of railway sleepers, telegraph poles, bridge timbers, &c.

An important and interesting investigation is that relating to the use of Australian timbers for the manufacture of butter boxes. Frequent complaints have been received from time to time that butter exported in boxes of hoop-pine developed wood taint. Most Australian butter is at present exported in boxes of New Zealand white-pine. The experiments have been most successful, and a rapid and cheap method has been developed for treating timber so as to prevent taint. Large scale tests are now in progress and an application has been made for a patent for the process.

Other successful investigations have been conducted on the use of certain Australian timbers for the manufacture of wallboards, on the extraction of sandalwood oil from trees grown in Western Australia, and on extractives from certain Australian timbers which have a high resistance to the attack of termites and fungi. Many timber organizations and individual firms have expressed their high appreciation of the valuable assistance rendered to them by the Division.

Whilst attention has been given mainly to practical problems of immediate importance, fundamental research, which is essential for the solution of many problems connected with Australian timbers, has not been neglected.

9. *Miscellaneous Investigations*.—In addition to the work of its six main Divisions referred to in the preceding paragraphs other investigations are either in progress or have already been completed. In 1930–31 the Council's work on problems connected with the cold storage and preservation of foodstuffs gave definite results of considerable industrial importance. The investigations on the transport and ripening of bananas were practically completed, and have resulted in the development of improved and very efficient methods for which a patent application has been lodged. It is understood that the process evolved by the Council is to be adopted commercially on a large scale at an early date. The work on the preservation of citrus fruits has shown the way in which Valencia oranges can be stored satisfactorily for long periods. These results are also being widely adopted industrially.

The extraordinarily valuable and spectacular results achieved in the destruction of prickly pear by insect enemies are now well known. The scientific work is being carried out by the Commonwealth Prickly Pear Board, which was created by the former Advisory Council of Science and Industry and has continued as an important activity of the Council in co-operation with the Queensland Prickly Pear Lands Commission and the New South Wales Department of Agriculture. The progress made in the destruction of pear, particularly by *Cactoblastis cactorum* is most satisfactory, and it is estimated that the original heavy growth of pear has already been destroyed over at least 3,000,000 acres. An Act for the settlement of the cleared lands has been passed by the Queensland Parliament, and large areas of lands formerly heavily infested by the pest are being made available for settlement. It is anticipated that in the next few years many millions of acres of further lands will be freed from the pest. It is impracticable to assess either the capital value of the work or the value of the increased production and benefits which are ensuing, but it is obvious that they must run into very large sums of money.

As regards investigations on the production of liquid fuels from coal, the Council has continued to maintain intimate contact with developments in other countries. A report on the matter was furnished by Dr. A. C. D. Rivett after his return from a visit to Europe in 1930, and was published as a Parliamentary Paper. As a result, close touch is being established with the international association recently formed between British, European and American interests.

The investigation on the flying fox problem has been completed, and a great deal of valuable light has been thrown on the problem.

The investigations on the mineral content of gold bearing ores have been continued with satisfactory results, and surveys made in various districts have indicated the existence of promising lodes worthy of further prospecting by bores, shafts and crosscuts.

The report of the Imperial Geophysical Experimental Survey has been published and has been reviewed very favorably in scientific Journals in many countries.

The arrangements made for the Australian tobacco investigations lapsed at the end of June, 1930. There was some delay in the negotiations for the continuance of the work, but a new Committee has been appointed to control it. The scientific investigations are being conducted by the Council's Division of Plant Industry.

Throughout the course of a year the Council receives many hundreds of requests for scientific information and advice on matters concerning the primary and secondary industries of the Commonwealth. There is no doubt that in this field the Council has met a definite want, and has indirectly been responsible for many improvements in industrial practices.

To sum up, the Council has already been responsible for large national savings many times greater than its annual cost, and its possibilities in the not far distant future are even greater. That various commercial and other interests concerned are fully aware of this position is indicated by the numerous grants in money and in kind and the assistance in the way of gratuitous services rendered to the Council. Sufficient has been said in this summary to indicate that scientific research is not only a most potent instrument in the efficient development of our industries and in the financial and economical rehabilitation of the Commonwealth, but also that it is capable of paying higher dividends in the form of practical results than any other type of national activity.

10. *Financial Provision for Research.*—Special attention was given by the Research Committee of the Imperial Conference, 1930, to the question of the provision of funds for national research. In its report the Committee stated that whilst the existing machinery for Imperial co-operation might be regarded as reasonably satisfactory, its efficacy will ultimately depend on the provision of adequate funds to enable the services in the different parts of the Empire to maintain and extend the scope of their operations. The Committee drew attention to the danger of Governments, in times of financial stress, being tempted to economize in the expenditure on scientific services on the grounds that the need for them is less urgent than for other forms of expenditure, and that research can well be put on one side until prosperous conditions return. The Committee emphasized the point that the need for scientific investigations and for the application of the knowledge gained thereby is more urgent when industries are depressed than when they are flourishing. Research cannot be expected to yield fruitful results if it is pursued in fits and starts. The Committee embodied its views in the following resolution :—

The Research Committee of the Imperial Conference, being convinced that progress will in the future be dependent to an increasing extent upon the growth and application of scientific knowledge, desire to direct the attention of the various Governments of the British Commonwealth of Nations to the importance of making adequate provision from State funds for the steady pursuit of scientific research into the various problems affecting the material well-being of mankind. They also desire strongly to urge their views that the severe economic depression from which the British Empire, in common with the rest of the world, is now suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utilization of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones.

The matter was considered by the Council at a meeting held in August, 1931, when a resolution was passed expressing appreciation of the financial support given by the Commonwealth Government to the work of the Council in a time of financial stress, of the generous gifts of money and material provided from outside sources (particularly from the Empire Marketing Board, the Pastoral Research Trust Fund and the Rural Credits Development Fund of the Commonwealth Bank) and of the valuable co-operative assistance given by the Government Departments, Universities and other institutions. The Council reiterated the belief that a country like Australia, which is dependent for its prosperity to such an extent on the welfare of its primary industries, must look to an increasing degree to scientific research to overcome many of the problems with which these industries—and particularly the pastoral and agricultural industries—are faced and thus to help to place them on a more secure basis.

II.—ORGANIZATION AND CO-OPERATION.

1. *Major Divisions of Council's Work.*—In regard to the major sections of the work on which the Council is engaged, it has adopted the policy of establishing Divisions and of placing each Division under the control of a recognized authority in the sciences concerned. Up to the present six Divisions have been formed, viz. :—

- (i) The Division of Plant Industry—Dr. B. T. Dickson, Ph.D., &c. (Chief).
- (ii) The Division of Economic Entomology—Dr. R. J. Tillyard, F.R.S., D.Sc., &c. (Chief).
- (iii) The Division of Animal Nutrition—Sir Charles Martin, F.R.S., D.Sc., &c. (Chief).
- (iv) The Division of Animal Health—Dr. J. A. Gilruth, D.V. Sc. (Acting Chief).
- (v) The Division of Soils Research—Professor J. A. Prescott, M.Sc. (Chief).
- (vi) The Division of Forest Products—Mr. I. H. Boas, M.Sc. (Chief).

In addition to the work of the six Divisions already established, a considerable number of other investigations are either in progress or have already been completed.

2. *The Council.*—During the year 1930–31 only one meeting of the full Council was held, viz., in August, 1930. In the past the practice has been to hold two meetings each year, but the meeting which should have been held in about March, 1931, was postponed for reasons of economy.

3. *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 36 meetings of the Executive Committee, allowing one meeting per day, were held. The 199th meeting of the Committee was held on 4th June, 1931.

4. *State Committees.*—The constitution of the 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, 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 of which the importance and potentialities had not been fully realized.

5. *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. The Council is gratified at the co-operative assistance rendered to it both by Commonwealth and State Departments and by the Universities. Not only have these bodies willingly adopted suggestions for co-operation made to them by the Council, but they have also in many cases themselves freely offered assistance. In previous issues of the Council's annual reports, particulars were given of the various investigations that are being conducted in co-operation with one or more of these bodies. It is not necessary to repeat these particulars in this report. It will suffice to state that very close co-operative arrangements have been established with all these scientific departments and other similar organizations throughout the Commonwealth, and that by far the greater part of the Council's investigations is, in fact, being conducted on a co-operative basis with one or more of them. In particular, as will appear from later parts of this Report, the Council has derived great advantage from its close association with the Waite Agricultural Research Institute of the University of Adelaide.

6. *Imperial Co-operation.*—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 this connexion, very close relations have been established with the Empire Marketing Board. 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, close relations have been established with bodies corresponding to the Council in other parts of the Empire.

7. *Agricultural and Pastoral Research.*—As a great deal of the work of the Council relates to problems affecting the agricultural and pastoral industries, special mention may be made of one or two matters concerning the organization and co-operation with respect thereto :—

(i) *Standing Committee on Agriculture.*—The Council's Standing Committee on Agriculture was appointed in 1927, and consists of the permanent heads of the six State Departments of Agriculture and of representatives of the Council. The principal objects in creating the Committee were firstly to ensure that there shall be intimate collaboration between the Council and the State Departments of Agriculture, and, secondly, to obviate undesirable duplication of effort in research work. Ordinarily the Committee meets twice a year, one meeting being held concurrently with the meeting of the State Ministers of Agriculture and the other some six months later. Owing mainly to the need for economy in expenditure on travelling, only one meeting of the Standing Committee was held during the year 1930–31, viz., in August, 1930. Some of the more important matters considered at that meeting were :—Tobacco investigations, dairy investigations, seed testing, the development of the Council's work on animal health problems, the question of Australia's contributions to the International Institute of Agriculture, problems connected with the export of apples, the introduction into Australia of new plants of economic value, and plant diseases.

The Standing Committee on Agriculture performs a most useful function in respect of co-ordination and development of research on agricultural and pastoral problems in Australia, and it is regretted that no meeting of the Committee has been held since August, 1930. Nevertheless, the Council has maintained close contact, so far as practicable, with individual members of the Committee by letter.

(ii) *Register of Agricultural Research.*—In order that research workers in Australia may be cognisant of the investigations which are being undertaken by the Council and by the State Departments of Agriculture and other institutions, arrangements were made for the compilation

by the Council of a Register of Agricultural Research from information furnished by the various Departments and Institutions concerned. Copies of the first Register were made available in 1928, and a Supplement bringing it up to date furnished in the following year. It is proposed to issue a new edition of the Register in 1932.

The Register has been of very considerable use in promoting direct contact between workers on various problems and in furnishing information not previously available as to the research activities on agricultural and pastoral problems in the Commonwealth. The Register has thus helped materially to bring about co-ordination of effort and to obviate duplication.

(iii) *Imperial Agricultural Research Bureaux*.—As a result of recommendations made by the first Imperial Agricultural Research Conference, which met in London in 1927, arrangements were 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. The eight Bureaux which have been established are as follow :—

IMPERIAL AGRICULTURAL RESEARCH BUREAUX.

| Bureau. | Location. | Direction. | Australian Correspondent. |
|--|---|--|--|
| Animal Nutrition .. | Rowett Research Institute, Aberdeen | Dr. J. B. Orr .. | Sir Charles Martin, Chief of Division of Animal Nutrition (C.S.I.R.), Adelaide |
| Animal Genetics .. | Animal Breeding Research Department, Edinburgh University | Professor F. E. Crew Deputy: Mr. Eldon Moore | Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne |
| Fruit Production .. | East Malling Research Station | Mr. R. G. Hatton .. Deputy: Mr. D. Akenhead | Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra* |
| Soil Science | Rothamsted Experimental Station, Herts | Sir John Russell .. Deputy: Dr. A. F. Joseph | Professor J. A. Prescott, Chief of Division of Soils Research (C.S.I.R.), Adelaide |
| Plant Genetics (Herbage Plants) | Welsh Plant Breeding Station, Aberystwyth | Professor R. G. Stapledon Deputy: Dr. R. O. Whyte | Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra |
| Plant Genetics (Plants other than Herbage) | Plant Breeding Institute, Cambridge | Sir Rowland Biffen Deputy: Dr. P. S. Hudson | Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra |
| Agricultural Parasitology | Institute of Agricultural Parasitology, St. Albans | Professor R. T. Leiper Deputy: Dr. B. G. Peters | Dr. I. Clunies Ross, Parasitologist, Division of Animal Health (C.S.I.R.), Sydney |
| Animal Health .. | Veterinary Research Laboratory, Weybridge | Dr. W. H. Andrews Deputy: Mr. W. A. Pool | Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne |

* Deputy Correspondent, Mr. W. M. Carne, Senior Plant Pathologist, Division of Plant Industry (C.S.I.R.), Perth.

III. PLANT INVESTIGATIONS.

1. *General*.—During the year 1930 laboratory buildings for the Division of Plant Industry at Black Mountain, Canberra, were completed and the staff of the Division moved into their new quarters during December of that year. The buildings consist essentially of a block of well-lighted and well-equipped laboratories, having on the ground floor rooms for plant pathology, physiology and genetics, and on the upper floor for plant introduction, agrostology, general botany, biometrics, noxious plants and herbarium. In addition, laboratories for the Australian Tobacco Investigation Committee are provided on the upper floor.

Glasshouses for pathological, genetical, physiological, plant introduction and tobacco studies, which are essential adjuncts to work in the laboratory and field, were nearing completion at the end of June, 1931. The funds for the erection of the glasshouse were made available partly by the Directors of the Commonwealth Bank from the Rural Credits Development Fund, partly from the funds of the Australian Tobacco Investigation Committee, and partly from other sources. The experimental plot area near the laboratory buildings at Canberra has been extended and a barn and shade-house have been erected.

In order to carry on satisfactorily the fundamental investigations on agrostology, genetics, plant introduction and pathology it is necessary to have an area of suitable land in reasonable proximity to the laboratory. The Commonwealth Government has accordingly made available about 100 acres of the Duntroon Farm area at Canberra for this work, and a grant from the Empire Marketing Board will enable necessary facilities to be provided and some additional staff to be appointed.

2. *Plant Diseases*.—In the preceding annual reports of the Council, attention has been directed to the very large losses incurred in Australia as a result of plant diseases and to the fact that it is estimated that the annual losses average about 10 per cent. of the value of all crops.

(i) *Plant Disease Survey*.—For the purposes of the work of the Division it is important to ascertain the dates and conditions of incidence, severity, localities affected, and success of control measures, &c., for the most important diseases of the principal crops.

Mr. C. C. Brittlebank has continued the collection of records of the occurrence of plant diseases in Australia with the result that there are now on file index-cards particulars of over 1,300 host plants with nearly 800 genera and over 6,000 species of fungi, bacteria, &c., which cause disease, together with 56,000 references to literature. In carrying out this work the State Departments of Agriculture have rendered valuable assistance.

(ii) *Apple Diseases*.—The investigations on the bitter pit and related diseases of apples have been continued by Mr. W. M. Carne, Senior Plant Pathologist of the Division of Plant Industry, in co-operation with Messrs. Pittman and Elliott, of the Western Australian Department of Agriculture, and with Mr. Thomas, of the Tasmanian Department of Agriculture. Further confirmatory evidence has been obtained concerning the relation of the incidence of bitter pit to immaturity at picking time. It is now considered that a solution of the problem of control of bitter pit has been found, and that the annual loss from this cause of about £100,000 in Australian export apples may now be reduced to negligible proportions. Further investigations are in progress concerning the incidence of water core and its relation to water core breakdown, to drought spot, internal cork and crinkle.

The importance of close correlation between the work in Australia and that being carried out by research organizations in England led to arrangements being made for Mr. Carne to make a travelling investigation abroad. The necessary funds were provided from a grant by the Empire Marketing Board. Reports received from Mr. Carne indicate that one of the major problems demanding immediate investigation is that of bruising in export fruits, since bruising is common and is the forerunner of fungal rots and breakdown. On his return to Australia in about October, 1931, a programme of work based on the results of his investigations will be prepared.

(iii) *Tobacco Diseases*.—Blue mould continued to occupy the greater part of the time given to tobacco diseases by Dr. H. R. Angell and Mr. A. V. Hill. As a result of field experiments carried out for the purpose of ascertaining the extent to which the disease spreads to healthy seed beds some considerable distances away from affected plants, effort was concentrated in the laboratory to determine the length of life of the conidia of the casual organism as affected by environment. Contrary to the hitherto generally accepted ideas regarding the longevity of conidia, it has been ascertained that those of the blue mould fungus may remain viable for a considerable period when exposed to extremely dry conditions. Preliminary results of this work, which have an important bearing on the control of the disease, will be published in the August, 1931, issue of the Council's quarterly Journal.

(iv) *Wheat Diseases*—(a) *Flag Smut*.—As pointed out in the last Annual Report of the Council, this disease causes heavy losses throughout the wheat-growing areas of Australia, the average annual loss having been estimated conservatively at 3 per cent. In some localities, however, losses of 10 per cent. are common. The object of the Council's work in this connexion is the duty of varietal susceptibility or resistance and the application of these results to the development of some resistant varieties. The casual organism is being investigated by Miss P. Jarrett. One of the main objects of her work was to determine whether the so-called resistant varieties were really immune from flag smut or whether they merely escaped the disease. Results have shown that provided a certain procedure is followed no variety so far tested is immune from infection. With reputedly resistant varieties infection was readily obtained. Tests are in progress on 40 varieties and 28 crosses, totalling 37,000 plants in the plots and 10,000 plants in the glasshouses, each tested individually.

(b) *Foot-rots*.—The term “foot-rot” is somewhat wide as it may be applied to the disease caused by any one of a number of fungi, the chief of which are species of *Fusarium*, *Helminthosporium*, *Wojnowicia* and *Ophiobolus*, with the first-named commonest. During the year several hundred specimens of diseased wheat plants were received from places throughout the Commonwealth, mainly through the State Departments of Agriculture, and hundreds of isolations were made therefrom. Mr. W. L. Geach has concentrated on the difficult problem of *Fusarium*, and Dr. H. R. Angell on the other organisms. They are being studied in culture with a view to determining whether strains of each or any are present, and tests are in progress with certain cultures to ascertain the relative susceptibility of various wheats.

(v) *Spotted Wilt of Tomatoes*.—The investigations on this disease were continued at the Waite Agricultural Research Institute by Mr. G. Samuel, an officer of the Institute, and Mr. J. G. Bald, an officer of the Division of Plant Industry. The host range of the disease has been increased to include natural occurrence on Iceland Poppy, Zinnia, and Nasturtium. The incubation period in the larval thrips has been determined as between five and seven days. Only thrips which have fed on diseased plants while in the larval stage are infective. It has been demonstrated that both *Frankliniella insularis* and *Thrips tabaci* are vectors only if they feed while in the larval stage on diseased plants. The results of the recent work will be published in a bulletin at an early date. In view of the probable difficulty in effectively controlling the casual insects, an effort is now being made to develop resistant tomato varieties.

(vi) *Pineapple Diseases*.—A third series of co-operative experiments with the Queensland Department of Agriculture and Stock aiming at control measures for soft rot (water blister) of pineapples were carried out during the summer months of 1931. Previous experiments had shown that salicylic, benzoic and boric acids applied to the cut stems would control stem infection which is responsible for 75 per cent. of the total loss. These results were confirmed by further experiments and a method of control has been recommended for commercial application. (See article in Council's quarterly Journal, August, 1931.)

(vii) *Coconut Diseases*.—As a result of arrangements made between the Commonwealth Government and the Papuan Administration, a second survey was made by Dr. H. R. Angell during May to August, 1930, of some of the coconut and rubber plantations in Papua. Generally the plantations were found to be free from serious diseases and comparatively free from those causing minor injury. Certain experiments, particularly with reference to the so-called stem bleeding disease of the coconut, were initiated by Dr. Angell, but it is yet too early to give definite information regarding their results.

(viii) *Powdery Scab of Potatoes*.—The Committee consisting of Dr. B. T. Dickson, Chairman, Dr. R. J. Noble (New South Wales), Mr. D. B. Adam (Victoria), and Dr. W. J. Dowson (Tasmania), continued the investigation into powdery scab of potatoes. Test plots were set out in Tasmania by Dr. Dowson with a view to ascertaining conditions of infection and the effect of planting clean tubers in land which had carried a crop with powdery scab. The work had not been completed by the end of June, 1931.

3. *Genetics and Plant Breeding*—(i) *Wheat*.—These investigations are concerned with the mode of inheritance and variation of plant characteristics of economic value with a view to facilitating the production of improved types. In view of the fact that wheat is the most important widely cultivated crop for export purposes, and that the average yields in Australia are relatively low, it was decided to concentrate on wheat problems with the object of ultimately improving the quality and yield per acre of this cereal. One of the most complicated problems is that of determining true drought resistance because of the physiological reactions involved. Nevertheless it is essential to attempt to ascertain the characteristics of true drought resistant wheats in order to be able to correlate those with other characters in breeding. Mr. J. R. A. McMillan in genetics and Mr. J. Calvert in physiology are tackling this problem. Certain wheats are being studied under controlled drought conditions, and physico-chemical studies of sap are planned. Mr. H. F. Smith is engaged in investigations to determine the cause of variation in the yield of different types, and variation in the yield of individual plants of the same progeny is under careful test in order to determine a reliable method for the estimation of yielding ability. A carefully planned variety trial has been laid down at the Duntroon Farm area in order to obtain information on the effect of environment on yielding ability. It should be pointed out that the Division is devoting attention to fundamental work of the nature indicated above, and that it is not engaged in wheat breeding work along lines similar to those followed by State Departments of Agriculture.

(ii) *Maize*.—Mr. J. R. A. McMillan is continuing maize breeding work at Gatton College, Queensland, which was initiated there in 1925–26.

4. *Plant Introduction*—(i) *General*.—As noted in previous Reports of the Council, arrangements have been made with various institutions abroad, and particularly with the Bureau of Plant Industry at Washington, for the exchange of plants of economic value, especially cereals and forage crops. During the year a large number of introductions was made from other countries. In order to make preliminary tests of plants suited to sub-tropical climates, arrangements were made to establish a small quarantine area at Gatton Agricultural College, Queensland, and about 140 new plants have already been planted at that place. In addition nearly 1,000 introduced plants were planted at Canberra, and there is reason to believe that about 40 at least of these are distinctly promising.

(ii) *Plant Introduction Record*.—In order to prevent unnecessary re-introductions and to acquaint all workers with what has been done, arrangements have been made for the compilation of a record of all plant introductions into Australia, going as far back as possible. A beginning has been made on cereals, grasses, clovers and other forage plants from information which is being obtained mainly from the State Departments of Agriculture as a result of an arrangement made by the Council's Standing Committee on Agriculture.

In order that the State Departments of Agriculture and other State institutions may be in possession of definite information regarding introductions made by the Division of Plant Industry a record of all such introductions up to December, 1930, has been prepared by Dr. A. McTaggart and Mr. W. Hartley. Copies of this record have been issued, as Plant Inventory No. 1, to all Departments and institutions concerned.

5. *Agrostology*.—The grass and forage plant crop is the most important in Australia, and this fact justifies extensive studies of the areas where most sheep and cattle are depastured with a view to arriving at facts regarding the present condition of pastures and their improvement. Owing partly to difficulties in obtaining suitably trained officers this Section of the Division's work has not yet been adequately developed.

(i) *Regeneration of Pastures—Koonamore, South Australia*.—In previous issues of the Council's Annual Report reference has been made to the co-operative arrangements for investigations on the regeneration of perennial pasture plants in an area of low rainfall at Koonamore. The co-operative arrangement was for a period of three years which terminated on the 30th June, 1931. Although the progress of the work was impeded to some extent by drought, certain valuable information has been obtained particularly regarding the grazing effect on saltbush vigour. Observations were also made on spear grass within and without fences, and the results showed that continued grazing during dry seasons removes many well-established plants which would normally serve both as seed producers and soil binders. Studies of root systems were made, and it was found that plants remaining green for eight months or over have highly developed root systems which penetrate to a depth of about four feet. Reports covering the work over the whole period are being prepared by Professor T. G. B. Osborn and Mr. T. B. Paltridge.

(ii) *Grasses of the Federal Capital Territory*.—The work of collecting and identifying the grasses of the Federal Capital Territory was continued during the summer of 1930-31, with the result that seventeen new species were found, making a total of 57 for both exotic and indigenous plants.

(iii) *Pasture Plant Studies*.—With a view to the improvement of native and introduced pasture plants, preparations have been made for investigations which will be financed by a grant from the Empire Marketing Board. Seedlings of a number of varieties have already been planted.

6. *Seed Testing*.—With a view to reaching uniformity in the methods of seed testing throughout Australia, Dr. B. T. Dickson, the Chief of the Division, at the request of the Council's Standing Committee on Agriculture, has prepared a report on the technique of seed testing as practised in the various States and in countries abroad. A report dealing with sampling, purity analysis, germination tests, weight determinations and certificates was prepared and submitted to the Standing Committee on Agriculture in August, 1930. Consideration is being given by State Departments of Agriculture to the suggestions therein, and in addition arrangements were made for Mr. W. M. Carne to take the opportunity whilst abroad of attending the International Seed Testing Congress at Wageningen, Holland, in July, 1931, in order to obtain further information on the whole matter.

7. *Water-logging (Seepage) in the Murrumbidgee Irrigation Areas*.—At the request of the New South Wales Government, Dr. B. T. Dickson and Professor J. A. Prescott visited the Murrumbidgee irrigation areas in order to examine the general position with respect to water-logging and seepage with a view to ascertaining the facts as far as possible and making

recommendations for remedial measures or for such further scientific investigations as appeared necessary. The New South Wales Water Conservation and Irrigation Commission proposes to take steps with a view to giving effect to the recommendations made by Dr. Dickson and Professor Prescott.

8. *Biometrical Studies*.—Detailed statistical examinations have been made by Miss F. E. Allan, biometrician in the Division of Plant Industry, of the results of the New South Wales wheat competitions for the years 1925-26 to 1930-31 with respect to the varieties most widely grown in order to compare yields in areas of similar average rainfall. The data available from the New South Wales Farmers' Wheat Trials have also been examined and the results studied in detail and frequency graphs drawn showing the average yield for each of twelve varieties and the extent to which yields may be expected to vary about the average.

9. *Survey of Light and Heavy Cropping of Apples*.—Mr. W. M. Carne, Senior Plant Pathologist, has drawn attention in a paper published in the May, 1931, issue of the Council's quarterly Journal to the position existing with respect to the apple crops of Australia. Since 1925 there has been an extraordinary fluctuation in apple production, as is instanced by the fact that in 1927-28 the production was about 11,500,000 bushels against about 5,300,000 bushels in 1928-29. Such a fluctuation makes it difficult to arrange shipping accommodation for exports. The problem is being studied with a view to ascertaining whether remedial measures are practicable. Mr. Carne has drawn attention to the value of crop predictions not only to enable necessary export shipping space to be arranged but also to determine the dates most suitable for the earliest consignments. There appears to be a very direct relation between the size of crop and the date at which the principal export varieties mature sufficiently for safe shipment. Heavy crops are late and light crops early as compared with medium crops.

10. *Bud Studies*.—Mr. C. Barnard, Botanical Assistant, has continued work on bud studies, his head-quarters having been transferred from the Council's Viticultural Research Station at Merbein to the Plant Industry Laboratories at Canberra. In connexion with the work on apples, pears, &c., Mr. Barnard has developed a special technique by which he can examine many hundreds of buds in a relatively short time. As regards the sultana grape vine the fruit buds which will bear next year's crop are usually developed during the early part of the bearing season of the present crop. To be able to predict yields, to prune or to manure scientifically, it is necessary to know the dates of fruit bud differentiation. Considerable progress has been made in the work, in which the State Departments of Agriculture are co-operating.

An investigation on the development of fruit buds of sultana grape vines has been continued. It has been determined that the period from the 16th August to the 7th September during which the buds are swelling prior to sprouting is of considerable importance because during that time the inflorescences develop rapidly and branch profusely. Branching ceases and flower formation takes place as the buds are opening so that during the period of swelling the size of the potential bunches is determined.

11. *Noxious Weeds*.—During the year 1931 the attention of the Division of Plant Industry has been directed mainly to the preparation of maps showing the distribution of various weeds and to enquiries regarding skeleton weed, Paterson's curse, and zamia palm.

12. *Herbarium*.—The completion of the Plant Industry building has enabled Mr. J. Calvert to arrange the specimens which had been accumulated with a view to the gradual establishment of a herbarium which now contains over 2,500 specimens of economic plants arranged in order of States and Territories.

IV.—ENTOMOLOGICAL INVESTIGATIONS.

1. *General*.—In previous issues of the Council's Annual Reports reference has been made to the enormous losses suffered by Australia's agricultural and pastoral industries through the depredations of insect enemies. No estimates of the total loss to Australia are available, but Dr. L. O. Howard, formerly Chief of the United States Bureau of Entomology, has stated that in his country the economic losses due to insects amount to £400,000,000 annually, or in other words, the work of more than 1,000,000 men is nullified every year. He believes that the insect enemies will ultimately be conquered, but that that condition will not be reached until the danger is more generally appreciated. Mr. A. M. Lea, Entomologist at the South Australian Museum, Adelaide, has recently estimated that in South Australia more than one-tenth of the crops are destroyed by insects. The Council is continually receiving requests for help in connexion with insect pests, and in order to enable it to cope at least with some of the more important problems of national or inter-State significance hence its decision some years ago to establish a Division

of Economic Entomology with its main laboratories and insectaries at Canberra. This has been rendered possible largely as a result of generous contributions by the Empire Marketing Board towards the capital cost and maintenance of the laboratories, and by the Directors of the Commonwealth Bank from the Rural Credits Development Fund towards the cost of the insectaries. During the year 1930-31, three new insectaries were put into commission. The largest has been used almost exclusively for the work on St. John's wort. The second has been devoted partly to work on Noogoora burr and partly to grass-grub, whilst the third and smallest has been used for sheep blowfly experiments on living animals.

2. *Noxious Weeds*.—The work in this Section has been continued with Mr. G. A. Currie as Senior Entomologist, Mr. S. Garthside at Farnham Royal, England, and Mr. S. G. Kelly at Manhattan, Kansas.

(i) *St. John's Wort* (*Hypericum perforatum*).—During the year further consignments of the three *Hypericum* feeding species of *Chrysomela* were received. The completion of the tests with these insects proved conclusively that all three species are entirely confined to *Hypericum*, that they will not attack any plants of economic value, and that they are capable of destroying St. John's wort by causing successive defoliations. With the co-operation of the State authorities concerned, several thousand beetles and larvae of the three species have been liberated in selected localities at Myrtleford, Bright and Dargo in Victoria, and near Tumbarumba, New South Wales. Observations to date indicate that the beetles suffer considerably from the hot dry summer weather and from certain predatory spiders and ants, but it is yet too early to state whether the colonies will be able to withstand these factors and to make a sufficient natural increase to affect the plant. Mr. Garthside has completed preliminary tests on another promising insect, the Tortricid moth *Lathronympha hypericana*, and tests are being carried out in order to ascertain whether it will attack any plants other than St. John's wort. Certain other insects are also being studied by Mr. Garthside.

(ii) *Noogoora Burr* (*Xanthium pungens*).—Several consignments of the seed fly, *Euaerista aequalis*, have been received from Mr. Kelly. Laboratory tests are nearing completion, and it is hoped that steps for liberation will be taken in the near future. Mr. Kelly is also carrying out investigations on a number of other insects which attack *Xanthium* in the United States of America.

(iii) *Ragwort* (*Senecio Jacobaea*).—A consignment of larvae of the cinnabar moth, *Tyria jacobaeae*, was liberated on ragwort in a selected locality in South Gippsland in December, 1930. Moths from this liberation may be expected to show up in September, 1931. Other preliminary investigations have also been carried out in connexion with bracken fern, gorse and lantana.

3. *The Buffalo-fly Pest*.—During the year the investigations on this pest have been carried out in three main directions, viz. :—

(i) *Work in the Netherlands Indies*.—This work has been centred at Buitenzorg, Java, under Professor Handschin, with Mr. G. L. Windred as assistant entomologist. Researches have been carried out on the biology of the buffalo-fly (*Lyperosa exigua*) and also on the possibilities of biological control. It has been definitely established that the development, activity and abundance of the fly are profoundly influenced by physical factors, and particularly by variations in the amount of moisture present. The most suitable conditions are afforded by moderately high temperatures (80°-90°F.) combined with a continued high humidity, but with rainfall not sufficiently high to keep the mass of dung, in which the fly breeds, continually saturated. These are the conditions found in the river swamps of North Australia and in swamps in parts of Java. With a higher or lower rainfall the numbers of the fly decrease rapidly. Twelve species of parasites have now been discovered in Java, but further investigations are necessary before any judgment can be given as to their suitability for the control of the fly in Australia. The most promising of the Javan parasites is the undescribed species of *Spalangia* known as BzC. Steps are being taken to introduce that parasite into Australia.

(ii) *Work in Northern Australia*.—Owing to unfavorable seasons at Wyndham the laboratory has been transferred from that place to Burnside, North Australia, and is now in charge of Mr. H. Willings. During April and May, 1931, Professor Handschin and Mr. Windred visited North Australia, and made an extensive tour of the country in order to compare conditions closely with those in Java. Arrangements have been made for the rearing of parasites at Burnside and for their distribution in the field.

(iii) *Spread into Queensland*.—From August to October, 1930, Mr. T. G. Campbell made a survey of the boundary of infestation by buffalo-fly, and ascertained that the fly had spread some 60 miles eastward into Queensland since 1929. As a result of the seriousness of the position, arrangements were made at the request of the authorities concerned, for Dr. I. M. Mackerras

and Mr. T. G. Campbell, accompanied by officers of the Queensland Department of Agriculture and Stock, to carry out a further survey in May and June, 1931. The results indicated that the fly had passed far beyond the established quarantine line, having made an eastward movement of nearly 100 miles, and that it had reached the east of the Leichhardt River beyond Burketown. In his report on the situation, Dr. Mackerras set out the main reasons for this rapid spread, and dealt with the infestation on Mornington Island which presumably was carried there by heavy wind storms. This indicates that a buffer area would have to be very considerably wider than previously anticipated. The expenditure necessary for the creation of such an area would be great, and no guarantee could be given that it would be ultimately effective in stopping the spread of the fly to the eastern coastline of Australia. By the use of spray races at rail-heads and trucking yards, and by control of the stock routes, the eastward progress of the fly could probably be checked for a considerable time. The Council is pressing on actively with its investigations on biological control in the hope that a suitable combination of parasites and competitors may be found which will reduce the intensity of the pest.

4. *The Sheep Blowfly Pest.*—Further progress has been made during the year 1930–31 with the investigations on the sheep blowfly pest. *Lucilia cuprina* is now known to be the most important cause of primary strike in sheep. *Chrysomya rufifacies* is the most important of the secondary species, and its larvae may be the cause of very extensive and serious injuries to the sheep. During the year some important results were published of researches made under the aegis of the External Parasite of Sheep Committee of the New South Wales Department of Agriculture. The services of Mr. Mulhearn, a veterinary research officer of the Council, were placed at the disposal of the Department in order that he might assist in the work. As a result of these investigations precise data are now available regarding one factor which affects susceptibility, viz., degree of wrinkliness of the crutch.* This work carried out from the veterinary side and the work done on the entomological side by the Council's Division of Economic Entomology both point in the same direction, and thus afford a sound basis for a future close co-operative effort. The studies of Dr. Holdaway and Mr. Mulhearn in the field during 1930–31 have shown that body strike is definitely associated with a stained condition of the wool. Dr. M. J. Mackerras has isolated *Bacillus pyocyaneus*, the casual organism of one kind of wool stain, and she and Mr. Mulhearn have succeeded in producing the same condition artificially by implanting cultures of this bacillus in the wool of sheep. The next step in the work was the breeding experimentally of an extensive infection of body strike on a ewe artificially infected with *B. pyocyaneus*, by means of the fly *C. stygia*, the fly only striking those areas which had been infected, and leaving the remaining parts of the fleece untouched. This important line of investigation is being followed up closely.

Control by trapping, carcass destruction, jetting and the application of curatives and preventives are being investigated. Work on biological control has been discontinued, as it was clear from Dr. Holdaway's work in Europe that the prospect of success of the application of this method to the blowfly problem in Australia was practically nil.

5. *Orchard and Fruit Pests.*—The work on the parasite *Trichogramma* as a control of codlin moth has been discontinued, as the results obtained both by the Council in Australia and by workers in California definitely indicated the inability of the parasite adequately to control codlin moth in the field. Mr. J. W. Evans has been engaged on an investigation of the apple thrips problem. It is possible that a solution of the problem may be obtained by the discovery and effective application of a suitable repellent.

6. *Deficiency Disease in Bees.*—As a result of a grant of £1,000 by the Directors of the Commonwealth Bank from the Rural Credits Development Fund, the Council has been able to undertake, in co-operation with the Victorian Apiarists' Association, a plan of research into the phenomenon commonly called "disappearing trick" or "D.T.". Mr. G. A. Currie is in charge of the work in association with Mr. F. R. Beuhne, of Tooborac, Victoria, and formerly Apiculturist to the Victorian Department of Agriculture.

7. *Field Crop and Pasture Pests.*—(i) *Red-legged Earth Mite and Clover Springtail in Western Australia.*—Mr. H. Womersley arrived from England in October, 1930, and has since been engaged in a study of these two pests in collaboration with Mr. L. Newman, Government Entomologist, Western Australia. So far no natural enemies of the mite have been found, but in the case of the springtail a promising enemy has been discovered in the form of a predatory mite of the genus *Biscirus*. It is hoped to establish the predator in other parts of Australia where the springtail is a pest. Extensive tests with various types of sprays, mechanical control, &c., are being conducted.

* See *Studies on Cutaneous Myiasis of Sheep*, New South Wales Department of Agriculture, Science Bulletin, No. 37, July, 1931.

(ii) *Clover Springtail in Tasmania*.—During the year 1930–31 recommendations made by Dr. R. J. Tillyard for control of the pest in Tasmania have been put into effect by the Tasmanian Department of Agriculture. Launceston is now the only port of entry for subterranean clover seed, and all shipments are very closely examined for the occurrence of springtail eggs. Results obtained from lime-sulphur spraying of the infested areas are encouraging.

(iii) *Tasmanian Grass Grub*.—The discovery of Mr. E. S. Gourlay, of the Cawthron Institute, New Zealand, of two Tachinid fly parasites of the common New Zealand Grass Grub of the genus *Porina* has opened out a promising line of research in the biological control of the Tasmanian species which belongs to the closely related genus *Oncopera*. Arrangements have been made for a supply of the parasites to be received from New Zealand.

(iv) *Tobacco Split-worm (Phthorimaea operculella)*.—Investigations are being made regarding the possibility of biological control of this insect which is a very serious pest of the tobacco plant in Australia.

8. *Termite (White Ant) Problem*.—Investigations by Mr. G. F. Hill, Senior Entomologist, and Mr. T. Greaves as Field Assistant, have been continued in close co-operation with the Council's Division of Forest Products in the testing against termite attack of untreated commercial timbers and of timber treated by preservation processes, and with the Commonwealth Forestry Bureau in the testing of commercial timbers and into investigations on the causes of the immense losses of standing commercial timber in the forests of south-eastern Australia.

9. *Section of Systematic Entomology*.—The original scheme for the establishment of an Entomological Museum has been abandoned owing to the financial position, and a Section of Systematic Entomology has been established under Mr. A. L. Tonnoir. During the year 1930–31 systematic work was reduced to the minimum necessary for the satisfactory continuation of the general work of the Division, and in this way officers of the Section were freed so far as possible for work of more direct economic importance. Mr. Tonnoir is working on the Diptera, Miss Kent Hughes on carrion and dung beetles and various families of Coleoptera, and Miss Graham on parasitic and other Hymenoptera. During the year officers of the Section carried out work on the following economic problems :—(a) grasshopper or locust plague, (b) sand fly or *Simuliidae*, (c) parasites of eucalyptus, (d) nursery weevil (*Orthorhinus cylindrirostris*) and certain other local insect pests in the Federal Capital Territory.

V. ANIMAL HEALTH INVESTIGATIONS.

1. *McMaster Laboratory*.—At the end of the year 1930–31, the erection of the McMaster Laboratory in the grounds of the University of Sydney, adjacent to the Department of Veterinary Science, was nearing completion, and it was anticipated that the laboratory would be ready for occupation in September, 1931. As stated in the last Annual Report of the Council, the erection of this laboratory was made possible by the generous gift of £20,000 by Mr. F. D. McMaster, of "Dalkeith," Cassilis, New South Wales. Closest co-operation has been established with the Department of Veterinary Science of the University of Sydney. Thus, arrangements have been made whereby the Department will transfer on loan to the laboratory the scientific equipment now being used in the study and teaching of pathology, bacteriology and parasitology. In return, the demonstration work for students in connexion with these subjects will be carried out at the McMaster Laboratory, while certain lectures and demonstrations will continue to be given by the Council's Parasitologist, Dr. I. Clunies Ross. Further, Mr. H. R. Carne, Lecturer in Veterinary Pathology and Bacteriology, will, with his assistant, be accommodated at the laboratory and will continue researches in association with the Council.

2. *Pastoral Research Committee*.—In the last Annual Report reference was made to the fact that the Trustees of the Australian Pastoral Research Trust Limited had indicated their willingness to co-operate with the Council in a programme of investigations relating to the health of sheep and to allocate a sum of £2,000 per annum for five years for that purpose. The Empire Marketing Board has agreed to contribute towards the cost of the work on a £1 for £1 basis, up to a maximum of £3,000 per annum for a period of five years. As a result of these contributions, it has been possible for the work of the Council's Division of Animal Health to be extended materially. Particularly has this been the case in reference to field work in Victoria with vaccinations for black disease, to parasitological experiments on a large scale in Queensland, New South Wales and Tasmania, to foot rot and pizzle disease in Victoria and to pregnancy disease of ewes and pulpy kidney of lambs in Tasmania. An account of the work which is thus being carried out was published in the Council's quarterly Journal (Vol. 4, No. 3, August, 1931).

3. *Black Disease of Sheep (Infectious Necrotic Hepatitis).*—One of the outstanding achievements of the year is the work of Dr. A. W. Turner, who has shown definitely that the disease is caused through an infection by *Bacillus oedematis*, following injury to the liver by young fluke, and has succeeded in preparing a vaccine which has been fully demonstrated to exert a valuable protective influence. The economic value of this work will be realized, when it is stated that the estimated annual loss from black disease in Australia is no less than £1,000,000 per annum. The Council has been informed authoritatively that the results of this work will lead to a saving of £100,000 per annum in Tasmania alone, with corresponding savings in other States affected.

The results of the investigations have been fully published in the Council's Bulletin No. 46. In addition, a popular account of etiology, symptoms, pathology, prophylaxis, &c., has been issued by the Council as Pamphlet No. 20, and distributed widely through State Departments of Agriculture and Graziers' Associations. In addition to the 60,000 sheep vaccinated in Victoria and New South Wales (as recorded in the Council's quarterly Journal, Vol. 4, No. 3, August, 1931), nearly 50,000 sheep have been vaccinated by State Veterinary Officers in Tasmania, with vaccine prepared by Mr. Oser, the Tasmanian Veterinary Pathologist, according to the method of Dr. Turner. In Victoria, the Council's Field Officer (Mr. D. Murnane) has co-operated with the officers of the State Department of Agriculture in the work of vaccination throughout the season. Since the beginning of the year 1931 the vaccine utilized by State Departments has been made and supplied in accordance with Dr. Turner's method, by the Commonwealth Serum Laboratories.

It is of interest to know that black disease has been found to exist in Germany, where it is called "Bradsot", and that an investigation in Great Britain has suggested that black disease occurs, unrecognized as such, in many parts of the world. The work done by Dr. Turner is, therefore, of world-wide significance.

4. *Braxy-like Disease of Sheep (Infectious Entero-toxaemia) in Western Australia.*—Mr. H. W. Bennetts, Veterinary Pathologist (seconded from the Western Australia State Department of Agriculture) has continued his investigations with very satisfactory results. The popular term is misleading, since the European braxy and the black disease of sheep in the eastern States are definitely distinct diseases. It has been ascertained that the casual organism is not true *Bacillus welchii*, as originally suspected by Mr. Bennetts, but a distinct organism of the same group. Accordingly it has been given the specific name *Bacillus ovitoxicus* while the disease it causes has been termed "infectious entero-toxaemia". Recent evidence strongly supports the belief that entero-toxaemia is much more prevalent in the eastern States of Australia than hitherto suspected, and that certain animals supposedly dead of black disease may have died really from entero-toxaemia.

Mr. Bennetts has evolved a vaccine against the disease and a large number of sheep were vaccinated during the year. The results from a comparatively small flock of 924 sheep showed that the deaths from the disease had been reduced from 4.6 per cent. in the unvaccinated half of the flock to 0.2 per cent. in the vaccinated half. About 10,000 sheep have more recently been inoculated but complete information is not yet available regarding the results. A report on the work done has been prepared by Mr. Bennetts and will be published as one of the Council's bulletins. A popular summary is being published in the September issue of the Journal of the Western Australia Department of Agriculture.

5. *Other Investigations in Western Australia.*—(i) *Gin Gin Disease.*—Although Mr. Bennett's work has been confined mainly to braxy-like disease, attention has been given by him to an obscure disease affecting young sheep in the Gin Gin and Moora districts of Western Australia. So far as is known, the disease is confined to a limited area and can be prevented by transferring healthy pregnant ewes for a short period annually to other pastures. Nevertheless, though apparently of but local importance, elucidation of the cause which is evidently associated with nutrition, may have a very wide significance. All available data have been collected and considered in relation to the geology of the affected region. Representative pasture and water samples have been collected at various periods and analysed. An experimental flock under the control of the Council's officers is essential for satisfactory continuation of the investigations, and it is hoped to be able to arrange for this at an early date.

(ii) *Denmark Cattle Disease.*—This disease is being investigated by Mr. J. F. Filmer, Veterinary Officer of the Western Australia Department of Agriculture, on lines determined in consultation with Dr. J. A. Gilruth. It has now been definitely proved that sheep are also subject to the malady, and the State Department of Agriculture has arranged for a special farm to be devoted to the investigation of the disease.

6. *Parasitological Problems*.—The investigations initiated last year by Dr. I. Clunies Ross, veterinary parasitologist, have been pursued actively and attended with a considerable measure of success. In his work, Dr. Ross has had the co-operation and assistance of Dr. Kauzal of the University of Sydney, and of Mr. Gordon, a research student under the Walter and Eliza Hall Trust. Since the beginning of 1931 he has also had the assistance of Mr. N. P. Graham, whose services have been provided from the joint funds contributed by the Empire Marketing Board and the Pastoral Research Trust.

Work in regard to the control of kidney worm of pigs (*Stephanurus dentatus*) was continued and extended during the year 1930–31, and has now been completed. The results will be published shortly by the Council as one of its bulletins. As a result of the study of the life-cycle of the parasite, methods of control and eradication have become practicable. These, if adopted, should result in a very marked decrease in the incidence of the parasite throughout eastern Australia, and it is confidently hoped that, with the co-operation of the State Departments of Agriculture in New South Wales and Queensland (the only States at present affected) the methods suggested by Dr. Clunies Ross and Dr. Kauzal will result in a rapid diminution of the incidence of this parasite.

Progress has been made by Dr. Kauzal in his investigations on the life-cycle and pathogenic importance of the large lung worm of sheep. A considerable amount of work has been done in testing the effects of various drugs administered in licks or in drinking water against stomach and intestinal worms. Field trials have been commenced on properties in Central Queensland, New South Wales and Tasmania in regard to various aspects of infestation of sheep by stomach and intestinal worms. Investigations are also being carried out on a number of other parasitological problems.

7. *Caseous Lymphadenitis*.—Reference was made in the last Annual Report of the Council to the investigations initiated on this problem, which is such a serious menace to the whole Australian export frozen lamb and mutton trade. At the Sydney University Veterinary School, Mr. H. R. Carne has continued his highly technical investigations on the casual organism, its toxin and diagnostic tests with interesting results. A large amount of detailed work has also been done by him in the elaboration of a diagnostic reagent.

Dr. L. B. Bull and Mr. C. G. Dickinson have continued their investigations directed particularly towards the discovery of a reliable vaccine at the Adelaide Hospital Laboratory, and some of the results obtained have been published in the *Australian Journal of Experimental Biology and Medical Science*.

Much further detailed information regarding the incidence of the disease, the methods of spread under natural conditions, means of prevention, &c., has been secured, all supporting in a general manner the conclusions arrived at by the Expert Committee, as published in the Council's Journal for August, 1930. Particulars of a series of experiments conducted on a flock on a Victorian property last year, were published in the Council's Journal (Volume 3, No. 3).

It was hoped that further field experiments could be carried out this year on the same property, but it was found that the proper conduct of scientific investigations caused undue disturbance to the ordinary routine of the management. Efforts are accordingly being made to obtain the lease of a suitable property near Melbourne where experimental stock can be depastured under proper conditions of control.

8. *Haematuria (Redwater) in Cattle*.—The laboratory investigation of this disease is being carried out at the Government Laboratory of Bacteriology and Pathology of the Adelaide Hospital, while field conditions are being studied in the Mount Gambier district of South Australia, where the disease is probably more prevalent than in any other part of the Commonwealth. During the year 1930–31, the systematic examination of the urine of cows from redwater farms in different States and from non-redwater farms was continued. This work has been conducted by Mr. A. T. Dann, chemist, under the general direction of Dr. L. B. Bull. Examinations have shown a definite low inorganic sulphate excretion, but have failed to show the presence of an excess of any of the common irritant substances present in normal urines. The study has also been made of the possible association of the disease with the definite manganese deficiency in plants in the Mount Gambier region. Tissues were collected from young animals that had never been off one farm on which redwater is common. These tissues failed to show a manganese content lower than that of normal lambs. Through the courtesy of the Chief Veterinary Officers samples of soil have been forwarded from farms affected by redwater in Tasmania and in Victoria, and these are being tested for manganese deficiency at the Waite Agricultural Research Institute. So far there has been no indication of such deficiency in these soils.

The results from both sets of observations, therefore, fail to indicate any association of manganese deficiency in soils or plants with redwater in cattle. Should these methods of investigation fail to indicate the possible cause of the disease, future work will have to be concentrated on field experiments arranged so as to examine the effects of various mineral supplements to the diet of the animals.

9. *Animal Health Problems in Northern Australia.*—In the last Annual Report of the Council, it was pointed out that Queensland and Northern Australia generally are responsible for practically the whole of the Australian export of beef and for many of the store cattle which are fattened in southern districts, and that the Council had been urged by many pastoralists of the north to undertake research work on conditions which militate against the success of their operations. The Council has now been able to make definite progress in the arrangements for the investigation of these problems, owing to the generous offer of the Empire Marketing Board to contribute up to £5,000 per annum for five years on a £1 for £1 basis, with local contributions in Australia, and also to the generous action of the Queensland Government, which has offered to place at the disposal of the Council its Stock Experiment Station at Townsville, and to contribute a definite sum of money annually to match part of the funds offered by the Empire Marketing Board. It is anticipated that the negotiations in regard to this matter will be completed at an early date, and that the Council will be able to begin active operations early in the year 1932.

10. *Other Investigations.*—Investigations on a number of other problems are in progress by the Council's Division of Animal Health. The following may be specially mentioned :—

(i) *Kimberley Horse Disease.*—Mr. D. Murnane who, with Professor Ewart, investigated the Kimberley horse disease or "walkabout" disease of tropical Australia (see Council's Bulletin No. 36) has, as opportunity permitted, continued the investigations by feeding horses on whitewood (*Atalaya hemiglauca*) leaves and seeds at the Melbourne University Veterinary Research Institute, it having been claimed by men with practical experience on the one hand that the disease occurs where whitewood is unknown, and on the other that where whitewood is prevalent, the horse disease is unknown. The object of the investigations was to produce the disease in horses far removed from localities where the condition occurs naturally. The results indicate that the dried leaves retain their toxic properties, producing death after prolonged continued feeding, but that some factor is apparently lacking in the dried leaf, since up to the present it has not been found possible to produce the more chronic form of the disease, characterized by marked cirrhosis of the liver and "walking" symptoms, which were induced by the feeding of fresh leaf. Further feeding experiments are in progress, and it is intended to continue investigations into the nature and cause of Kimberley disease both at the laboratory and in the field, in connexion with the scheme of work which will be undertaken at Townsville.

(ii) *Caustic Vine (Sarcostemma australe).*—This plant, not hitherto recognized as dangerous, was tested on animals at the Melbourne University Research Institute and proved to be highly toxic in small quantities for sheep. A brief account of the preliminary experiments was published in the Council's quarterly Journal, Vol. 4, No. 1, February, 1931. Further experiments are in progress. The toxic principle is being investigated by Mr. H. Finemore, of the University of Sydney, on behalf of the Council's Poison Plants Committee.

(iii) *Export of Pork.*—The possibility of adding to Australia's frozen meat exports by consignments of pork has recently commanded attention and, at the request of various organizations, the Council has arranged for a special investigation to be made in America by Mr. R. B. Kelley, a research student under the Science and Industry Endowment Act.

VI. ANIMAL NUTRITION INVESTIGATIONS.

1. *Division of Animal Nutrition.*—It was reported last year that in January, 1930, this Division had suffered a heavy loss owing to the death of its first Chief, Professor Brailsford Robertson. Shortly afterwards inquiries were instituted with a view to appointing a successor, and the position was offered to and accepted by Sir Charles Martin, M.D., D.Sc., F.R.S., who was for many years Director of the Lister Institute of Preventive Medicine, London, and before that occupied the Chair of Physiology at the University of Melbourne. The Council considers that it is very fortunate in obtaining the services of this eminent scientist and inspirational force. Sir Charles Martin reached Australia in March, 1931. In the interim between that date and the time of Professor Robertson's death, the Division was very effectively directed by Mr. H. R. Marston.

Shortly before the new Chief was due to leave England, a number of representatives interested in nutrition and drawn from practically all parts of the Empire were in London in connexion with the Imperial Conference, 1930. Sir Charles took advantage of this fact to hold a series of meetings at the Lister Institute with a view to the general discussion of nutrition

problems, and the bringing about of team work throughout the Empire in so far as research in that subject is concerned. On his way out to Australia he also spent a little time in South Africa, including about three weeks at the Veterinary Research Institute, Onderstepoort. As a result of these discussions Sir Charles is closely in touch with nutritional investigations in widely scattered places, particularly with those in South Africa where many problems exist similar to those of Australia.

During the period under review arrangements were made whereby the Division would carry out a portion of the research work on sheep laid down under the Australian Pastoralists' Research Trust—Empire Marketing Board scheme. This portion consists of researches that have been initiated with the ultimate object of determining the best and most economical methods for supplementary and hand feeding of sheep during drought and for combating evils attendant on an insufficient amount of phosphorus in the herbage on which sheep are pastured. It will be greatly facilitated by a small annexe to the Division's laboratory at Adelaide, which is now being erected to house the metabolism experiment with sheep. The building comprises a metabolism room, calorimeter room, operating room, store and sheep pens. Its cost is being covered by a grant of £1,000 from the Rural Credits Development Fund of the Commonwealth Bank.

Work on most of the programme laid down by Professor Robertson has been continued. In the laboratory, the survey of various proteins from the point of view of their cystine content has been continued, and a number of estimations of cystine have been carried out on wheat, wheat offals, oats, rubber seeds, blood meal, fish meal and yeast. The importance of cystine to the sheep from the point of view of wool production has been indicated in previous reports in particular in connexion with the work carried out at the "Meteor Downs" Field Station. A large amount of work has been carried out in connexion with the determination of phosphoric acid in tissues. Results obtained to date seem to indicate that there is little difference in the ratio of calcium and phosphorus in the bones of different sheep even where the bones come from badly developed and malformed animals.

Further work on the iodine survey of thyroid glands obtained from various parts of Australia has failed to give any indication that iodine deficiency exists in the country. It must be pointed out, however, that there are large areas on the Continent from which specimens have not yet been collected for examination.

Other investigations in progress in the laboratory concern the conditions determining the solubility of calcium phosphate in the intestines of sheep; the effects of the removal of the thyroid and pineal glands; the effect of a small daily intake of fluorine upon the well-being of the sheep; and studies on the intake, storage and output of nitrogen and sulphur in the Merino sheep. The work with the pineal gland has confirmed the results of previous work by Dr. Demel in Vienna in so far as they have demonstrated that the treated animals grow from 40 to 80 per cent. more wool (and of a better quality) than the untreated sheep. The treated animals, however, reached full weight, whereas those of Dr. Demel grew to only two-thirds of what would otherwise have been their normal weight. It is realized, of course, that it would be quite impracticable to operate on any considerable proportion of Australian flocks in this way, but nevertheless the fact remains that it has been found possible to increase the wool per animal very considerably, and further work may ultimately indicate a way in which this can be done on a practical scale.

At the Waite Institute, the Division is continuing its experiments on the optimal growth of the Merino sheep with a view to obtaining an average growth curve for this breed under luxurious conditions of nutrition for use as a standard of reference. Experiments on the growth of wool on a diet deficient in cystine and on the same diet supplemented by wool hydrolysate (which is naturally rich in cystine) are in progress.

Finally the calorimeter housed at the Institute has been used to determine the "basal" metabolism of the Merino sheep, that is, the energy expended by the fasting animal at rest with an environmental temperature of 20–25 degrees C. This figure is a measurement of the energy required just to keep the animal alive and its internal temperature constant. It is a determination fundamental to further work connected with drought feeding.

The various small field stations that have been set up in co-operation with several owners of stations serve the dual purpose of enabling results obtained in the laboratory to be tested on a practical scale, and of drawing the laboratory's notice to practical problems in the field. Work has been continued at "Niawanda" near Beaufort, Victoria, with a view to determining the effect of top dressing pastures with sulphur; at "Keytah" near Moree, New South Wales, where the effect of adding iodides to licks is under test; at "Meteor Downs," Central Queensland, where the effect of adding high cystine supplements (sterilized blood meal) to the diet of the sheep is being studied, and where during the period under review the results of the previous 30 per cent. increase in wool yield per animal have been maintained; at "Dismal Swamp," near Mount

Gambier, South Australia, where different forms of phosphatic licks are under examination ; at "Wambanumba," near Young, New South Wales, where the response of the locality in terms of wool to manuring with sulphur, nitrogen and phosphates is being examined ; and at the most recently established station at "Hawk's Nest," Kangaroo Island, where the Australian Pastoralists' Research Trust—Empire Marketing Board work on phosphorus deficiency is being carried out.

2. *Mineral Deficiencies of Pastures*.—Work on this problem is being carried out as a co-operative enterprise by the Empire Marketing Board, the University of Adelaide and the Council, the investigations being centred in the Melrose Laboratory of the Waite Agricultural Research Institute under the direction of Professor A. E. V. Richardson.

Of recent years it has been conclusively demonstrated that the mineral content of a grass has a very important bearing on its nutritive value for stock, and that in general a grass must contain adequate amounts of various minerals such as compounds of phosphorus potassium, manganese, calcium, nitrogen, &c., for it to be of value for pastoral purposes. 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 most important crop and her outstanding source of wealth, the importance of this mineral deficiency work is obvious.

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 alleviating their effects.

During the past year three reports dealing with various aspects of the work have been issued. The first of these (Pamphlet 18) deals with the influence of the frequency of cutting on the productivity, botanical and chemical composition and nutritive value of natural pastures in southern Australia. Bulletin 49 deals with the factors affecting the mineral content of pastures, with particular reference to localities where alternating periods of winter rainfall and summer drought prevail. Under these conditions it is shown that it is possible to increase considerably the supply of minerals in pastures and thus to increase the output of grazing animals by the use of three inter-dependent principles as follows :—(i) the establishment of persistent species (and strains) capable of assimilating adequate nutrients over an extended period of the year, (ii) the efficient utilization of herbage by satisfactory systems of management, and (iii) the maintenance of soil fertility at a sufficiently high level by the application of suitable fertilizers to soils deficient in essential minerals. Bulletin 48, dealing as it does with the experimental error of the yield from small plots of "natural" pasture, is of value more particularly to scientific investigators.

VII. SOIL INVESTIGATIONS.

1. *General*.—The Division of Soil Research is located in the Melrose and Darling Laboratories of the Waite Agricultural Research Institute under a co-operative agreement with the University of Adelaide. The Darling Laboratories, made possible by the generous gift of £10,000 by Mr. Harold Darling, on behalf of the family of the late John Darling, were formally opened by His Excellency, the Governor-General, Lord Stonehaven, in September, 1930. The main objects of the Council's soils investigations are two-fold, viz. :—

- (a) To advise settlers as to the treatments required in order to make their blocks more productive and to minimize the serious troubles with which many of them are faced at the present time, and
- (b) To make soil surveys of virgin areas for future settlement and development and thus to render possible an avoidance of costly mistakes similar to those which have been made in the past.

Owing to the necessity for the conservation of funds, the policy of the Division of Soil Research during 1930–31 was one of consolidation rather than of expansion.

2. *Soil Surveys*.—The work of the Division has been directed primarily to investigations of the more closely settled and more valuable lands, namely, irrigation settlements. The task of surveying has been divided into convenient units, each involving about six months' work for a surveyor with twelve months' associated laboratory work for a chemist. Satisfactory progress was made during the year 1930–31 with the soil survey work on the Murray River Settlements, and it is hoped that the survey of all these settlements will be completed in about two or three years' time. Two of the largest areas yet to be surveyed are those at Mildura and Lake Bonney (near Barmera and Berri). The survey of the whole of the Renmark irrigation area has now been completed, the soil surveys of Blocks A, B, C, D and F of that area having been finished during 1930–31 by Messrs. T. J. Marshall and P. D. Hooper. The work on the soils of the Lower Murray was also completed by Messrs. J. K. Taylor and H. G. Poole, and the results are being published

as one of the Council's Bulletins. The laboratory work on the survey of the bed of Lake Albert at the mouth of the Murray River, referred to in the last Annual Report of the Council, was also completed and the results of the survey reported to the South Australian authorities and published in the Council's quarterly Journal (*see* Vol. 4, No. 2, 1931). The very variable character of the lake bed and the difficulties likely to be met in the reclamation of the more important soil type revealed by the survey have resulted in the abandonment of the project of reclamation, as it was considered that the project was likely to prove unsuccessful. In this way the saving has been effected of a very large sum of money which would have been expended uneconomically.

The irrigation settlement at Cadell, South Australia, has been surveyed by Messrs. T. J. Marshall and N. J. King. This settlement has presented a considerable problem to the South Australian authorities since it was found that more than 10 per cent. of the area is subject to salt and seepage trouble. As a result of the survey the origin and nature of the trouble have been revealed, and steps are being taken in co-operation with the State irrigation engineers to carry out further work with a view to a solution of the difficulties which are at present encountered.

As a training ground for new soil surveyors the Hundred of Kuitpo, within easy reach of the Laboratory of the Division, is used for systematic survey during the summer months. An area of 30,000 acres has already been surveyed and, pending the completion of the work, the details have been made available to the State authorities.

At the request of the Tasmanian Department of Agriculture and to act as a basis for further work by the Tasmanian agricultural and veterinary officers, a soil survey of King Island has been undertaken. The preliminary field work has been completed and the associated laboratory work is now in progress. Messrs. C. G. Stephens and J. S. Hosking are in charge of this work, while associated pasture problems are being dealt with by Mr. A. E. Scott, an officer of the Waite Agricultural Research Institute. It is anticipated that this work will be completed early in 1932.

In the Murrumbidgee irrigation areas Mr. H. N. England has completed the greater portion of the survey of the rice soils of the area and the associated laboratory work is in progress. Owing to the serious development of seepage and water logging in the area a re-orientation of the soil survey work at Griffith Research Station has been necessary so as to enable the problems arising through the development of a water table in much of the area to be solved as speedily as possible. It appears that the essential cause of the trouble is that the irrigator has been using too much water and that there is no natural drainage system to take away the excess supplied. The solution of the problem seems to lie in the use of less water by the settlers and also in the drying out of the excess water by growing crops of plants which have a high transpiration ratio as, for example, lucerne and Bokhara clover. Arrangements are being made for a co-operative attack on the problem by the Council and the New South Wales Water Conservation and Irrigation Commission.

In Victoria, arrangements have been made for soil survey work to be undertaken at Nyah and Tresco in co-operation with the State Department of Agriculture and the University of Melbourne. The results obtained by Mr. J. E. Thomas from the soil survey work at the Council's Viticultural Research Station at Merbein (*see* page 29), indicate that the distribution of salt is the result of previous climatic and biological conditions rather than the result of irrigation as had been generally thought. This is a matter of considerable importance, as it means that a salt soil survey of virgin areas prior to settlement will be of very great value and use.

The opportunities afforded to the Chief of the Division, Professor J. A. Prescott, of consulting with the authorities in the several States, particularly with the Surveyors-General, have been made use of in the preparation of a short monograph summarizing and correlating existing information regarding the soils and associated vegetation types of Australia, particularly in relation to climatic conditions. This report will appear as one of the Council's bulletins, and will include vegetation and soil maps of Australia. In preparation for the projected soil survey of the Berri-Barmera group of settlements, the co-operation of the Royal Australian Air Force has been obtained and a photographic survey of the area has been completed. Close collaboration has been maintained with the State Departments concerned in the work of the Division.

During the year 1930-31, Mr. N. J. King, of the Queensland Department of Agriculture and Stock, and Mr. J. O'Donnell, of the Western Australia Forests Department, were seconded to the Division by their respective Departments for special training in soil survey work.

3. Laboratory Technique and Soil Fertility Investigations.—This section of the activities of the Division has been developed by officers both of the Council and of the University of Adelaide. Mr. R. J. Best has published the results of an investigation into methods for the determination of the hydrogen ion concentration of soils, and has standardized the use of the

antimony oxide electrode for use with Australian alkaline soils. Mr. C. S. Piper has reported his investigations on factors controlling the availability of manganese in the soil; the availability appears to be controlled by two principal factors, hydrogen ion concentration and oxidation-reduction equilibrium. Mr. J. S. Hosking has reported his investigations on the treatment of soils with hydrogen peroxide. Miss P. Rountree has begun investigations on the sulphur oxidising power of the Renmark soils with a view to possible reclamation of some of the more intractable soils by the biological oxidation of sulphur. Mr. H. G. Poole is engaged in an investigation into the possibility of the utilization of moisture equivalents and similar single values as a method of assisting the soil surveyors and irrigation engineers to accurate and rapid definitions of the physical properties of the various soil types.

VIII. IRRIGATION SETTLEMENT INVESTIGATIONS.

1. *General*.—In the last Annual Report of the Council, attention was directed to the importance of research work aimed at the improvement of methods of production in the Murray River Irrigation Settlements. The dried fruit industry of Australia has an annual turnover of nearly £3,000,000, and the citricultural industry has led to the establishment of many thousands of homes in the irrigation areas, and to the expenditure of large sums of money on dams, channels, pumping stations, &c. Investigations have been undertaken by the Council on problems relating to dried vine fruits and citrus fruits which constitute the main production of the settlements. In addition the Council is carrying out investigations on the soils of the areas, but particulars of that work have been given in the preceding section of this report, relating to soil problems.

2. *Viticultural Investigations*.—Investigations on production problems of vine fruits are being carried out at the Commonwealth Research Station, Merbein, under the direction of a Committee of Control. Mr. A. V. Lyon is the officer in charge of the station. In previous issues of the Council's Annual Report, information has been furnished regarding the valuable results of the investigations carried out at this station, and it has been pointed out that application of these results is becoming more and more general with consequent increases in yields, improvements in processing methods and enhanced prices of products. The monetary value of the results of the Council's investigations on these problems already runs to many thousands of pounds sterling.

During the year 1930-31 special attention has been given to investigations in processing methods, particularly in the direction of testing the application of various methods of processing sultanas available at the station to other districts where soil and climatic conditions are different. This work is being carried out in co-operation with officers of the Agricultural Departments in the States of Victoria, South Australia and New South Wales, and is under the general control of a Committee consisting of representatives of the Council and of these Departments. This Committee has also directed an investigation on the sulphuring of apricots, to which reference was made in the last Annual Report of the Council, and recommendations have been issued to growers based on results of co-ordinated experiments (*see* C.S.I.R. quarterly Journal, Vol. 3, No. 3, 1930). The investigation of the keeping qualities of dried fruits has been commenced. A series of boxes of fruit selected for obvious variations in moisture content and treated by various processing methods has been placed in store. Records of the moisture, acidity, sugar content, colour, treatment in processing and general appearance and grade were made on each box at the beginning of storage. The experiment will be continued in order to determine if any of these factors are correlated with deterioration subsequent to packing. Crystallization of sugar ("sugaring"), adherence of the berries to one another ("stickiness" and "clamminess") and change in colour are disadvantages at present experienced by the trade. It is expected that at least some of the stored boxes of fruit will in time exhibit some of these undesirable characteristics, and it is anticipated that information of considerable value to the trade will be obtained. The experiments are being carried out in co-operation with Mr. W. R. Jewell, Research Chemist, Department of Agriculture, Victoria.

In the last Annual Report, reference was made to investigations relating to the "duty" of irrigation water, and it was pointed out that the recommendations made by the Council on this matter had already resulted in an estimated saving of £9,000 per annum in the Mildura and Redcliffs districts alone. Similar irrigation studies have been continued on selected sites representing various soil types in the irrigation district of Merbein (Victoria), Renmark (South Australia) and Curlwaa (New South Wales). The data include penetration of water from an irrigation furrow in various periods of time, the depths at which free water occurs under present practice, and the soil moisture changes in six inch samples to a depth of three feet during the inter-irrigation periods. An interim report is being prepared for publication, and preliminary recommendations in respect to periodicity and methods of irrigation for soils to which the data are applicable will be included.

A field of virgin soil (17 acres) at the Station has been allocated to a study of the influence of irrigation on the distribution of salt. The result of part of the preliminary investigations have been published (*see*, C.S.I.R. Journal, Vol. 4, No. 1). The field has been prepared for planting in August, 1931, and future work will include investigations on the changes in the distribution of salinity resultant on irrigation; the effects of the application of varying quantities of water on the growth and development of sultana vines under controlled irrigation conditions and known soil types.

Further investigations are being conducted into the occurrence and extent of damage by insects to dried fruits. Inspection of packing houses and store houses disclosed that there is still need for improvement and that insect infestation cannot be eliminated or reduced to a minimum under the existing conditions in these houses.

An exhaustive inquiry has been carried out in certain packing houses in the Merbein district in order to determine the extent of infestation of fruit after processing and appropriate steps have been taken through the Department of Markets to secure an improvement in the conditions of the packing houses which were shown to be faulty and for a special inspection of all shipments prior to the reception of new season's fruit in order to ensure compliance with existing regulations. The work of the Station has been materially assisted by a grant made by the Dried Fruits Control Board.

3. *Citricultural Investigations.*—Steady progress has been made along the lines of the experiments laid down in previous years at the Council's Research Station at Griffith, in the Murrumbidgee Irrigation Areas, which Station is in charge of Mr. E. S. West. The investigations are being financed jointly by the Council and by the New South Wales Water Conservation and Irrigation Commission. The main investigations of the Station concerned:—

- (a) the effect of different soil treatments on the structure, yielding capacity and other properties of the soil;
- (b) the most profitable fertilizer treatment for citrus fruit;
- (c) the effect on soil and citrus trees of various methods of green manuring.

The deductions from the results of field experiments were confirmed during the past season making it possible to determine definitely that under existing conditions certain practices adopted at the Station must prove of substantial benefit throughout the whole Murrumbidgee Irrigation areas. The influence of the investigations carried out at the Station has been evidenced by the increased use of nitrogenous fertilizers in citrus culture, the use of winter green manuring crops, and more careful attention to the application of water to the soil so as to avoid the raising of the water table.

The work on green manures has been continued and the following results have been obtained:—

Trees manured with—

| | | | Diameter of butt. |
|---|----|----|-------------------|
| A winter green crop (tickbeans) .. | .. | .. | 85.7 cms. |
| Continuous clean cultivation .. | .. | .. | 81.1 cms. |
| Biennial green crop (Bokhara clover) .. | .. | .. | 75.9 cms. |
| Summer green crop (cowpeas) .. | .. | .. | 73.1 cms. |
| Perennial green crop (lucerne) .. | .. | .. | 66.9 cms. |

The results shown in the relative sizes of the trees are clearly reflected in the yield of fruit obtained for the first time last season. As a result of the green manure experiments winter green manuring is being practised to an increasing extent on the Murrumbidgee Irrigation areas.

A considerable amount of attention is being given by the Station to studies of soil and the moisture content and much valuable information is thus being obtained in regard to the different amounts of irrigation water to apply at different times and without increasing the height of the water table. Thus studies on the soil column have been continued in order to determine what movement of soluble salt occurs when the water table is maintained near the surface of the soil under natural field conditions. During the year a water table had been maintained at a distance of about 1 metre from the surface of the soil. The results apparently indicated that under these conditions little if any rise of salt would take place, and that the previous idea that salt solutions would rise by capillary attraction is hardly tenable.

A detailed examination has been made of the type of fruit and foliage on individual Washington Navel trees on the green manure field, and the results of this examination and the remarkable uniformity and good quality of the fruit received in the packing shed last season and seen on the trees this season furnish an impressive demonstration of what can be achieved by giving proper attention to the selection of budding wood from trees true to type. It is

understood that the planting of citrus trees of this size at the Station is the oldest in Australia where the origin of the buds from which the trees were produced is known and a good source of reliable budding wood is thus available. Investigations have also been carried out on the occurrence of frosts, and the part which the Mallee scrub plays in causing frosts or intensifying them in its immediate neighbourhood. Such information is obviously of considerable economic value to those whose duty it is to lay out closer settlement schemes in which the crops to be grown are likely to be damaged by frost, as for instance, vines. An account of this work will be published in the Council's Journal.

IX. FOREST PRODUCTS INVESTIGATIONS.

1. *General.*—During the year 1930–31 steady progress was made in the work of the Division of Forest Products, and very satisfactory relations were developed with the timber trade both in sawmilling and utilization. These industries now avail themselves fully of the services of the Division and many letters appreciative of the advice and assistance rendered have been received. The policy of concentrating a large proportion of the work of the Division in the direction of collecting existing information and getting it put into use has been continued. In pursuance of this policy two new methods were applied during the year, viz. :—(a) the issuing of trade circulars, each dealing with a specific problem discussed in terms which can be readily understood by the layman, and (b) the delivery of a series of lectures on timbers at technical schools and elsewhere.

As a result of recent re-arrangements, it will be possible to increase to some extent the accommodation available in the outbuildings at the Head Office premises of the Council for the purposes of the Division. It is proposed to utilize one room as a box testing laboratory and another as a wood-working shop. As stated in the last Annual Report of the Council, the erection and equipment of a Forest Products Laboratory on thoroughly satisfactory lines have been postponed owing to the financial stringency.

Very close co-operation has been maintained between the Division and other Forest Products Laboratories abroad and with the Commonwealth and State Forestry Services. During the year 1930–31 officers of the Commonwealth School of Forestry, the Creswick State Forestry School, and several of the State Forestry Departments have either undertaken special courses of training in the Division's Laboratories or have attended special classes arranged by the Division. The Forestry Departments of Victoria and Western Australia have appointed utilization officers to act as means of liaison between the Division and their Departments.

While the development of the policy of concentrating on the application of existing knowledge has taken precedence, the need for more fundamental research in order to provide data upon which to base sound practice has not been neglected. Research work has been confined mainly to the sections of chemistry and wood technology, and to a lesser extent to wood preservation and seasoning. In the year 1930 a programme was outlined consisting of 58 projects. Work has actually been carried out in 48 of these and 52 progress reports have been prepared. In some cases sufficient advance has been made to justify publication. Mr. S. A. Clarke, previously Senior Seasoning Officer, has been appointed to the position of Acting Deputy Chief of the Division.

2. *Timber Seasoning.*—By far the greatest call from the industry is for help in this direction and recognition of the fact that faulty seasoning has been the cause of much of the prejudice which undoubtedly exists against Australian hardwoods is now fairly general. During the year 1930–31 a second experimental kiln was installed at the Council's Head Office premises, the single kiln being unable to cope with the volume of work. A definite research programme has been put into operation. The close contact with the timber industry has been strengthened and extended, and a large part of the time of the staff has been taken up in attending to requests from the industry for help or advice. Over 90 inquiries were received and more than 70 calls were made by officers of the Section. As a result of this work eight kilns and several wood reconditioning chambers have been built in accordance with plans provided by the Division, and several others have been designed and will be erected shortly. The kilns were erected in Western Australia, Queensland, South Australia and Victoria, thus indicating that the work of the Division is having its effect throughout the Commonwealth.

Valuable progress is being made in working out definite seasoning schedules for various timbers such as brush box (*Tristania conferta*), *Pinus radiata*, hardwood case stock, karri and jarrah case ends, cricket bat willow, jarrah flooring and various New South Wales timbers. The work on *P. radiata* has assumed great importance because of the large operations in South Australia and of the decision of the Woods and Forests Department of that State to sell only kiln dried

timber. Very satisfactory results have been obtained from the work on investigations on the use of hardwoods for stock for manufacturing cases and boxes. In the laboratory kiln $\frac{1}{4}$ in. boards were dried and reconditioned in twelve hours with very satisfactory results, and it is expected that a 24-hour schedule will be readily obtainable on a commercial scale. Valuable results have also been obtained from the work on the investigation of vacuum drying kilns, moisture meters and various other miscellaneous projects. The annual report of the senior seasoning officer (Mr. S. A. Clarke) shows in detail the nature of the work done. It indicates that close contact has been maintained with all the kiln drying installations in Australia. The most heartening feature is the extent to which the work is being availed of by the sawmilling industry, and the improvements which are being effected in the way of the introduction of proper plants and methods.

3. *Wood Technology*.—One of the disabilities under which the Australian timber industry operates is the difficulty in making a precise determination of the variety of a timber merely by an examination of the sawn plank. Work on the microscopical examination of timbers for the purpose of developing an identification test was begun by the Council in 1929 in co-operation with the Commonwealth Forestry Bureau. In April, 1931, the work was transferred to the Headquarters of the Division in Melbourne. The major problem is the development of a satisfactory key for the identification of Australian woods. The importance of such a key is evidenced by the fact that numerous requests for the identification of timber have been received from the State Forestry Services, the Postmaster-General's Department and many other sources. There can be no adequate control of the export of timber with the subsequent development of overseas markets unless the timber sold can be identified definitely, and the development of an identification key for Australian woods will thus prove of value to all timber users and timber industries. The work of the Section during the year 1930-31 was confined mainly to the study of the redwoods of the genus *Eucalyptus*, and to the determination of the density of Australian timbers. Precise knowledge of the density of different species is of great value since it has been shown by the United States Forest Products Laboratory that there is a definite relation between density and mechanical properties. Although identification is the first object of this work it will gradually extend into an investigation of the relation between microscopical structure and the properties of timbers. A further extension will be to co-operate with the work on seasoning, preservation and mechanics in an investigation into the physical causes of behaviour of timbers under experimental operations. The chemists' work on identification has proved to be of great assistance to the microscopists and indeed offers the best chance of still further classifying the *Eucalyptus* groups.

4. *Timber Preservation*.—In December, 1930, a 4 ft. pressure cylinder and its accessory plant were completed and made available for experimental purposes. A small laboratory has been fitted up for work on toxicity and decay. Various public utilities and many private firms are already making regular use of the work of this Section, and a considerable amount of information has been distributed which will lead to large savings of timber. It is a feature of the work that the main projects extend over long periods, and that in some cases they can yield positive results only after some years of work. The pressure cylinder has been occupied firstly in testing out methods of creosoting piles of *E. globulus*, *E. regnans* and *E. obliqua* for the Tasmanian Forest Service, and in testing species of timbers from various States selected by the Forestry Departments as being the most important woods. Valuable results have already been obtained, and a preliminary classification of the results according to a considerable number of different treatments has been made.

In co-operation with the Postmaster-General's Department, the Victorian Forests Commission and the Council's Division of Economic Entomology, further installations have been made of powellised and fluarised karri and stringybark crossarms.

Further service tests of treated karri sleepers are being made in Western Australia.

An experiment on treated pole stubs is being made in New South Wales for the Public Works Department.

Experiments on the preservation of poles treated with arsenic collars and with a brush treatment with creosote are being made for the Postmaster-General's Department.

The first annual inspection of the international termite exposure tests has been made and a report prepared.

Timber treated with various Australian gums is being tested in field plots. Some difficulty in getting suitable penetration has been found, and work is proceeding in conjunction with the Section of Wood Chemistry in order to overcome this. The work of this Section is of very great economic importance, as is indicated firstly by the fact that various public utilities of Australia are faced with an annual bill of more than £1,000,000 owing to necessary replacements

of railway sleepers, telegraph poles, bridge timbers, &c., and secondly, by the increasing number of requests for advice and assistance received by the Division from various Commonwealth and State Departments and other sources. It will, however, be some years before all the necessary data can be obtained regarding the proper treatment for the preservation of Australian timbers.

5. *Wood Chemistry*.—Work in this Section is directed to a study of the fundamental chemistry of Australian timbers. This involves the collection of an enormous amount of data from many samples of each of the hundreds of species which occur. The programme of work will thus naturally take several years to complete. Meanwhile the special application of chemical methods to timber identification is being studied. In this direction two objectives are kept in mind, firstly, the establishment of definite chemical tests which will enable the precise identification of many species of timber which are readily mistaken for others and which often cannot be differentiated by the microscope, and secondly, the development of simple qualitative tests of identification which can readily be applied in the field. During the year 1930–31 considerable advance has been made in the work which has already resulted in the development of methods of rapidly differentiating between certain timbers which previously could be distinguished only with great difficulty. The extractives of cypress pine (*Callitris sp.*) have been studied. At the request of the Western Australian Forests Service an investigation into the methods of extraction of sandalwood oil and of the content and quality of oil from wood grown in various localities has been completed, and a report which is confidential for the present has been forwarded to the Western Australian Department. A study of the extractives from woods with a high resistance to the attack of termites and fungi is in progress. This has as its objective the development of cheap and effective wood preservatives. Numerous oils, gums and resins which are bye-products of the living trees are being studied, and a process of elimination has led to concentration mainly on one product.

6. *Utilization*.—It has not so far been practicable to form a separate section of the Division for the important study of the utilization of Australian timbers. A satisfactory beginning has, however, been made by officers of the Seasoning and Preservation Sections. Considerable use has also been made of the services of three research students who are at present abroad under the Science and Industry Endowment Fund, and who have investigated a number of special timber industries and made reports of substantial value.

(i) *Wallboards*.—The utilization of wood waste by conversion into wallboards and insulating boards is an industry which has had enormous development in recent years, particularly in the United States. The Forests Services of New South Wales and Western Australia have co-operated with the Division in an investigation into the possibilities of Australian hardwoods for this purpose. Quantities of karri, jarrah and blackbutt (*E. pilularis*) were shipped to an experimental plant in Cleveland, Ohio, and were there converted into insulating and hard pressed boards. The results showed that the woods made excellent products, but the economic possibility of the industry in Australia depends mainly on the ability of the market to absorb the output of a factory sufficiently large to be worked as an economic unit.

(ii) *Utilization of Pinus radiata*.—This is by far the most important utilization problem which has so far been studied by the Division. The forests in the South-east of South Australia are coming into the productive stage, and the South Australian Department of Woods and Forests has begun operations mainly on thinnings, but including a small amount of clear felling. The Department's plan is to cut 7,000,000 feet of pine in the year 1931–32 and to increase this quantity slowly at first, and then with greater rapidity until by 1950 the cut will be 100,000,000 feet. It is, therefore, the most important softwood operation in Australia, and it is likely to remain so for many years. The Department of Woods and Forests has requested and has obtained the co-operation of the Division in planning its operations, and the Conservator of Forests has freely expressed his recognition of the value thus rendered.

(iii) *Wood Taint in Butter*.—Frequent complaints have been received from time to time that butter exported in boxes of hoop pine developed wood taint. No other Australian wood had been found suitable for packing butter, and most Australian butter is exported in boxes of New Zealand white pine. Arrangements were accordingly made for Mr. W. J. Wiley, formerly a Research Student under the Science and Industry Endowment Fund, to be attached to the Division of Forest Products for the purpose of an investigation into this problem. The work has consisted of two parts, (a) an investigation into the causes of wood taint, and (b) a search for a method of prevention. Valuable progress has been made; the cause of the taint has been shown to be due to volatile oils in the woods and a rapid method has been devised of testing whether or not a timber will cause taint in butter. More important has been the development of a method of prevention which has proved successful over a period of nine weeks, and of which the cost is small. Arrangements have been made for a large scale trial in South Australia of

50 boxes of *P. radiata* and in New South Wales and Queensland of 50 boxes of hoop pine. The tests will be completed by the end of 1931. An application has been made for a patent covering the processes devised by the Division.

Other problems studied in connexion with utilization have been the suitability of timbers for lead pencils, battery separators and various minor uses.

7. *Standards*.—A section of the co-operative work undertaken by the Council is in connexion with standards for timber. The Standards Association of Australia has appointed a Timber Committee of which the Chief of the Division is Chairman, and two of its staff Joint Secretaries. The work has been of a laborious nature, and though final results are necessarily slow in attainment very definite progress has been made. Practically complete agreement has been attained with regard to the definitions of timber terms, and finality has been reached in the matter of standard methods of timber testing. A beginning has been made in the difficult problem of the preparation of basic grading rules for flooring timbers.

X.—COLD STORAGE INVESTIGATIONS.

1. *General*.—Evidence continues to accumulate in support of the opinion reached by the Council some time ago, that investigations into the preservation, storage and transport of the perishable foods which Australia can produce in abundance are of wide national importance. For instance, people closely in touch with the citrus fruit industry have pointed out that already the plantings of orange trees are such that the annual production in sight is more than sufficient for the Australian market, and that the future well-being of the industry is dependent on the successful establishment of a fairly extensive export trade in the next few years. It is well known too that there is room for considerable improvement in present practices relating to the cold storage and transport of other fruits and also of meats, such as chilled beef, &c.

During the last year, the Council's Adviser on Cold Storage Problems, Associate-Professor W. J. Young, Bio-chemistry Department, University of Melbourne, and the Committees mentioned later, continued to afford the Council valuable advice and assistance. The investigations in this field have not been organized into a Division. However, with the recent return to Australia of Dr. J. R. Vickery, who for the last four years has been at the Low Temperature Research Station, Cambridge, as an 1851 Exhibition Research Scholar and also as an officer of the Council, it has been decided to set up a Section of Food Preservation. This Section will work in close conjunction with the Committees controlling existing investigations, and in addition to conducting work on its own behalf will be of value to these Committees in their particular researches. The Section has been placed under the charge of Dr. Vickery, who will be assisted by, among others, Mr. N. E. Holmes and Dr. S. A. Trout, two recently returned trainees appointed under the Science and Industry Endowment Fund.

2. *Co-operation with British Food Investigation Board—Expedition to New Zealand*.—In the last Annual Report, reference was made to the scientific survey of the freezing, storage and transport of New Zealand lamb initiated by the British and New Zealand Departments of Scientific and Industrial Research, and to the fact that the Council was co-operating with these bodies by attaching two investigators to the survey party.

The work was completed last year, and a comprehensive, confidential report has been issued to the various bodies participating. It is believed that the findings of this survey will also be applicable, with slight modifications, to the export of Australian frozen lamb and mutton.

In particular, the results have indicated the extent of the loss of bloom to be expected from each of numerous sets of conditions obtaining from slaughter in the producing country to sale in Great Britain. They have shown, too, that the loss of bloom cannot be avoided except by the reduction of the rate and extent of the loss of weight to certain minimum values. Loss of weight, in itself, is an important factor in the trade, for it is estimated that, for an average season's export from Australia, a reduction of 20 to 25 per cent. in the loss of weight that is now experienced would mean £30,000 per annum to the industry. The breed of lamb, too, was found to exert a considerable effect both on the initial bloom and on the subsequent loss of bloom. The necessity has been shown for great care being exercised during the transport of the frozen carcasses by rail and overseas vessels and during the loading and discharge. A study of the loss of quality and bloom during storage was made, and the extent of the deterioration likely to occur during storage in England has been emphasized.

3. *Problems of the Storage and Transport of Citrus Fruit*.—The investigations of the Citrus Preservation Committee have been actively pursued throughout the year. Further attention has been given to the determination of the best temperatures at which to store the different varieties.

The results of the experiments for the last three years indicate that treatment of the fruit with borax and bicarbonate solutions has a good effect in that it reduces waste and the incidence of mould. There is no reason to believe, however, that the treatment can in any way prolong the normal storage life of the fruit which is dependent upon the properties of the materials the fruit contains and the rate at which these are used up in respiration, &c. All that can be expected of the treatment is that it should prevent the normal storage life from being cut short by the development of moulds.

During the year the Committee has paid special attention to the requirements of the export trade and in this connexion has formulated a set of recommendations for the handling of fruit intended for export. These were published in the Council's Journal (Vol. 4, No. 2).

It is encouraging to report that the results of the Committee's work are being applied by the industry concerned on an ever increasing scale. For instance in June, 1931, two fairly large experimental shipments of navel oranges, a proportion of the fruit having been treated according to the Committee's recommendations, were sent by Murray River growers to China and Canada respectively. In addition three plants for the mechanical treatment of oranges with bicarbonate solutions have been erected by commercial interests in the producing districts. Fruit is also being cold stored to an ever-increasing extent.

4. *Banana Investigations.*—The experiments into the maturation and transport of bananas have been continued in Queensland and in Melbourne. The work on ripening is now practically complete and a full report giving directions to commercial ripeners as to the kind of rooms, insulation, suitable constant temperature and humidity equipment, and also discussing the best conditions of temperature humidity, the use of ethylene or coal gas necessary for ripening in winter and in summer, is being prepared. It will be published shortly as one of the Council's Bulletins. Application has been made for a patent for the process recommended by the Council's Committee.

The report contains a short account of the transport investigations written by Messrs. Holloway and Barr (of the New South Wales Railways Department) who have had charge of this section of the work. These particular investigations are not yet complete, but the work done to date has yielded valuable information, particularly with regard to the condition of the fruit at packing and to its treatment prior to its leaving Queensland. They show, for instance, that much of the loss which is attributed to railway transport is really due to the conditions before such transport and they point to remedies which may be applied to prevent this loss.

Here again the results of the work are being applied by industry to a considerable extent. The Banana Committee has, for instance, received numerous enquiries from commercial ripeners as to the fitting up of suitable rooms. Further, in the light of the information obtained by the Committee, the fruit marketing authorities in Queensland have now taken over full control of all bananas from that State and steps are being taken by these authorities to have ripening chambers erected in Brisbane, Sydney and Melbourne in accordance with the Committee's recommendations.

5. *Meat Problems.*—The somewhat fundamental investigations into the cause and nature of the "drip" which oozes out of a cut surface of meat after freezing and thawing have been continued. Variations in quantity of drip have been found in various muscles of the same carcass and in any particular muscle obtained from different carcasses. To determine the factors causing this variation studies are being made of the effect of age at the time of death, the rate of thawing and in particular the acidity and salt concentration in the muscle juices.

XI.—OTHER INVESTIGATIONS.

1. *Commonwealth Prickly Pear Board.*—In the last Annual Report of the Council an account was given of the action taken by the former Advisory Council of Science and Industry leading to the creation of the Commonwealth Prickly Pear Board for the purpose of controlling generally the co-operative investigations of which the costs is being borne by the Council, the New South Wales Department of Agriculture, and the Queensland Prickly Pear Lands Commission. In that Report it was stated that the results of the work had been so satisfactory that the Queensland Government had introduced a Bill to facilitate the settlement of large areas of land which had either already been cleared of the pest or were in an advanced stage of clearing.

During the year 1930–31, the investigations have proceeded satisfactorily. In addition to the natural increase, over 500,000,000 eggs of *Cactoblastis cactorum* were supplied to landowners by the Queensland Prickly Pear Lands Commission in 1930–31, and over 200,000,000 by the

New South Wales Department of Agriculture. In a few districts there was a heavy mortality among *Cactoblastis* owing to septicæmic disease due to various bacterial organisms. Outbreaks of such diseases are, however, ordinarily to be expected in such cases of over-crowded insect life.

The progress made by *Cactoblastis* during the year 1930-31 was most satisfactory, except in a few districts comprising, firstly, those areas in which disease was prevalent, and secondly, certain other areas where the pear is of a hard type, particularly, for example, in the Toowoomba (Queensland) and Scone (New South Wales) Districts. The large scale distribution of *Cactoblastis* in recent years has resulted in a general infestation throughout the pear areas, and in many new localities effective destruction became apparent during the past year. It is estimated that the original heavy growth of pear has now been destroyed over at least 3,000,000 acres. An Act for the settlement of prickly pear lands has been passed by the Queensland Parliament and is being administered by the Queensland Prickly Pear Lands Commission, and large areas of land formerly infested heavily by prickly pear are now being made available for settlement. Vast areas of country previously covered by prickly pear are thus being gradually freed of the pest and are being reclaimed for settlement. It is, unfortunately, impracticable to assess the monetary value of the increased production and benefits which will thus ensue. The problem of the regrowth of the pear, after the original growth has been destroyed, is being carefully studied by the Prickly Pear Board's officers.

2. *Flying Fox Pest*.—As pointed out in the last Annual Report of the Council, efforts to control the flying fox pest by means of shooting, poison gas, explosives, flame guns, poisoning in the orchards, &c., had proved ineffective, and the Council accordingly decided to carry out an investigation of the whole problem in co-operation with the New South Wales and Queensland Departments of Agriculture. The primary object of the investigation was to obtain as complete information as possible regarding the flying fox population in Australia, its size and extent, the relation of the different species one to another, the nature and cause of the migrations, the individual and collective habits of the animals, and the extent and value of the economic losses involved. It was considered that when full information regarding these matters had been collected, it would then be practicable to determine whether effective control measures or promising lines of further investigation could be suggested.

Mr. F. N. Ratcliffe was appointed to carry out the investigation for a period of two years, and he has presented his report which is being published as one of the Council's Bulletins. In it he states that there are four species of *Pteropus* in Australia, namely, *Pt. poliocephalus* (the grey headed flying fox), *Pt. Gouldi* (black fox), *Pt. conspicillatus* (the spectacled fox) and *Pt. scapulatus* (the little red fox). These species are confined practically to the coastal areas of Queensland and northern New South Wales, and their numbers (which cannot be accurately assessed) must amount to many millions in the numerous "camps" scattered along the North-east stretch of some 2,000 miles.

Mr. Ratcliffe reached the conclusion that no proved method of mass destruction is likely to be effective and sufficiently inexpensive in operation and that indirect methods of control, for example, by an introduced disease are not practicable. He has shown that the animal is mainly a blossom feeder, and that contrary to the general belief it is not a serious menace to the commercial fruit industry, although much loss occasionally occurs, notably where soft fruit such as figs, peaches, nectarines, &c., are grown. He condemns the scalp bounty system administered by a number of Pest Destruction Boards in Queensland as being generally ineffective, partly because of the relatively small number of animals destroyed under the system, partly because the animals are shot where most convenient and not where particular damage is done, and partly because a large proportion of the animals shot belong to the species *Pt. scapulatus* which is almost exclusively a blossom feeder. Such beneficial effects as may accrue from the scalp bounty system could almost certainly be achieved more economically by other methods.

3. *Tobacco Investigations*.—Changes have taken place during the year in the control of the Australian Tobacco Investigation which, as indicated in last year's report (p. 37) was initiated in July, 1927, as the result of a co-operative agreement between the British Australian Tobacco Company Limited and the Governments of the Commonwealth and the five mainland States. The arrangement then made was for three years and in its original form it lapsed at the end of June, 1930. There was some delay in negotiations for the continuance of the work, but most of the investigations, both in the field and in the laboratory, were carried on without serious break. In March, 1931, the term of appointment of the Director of Investigations (Mr. C. M. Slagg) came to an end and he returned to America. Pending reorganization, the Chief of the Council's Division of Plant Industry, Dr. B. T. Dickson, undertook the duties of Acting Director.

In April last, at the request of the Minister, a report was prepared by the Hon. J. Gunn and Dr. Rivett containing definite proposals for the future conduct of the Investigation and these, together with the somewhat divergent recommendations of the Parliamentary Select Committee of the tobacco industry which reported in July last, were the subject of much discussion with the following results :—

- (a) The control of the investigation was placed in the hands of a Committee of three with the Secretary to the Prime Minister's Department (Mr. J. G. McLaren) as Chairman and the Director of Development (Mr. J. Gunn) and the Chief Executive Officer of the Council (Dr. A. C. D. Rivett) as members.
- (b) To finance the work the Commonwealth Government promised to provide £3,000 per annum for three years and the British Australasian Tobacco Company agreed to contribute a like sum. Other tobacco manufacturers have been invited to join in the work.
- (c) The State Governments were not asked to contribute, it being contended that they already had sufficient responsibilities in connexion with their own necessary extension and demonstration work, a field into which the Investigation would not enter.
- (d) Scientific work both in the laboratory and in the field was placed under the Council for Scientific and Industrial Research which allotted it to the Division of Plant Industry. The Chief of the Division was given the title of Director of Tobacco Investigations.
- (e) Financial and general administration was made the function of the Prime Minister's Department.

During the year there has been an extraordinary growth of interest in tobacco production. On the whole this is a most satisfactory development for which the former Australian Tobacco Investigation can claim some credit, particularly in Queensland. To a certain extent, however, present conditions are abnormal and the unprecedented rush of farmers, many of them without adequate experience, to plant tobacco may lead to a measure of failure and loss before the industry is placed upon a sound basis.

The new Committee will continue work on areas which, as a result of past investigation and experience, have been found to give definite promise of success in the commercial production of tobacco leaf of a type and quality suitable for Australian requirements. Laboratory work on diseases and measures for their control will be continued. By accepting responsibility for the conduct of the whole of the scientific work, the Council has added considerably to the load placed upon the Division of Plant Industry; but the possibilities of the tobacco industry are such as fully to justify this action. The investigation will issue its own reports from time to time.

4. Fuel Problems.—In previous Annual Reports of the Council it has been pointed out that research in connexion with the production of liquid fuels from coal either by low temperature distillation or by hydrogenation, &c., involves not only the provision of complicated and expensive plant but also the employment of highly qualified officers, and that large sums of money have been expended on such researches by public and private interests in various European and American countries. The Council accordingly decided that it would be undesirable for it to undertake research work in Australia on these problems and that its appropriate policy would be closely to watch the course of developments in other countries. Close liaison was therefore established and has been maintained between the Council and the British Department of Scientific and Industrial Research, and the Council is thus in the fortunate position of being kept in intimate touch, through the British Fuel Research Board, with all developments in the field of liquid fuel research.

Information regarding the present position of investigations on the production of fuel oil from coal was obtained by Dr. A. C. D. Rivett, the Chief Executive Officer of the Council, during a visit to Europe in 1930 and a report on the matter furnished by him was published as a Parliamentary Paper in 1931.* Dr. Rivett attached to his statement two reports prepared respectively by Dr. A. S. Fitzpatrick on "Costs in Liquid Fuel Production from Coal" and by Mr. L. J. Rogers on "The Production of Liquid Fuels from Coal". In his report he discussed separately the problems presented by black and brown coals under the following headings :— (a) Low temperature distillation of black coal; (b) hydrogenation of black coal; (c) low temperature distillation of brown coal; and (d) hydrogenation of (i) brown coal, (ii) brown coal

* See Memorandum on the Present Position of Investigations on the Production of Fuel Oils from Coal, by A. C. D. Rivett, M.A., D.Sc., Parliament of the Commonwealth of Australia, No. 178, 1931, Government Printer, Canberra.

tars. He expressed the opinion that the initiation and development of an Australian industry, if practicable, could best be effected by some such organization as the then proposed association of international interests and he considered it desirable that a close liaison should be established between the Commonwealth Government and these interests through their British member. Since the date of publication of Dr. Rivett's report the negotiations for the organization of international interests have led to the formation of the International Hydrogenation Patents Company of which the principal members are the Standard Interessen-Gemeinschaft Company (representing interests of the Standard Oil Company of America and the I.G. Farben-Industrie of Germany), the Royal Dutch Shell Group and Imperial Chemical Industries Ltd. As a result of Dr. Rivett's recommendation action has been taken by the Commonwealth Government with a view to the appointment of the Council as the liaison authority with the international organization through its British member, Imperial Chemical Industries Ltd.

5. *Australian Radio Research Board.*—The Third Annual Report of the Board (for the year ending 30th June, 1931) will be published in full in the November, 1931, issue of the Council's journal. During the period under review the field strength survey of the larger Sydney broadcasting stations was completed and the results published as the Council's Bulletin 47. Measurements were taken for roughly 100 miles distant from the stations. The results obtained, indicating as they do the attenuating effect of wooded hills, &c., are of value in connexion with the location of further transmission stations. Investigations in progress now relate to two main matters, viz., fading and atmospherics.

The work on fading is of a fundamental nature and in regard to it particular attention is being given to the characteristics of the Heaviside layer in the Southern hemisphere. Further knowledge of such characteristics will no doubt be a fruitful source of improvement in wireless practices. Already the Board's investigators have obtained indications of methods whereby it may be possible to reduce the fading of broadcast programmes which is such a serious annoyance in the country districts of Australia. These methods are now being studied more closely. The different aspects of the investigations on fading and the Heaviside layer are being followed up in Victoria and New South Wales. The analysis of records has established the fact that most of the fading experienced falls into two main types, namely, the larger slow fading cycle of say three minutes in period and superimposed on this a smaller quicker type of fading of say twenty seconds period. The first type is attributed to an ionized layer at a height of about 62 miles and of relative stability, while the second type seems to be associated with a considerably higher layer. The investigations have also demonstrated that in the Southern hemisphere the rotation of the plane of polarization of a skywave is in a clockwise direction, which finding is in accordance with one of the main points of the theory of the Heaviside layer.

The work on atmospherics is being carried out by means of two cathode ray direction finders located at either end of the 300 miles base line between Laverton (Victoria) and Mt. Stromlo (Federal Capital Territory). During the year the inter-communication between these two places has been considerably improved by the generosity of the Royal Australian Air Force and the Postmaster-General's Department. Investigations have all through given no indication that conditions in Australia are any different from those of other countries where it has been found that atmospherics are closely associated with the advancement of cyclonic disturbances and low pressure areas; in other words, with thunder or rain storm areas. The work has thus demonstrated the value to Australia of the use of cathode ray direction finders for long range weather forecasting and in connexion with the following of thunderstorms with a view to warning aircraft.

During the year the atmospherics recorder which had been in operation for some time at the Watheroo Magnetic Observatory, Western Australia, was converted into a new type instrument and returned to Watheroo.

6. *Geophysical Prospecting.*—Mention of the Imperial Geophysical Experimental Survey is made owing to the fact that the Council was largely responsible for the administrative work of the Survey, although that portion of the Survey's funds contributed from the Commonwealth was made from sources other than those of the Council. The other portion (one-half) of the necessary funds was contributed by the Empire Marketing Board.

It was stated in the previous report of the Council that the field work of the survey had been completed in January, 1930. Since that time the final report of the Survey has been completed and published in book form by the Cambridge University Press. It was prepared in two parts in the belief that by this arrangement it would prove of value to a wider range of readers than might otherwise have been the case. In the first part, the field investigations made by the Survey together with elementary explanations of the various methods employed are given

in such a manner that they can be followed without serious difficulty whether the reader be physicist, geologist or mining engineer. The second part of the report is devoted to a more detailed explanation of field procedure, design of apparatus, interpretation of results, and other theoretical considerations for a complete understanding of the principles upon which the methods are based. The report thus constitutes a very comprehensive text-book.

A lengthy review of the report was prepared by Emeritus-Professor Sir T. Edgeworth David, K.B.E., F.R.S., and published in the Council's journal (May, 1931). In addition, the report has been favorably reviewed in various scientific journals throughout the world.

Quite an amount of success was achieved by the Survey in relation to the main purpose that prompted its establishment, namely, the testing of the applicability of various geophysical methods to field conditions in Australia which might be regarded as characteristic of considerable portions of the Empire. In addition several interesting discoveries were made, for instance, at Gelliondale in Victoria the underground limits of a brown coal bed were defined by the gravimetric method with such accuracy that the Survey challenged the log of a bore which had been put down in the field years before. As a result, fresh bores were put down and completely vindicated the Survey's contentions. At Gulgong, by the use of the seismic method, the courses of various gold leads that had been buried under a considerable thickness of basalt were determined. Finally the electrical methods proved useful in the discovery of previously unknown deposits of copper-nickel near Zeehan in Tasmania, of tin bearing ores near Renison Bell in Tasmania, of graphite at Port Lincoln, South Australia, and of silver lead ores in one or two parts of New South Wales.

7. Mineragraphic Investigations.—Of recent years the Australian gold and base metal mining industry has suffered a serious decline largely as the result of the working out of many of the richer deposits of ores. The rehabilitation of the industry will thus involve, *inter alia*, the development of the lower grade but extensive deposits which are known to exist in various parts of the continent. This in its turn will involve the utmost efficiency in treatment methods. In the past, a difficulty that has always hampered the development of the best method of ore treatment has been the lack of information regarding the precise mineral content of the deposits. Ordinary assays are not enough. What is of even greater importance is a knowledge of the precise minerals which occur in the ore, the size of their individual crystals, their associations with each other, &c. Once information of this nature is available, it becomes possible to determine the degree of grinding that will render the most economic separation possible, the minerals that can be most economically floated, &c. A knowledge of the relation of the individual minerals to each other is also quite frequently of vital importance to the mining geologist, giving him information as to the genesis of the deposit and thus leading to suggestions for the better underground development of the mine.

In the past, the obtaining of full information regarding mineral associations in an ore has been practically impossible owing to the fact that most minerals are opaque to light and thus cannot be determined by the ordinary and well known petrographic methods. Of recent years, however, the difficulty has been largely overcome by the development of a special technique depending on the use of reflected light. This technique is used by the Council's investigator, Dr. F. L. Stillwell.

During the past year Dr. Stillwell has specialized on the telluride ores of Kalgoorlie (Western Australia), the copper-tin ores from the Oonah mine at Zeehan (Tasmania), the zinc-lead ores from Captain's Flat (New South Wales), and the copper ores from Moonta (South Australia).

The Kalgoorlie ores which have formed the major subject of investigation, contain, apart from native gold, ten species of the rare tellurium-bearing minerals and at least twelve sulphide minerals and one selenide. The most abundant species of tellurides are calaverite, coloradoite and krennerite, and these, together with the rarer altaite, melonite and nagyagite only occur in the unaltered primary ore. Sylvanite, petzite and hessite also occur as primary minerals, but in addition have been recognized for the first time as secondary minerals which can develop in the ore as a consequence of the action of descending solutions from the oxidized zone on primary tellurides.

The examination of the complex stannite ore from the Oonah mine at Zeehan revealed the existence of two generations of the metallic minerals with the unusual feature of a tin-bearing mineral in each generation.

Dr. Stillwell's services have also been used in connexion with surveys of various parts of Australia that have been made with a view to the encouragement of gold-mining, and as a result several promising lodes have been indicated as worthy of further prospecting by bores, shafts and crosscuts. The investigations carried out by Dr. Stillwell have been greatly facilitated by

a grant of £400 from the Australasian Institute of Mining and Metallurgy. The University of Melbourne has also assisted by granting the investigator laboratory accommodation at the Geology School.

8. *Standards Association of Australia*.—In the last Annual Report of the Council, attention was drawn to the fact that largely as a result of suggestions made by the British Economic Mission that visited Australia in 1928–29, steps had been taken for the re-organization of the Australian Engineering Standards Association and the Australian Association for Simplified Practice which bodies had been combined under the title of the Standards Association of Australia. The Commonwealth Government decided that the Council should be the means of liaison between the Association and the Government. The year 1930–31 was one of very considerable difficulty for the Association owing to restriction of its funds. It was accordingly found necessary during the year very seriously to curtail the salaries of the Association's officers, and to dispense entirely with the services of others. The Association was able to carry on its extensive and important programme of work not merely by means of the monetary grants and subscriptions received, but also very largely as a result of the contributions in the form of voluntary services rendered by members of the numerous Committees throughout the Commonwealth.

Notwithstanding the difficulties occasioned by the drastic reduction in the numerical strength of the Association's technical staff, it was found possible to maintain a substantial part of the Association's activities during the year 1930–31. Projects of lesser urgency have been deferred until more favorable conditions prevail, and in other instances, the rate of progress has necessarily been retarded. There has nevertheless been a satisfactory advance in the work of the Association, and several publications of outstanding importance have been completed and issued.

XII.—MISCELLANEOUS.

1. *Publications of the Council*.—The following publications were issued by the Council during the year :—

(i) *Bulletins*—

- No. 44.—Investigations on "Spotted wilt" of Tomatoes, by Geoffrey Samuel, M.Sc., J. G. Bald, B.Agr.Sc. and H. A. Pittman, B.Sc.Agr.
- No. 45.—A Soil Survey of the Woorinen Settlement, Swan Hill Irrigation District, Victoria, by J. K. Taylor, B.A., M.Sc., and F. Penman, M.Sc.
- No. 46.—Black Disease (Infectious Necrotic Hepatitis) of Sheep in Australia, by A. W. Turner, D.V.Sc.
- No. 47.—Radio Research Board: Report No. 1—
 - (1) Corrections to Field Strength Measurements with Loop Antennae, by W. G. Baker, B.Sc., B.E., and L. G. H. Huxley, M.A., D.Phil.
 - (2) A Radio Field Strength Survey within 100 miles of Sydney, by W. G. Baker, B.Sc., B.E., and O. O. Pulley, B.Sc., B.E.
- No. 48.—The Experimental Error of the Yield from Small Plots of "Natural" Pasture, by J. Griffiths Davies, B.Sc., Ph.D.
- No. 49.—Factors Affecting the Mineral Content of Pastures, by A. E. V. Richardson, M.A., D.Sc., H. C. Trumble, M.Agr.Sc., and R.E. Shapter, A.A.C.I.
- No. 50.—The Poisonous Action of Ingested Saponins, by A. J. Ewart, D.Sc., Ph.D., F.L.S., F.R.S.
- No. 51.—A Soil Survey of the Swamps of the Lower Murray River, by J. K. Taylor, B.A., M.Sc., and H. G. Poole, M.Sc.
- No. 52.—The Soils of Australia in relation to Vegetation and Climate, by J. A. Prescott, M.Sc.

(ii) *Pamphlets*—

- No. 18.—The Influence of Frequency of Cutting on the Value of "Natural" Pastures in Southern Australia, by J. Griffiths Davies, B.Sc., Ph.D., and A. H. Sim, B.Sc., B.Agr.Sc.
- No. 19.—Black Disease, by A. W. Turner, D.V.Sc.

No. 20.—The Identification of Wood by Chemical Means—Part I., by H. E. Dadswell, M.Sc.

No. 22.—The Density of Australian Timbers—A Preliminary Study, by H. E. Dadswell, M.Sc.

No. 22.—The Chemistry of Australian Timbers—Part I.; A Study of the Lignin Determination, by W. E. Cohen, B.Sc., and H. E. Dadswell, M.Sc.

(iii) *Quarterly Journal*—

Vol. 3, No. 3, August, 1930.

Vol. 3, No. 4, November, 1930.

Vol. 4, No. 1, February, 1931.

Vol. 4, No. 2, May, 1931.

(iv) *Annual Report* for the year ending 30th June, 1930.

The confidential Monthly Summary is being issued as previously to members of the Council and its State Committees. It is of special service in that it keeps members of the staff and students who are working in isolated positions or who have been sent overseas well in touch with the general work of the Council. This summary is also issued to the officers of the Council and to certain research organizations in other parts of the Empire. In the last-mentioned direction it thus serves as one means of keeping these organizations acquainted with the various investigations, and to that extent plays its part in the general movement for the closer co-ordination of research work throughout the Empire as a whole.

2. *Catalogue of Scientific Periodicals*.—The completion of the Catalogue and the distribution of the printed volume was mentioned in the last annual report. Since that time it has been evident that it would considerably detract from the usefulness of the Catalogue if some attempt were not made to keep it up to date. Owing to the great amount of work involved in preparation and printing, by the time the bound volume actually appeared, twelve months had already elapsed since the last entries that had been included in it had been received.

It was accordingly decided that a small committee consisting of Mr. E. R. Pitt, of the Melbourne Public Library, Mr. W. H. Ifould, of the Public Library of New South Wales, and the Council's Librarian (Miss E. Archer) should make the necessary arrangements for the issuing of Supplements. Owing to the financial stringency it had been impossible to place any sum on the 1930-31 Estimates for the work involved in the compilation of such Supplements. The routine necessary in collecting and co-ordinating the entries received from the various libraries had therefore to be undertaken by the Council's library staff in conjunction with the regular work. Arrangements were made with the co-operating libraries to commence the work of bringing their Catalogue entries up to date.

At first it was hoped to issue mimeographed copies of a preliminary supplement, at any rate to co-operating libraries, some time during the year. It has been found, however, that owing to the unexpected number of entries received, and to other unavoidable delays, it has so far been impossible to prepare this supplement. When once the preliminary supplement has been prepared and issued, it is hoped to make arrangements so that it will be possible for librarians to forward to the Council at regular intervals any additions and amendments that occur in their libraries. This will mean that there will always be available at the Council's library a Catalogue that is up to date.

3. *Library*.—The additions to the library at head-quarters during the past year have been 435, of which 292 are bound volumes of periodicals. The number of bulletins, pamphlets, reports, &c., received has averaged 702 per month. These numbers are smaller than the previous year owing to the fact that many publications formerly received in the head-quarters library are now being filed in the Divisional libraries.

As explained in the previous report (1928-29) the head-quarters library is acting as a co-operating body for the Divisional libraries. A catalogue of the publications in the Divisional libraries is maintained at the Council's head offices, and this is proving increasingly helpful as it prevents overlapping and permits of borrowing from one library to another without undue delay. A list of additions to the head office and Divisional libraries is circulated among the staff each month.

i In 1928 what was then the Australasian Association for the Advancement of Science nformed the Council that, as its library was not being used to any great extent in Sydney, the suggestion had been made that the Council might be willing to add the Association's library to its own in order to form the nucleus of a scientific library in Canberra. The Council accepted this offer, and the books, &c., are being placed on the shelves and indexed as opportunity offers.

4. *Bureau of Information*.—As in the previous years a great deal of information has been disseminated among the general public as a result of inquiries received personally or by letter. An increasing number of these inquiries have had to do with the manufacturing or secondary industries.

A few of the subjects on which it has been possible to supply information are as follow :—

(i) *Agricultural and Horticultural*.—Gingelly, Phormium tenax, cricket-bat willow cultivation, tung oil, senna, bracken fern control, blackberry pest eradication, " bidgee widgee " burr, weed poisoning, drought feed of sheep, apricot dieback, clearing of tea-tree swamps, cystine-os, wool scouring, kapok growing, tick bean, asparagus cultivation.

(ii) *Food Preservation*.—Freezing of berry fruits, curing of lemons, fruit preservation—Bohle process, Ottesen fish freezing process, fish refrigeration, tests for milk adulterations, drying of nectarines, cold storage of eggs, canning of bananas, meat preservation, cheese mite control, fish canning, pea canning.

(iii) *Industrial Minerals*.—Stannite ore, sulphur recovery, tantalite ore, bentonite, kaolin, titanium minerals, zirconium minerals, ferrous sulphate.

(iv) *Manufactures*.—Malted milk, fish paste manufacture, adhesives, cellophane, papain, tailors' chalk, agar from seaweed, carbon paper, synthetic resins, molding powders, cider making, nicotine spray, iodine manufacture, quinine manufacture, artificial fruit, coir fibre, dry cells, patent gas producer, magramite, Xanthorrhoea gum, toys from plastic materials, shark leather, artificial wool, calcium glycerophosphate, soap manufacture, condensed milk manufacture, yeast—home brewed, aluminium waste, colouring of glass beads, vinegar manufacture, cement from oyster shells, solvol manufacture, sugar beet extraction—De Veechis process.

(v) *Miscellaneous*.—Wine-costs of production, tobacco curing, water proofing brick walls, trochus shell industry, sheep branding fluids, anti-corrosion process, recovery of wool grease, illumination of buildings, patent rail, silver-fish eradication, tea-tree oil, shark fishing industry, exploitation of limestone and of sea shells, use of low grade wools, patent headlights, carriage of ferro-silicon, removal of citrus taint, sugar cane by-products, opossum fur for felt hats, finger cherry-poisonous properties, chemical composition of honey.

XIII.—FINANCIAL MATTERS AND STAFF.

1. *Finance*.—The statement of expenditure from 1st July, 1930, to 30th June, 1931, is as follows :—

| | £ | £ | £ |
|---|-------|-------|---------|
| 1. Salaries and contingencies | .. | .. | *14,819 |
| 2. Remuneration of Chairman and Members of Council | .. | .. | †3,231 |
| 3. Investigations— | | | |
| (i) Animal Problems— | | | |
| (a) Black disease and footrot | 2,624 | | |
| Less contributions from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England | 598 | | |
| | | 2,026 | |
| (b) Parasitology | 1,550 | | |
| Less contribution from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England | 636 | | |
| | | 914 | |
| (c) Caseous lymphadenitis | | 1,194 | |
| (d) Sheep Blow-fly | | 301 | |
| (e) Haematuria in cattle | | 536 | |
| (f) Braxy-like (Beverley) disease, Denmark disease, Moora (Gin Gin) disease (Western Australia) | | 1,548 | |

* 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 £14,819 was provided as follows :—

| | |
|---|--------|
| From Consolidated Revenue Fund | £ |
| From Science and Industry Investigation Trust Account | 4,984 |
| | 9,885 |
| | 14,819 |

† Provided from Consolidated Revenue Fund.

| | £ | £ | £ |
|---|--------|--------|--------|
| (g) Flying Fox Pest | 712 | | |
| <i>Less</i> contributions from Govern- ments of New South Wales and Queensland towards 1930-31 expenditure | 250 | | |
| | | 462 | |
| (h) Cattle Tick Dips | 288 | | |
| <i>Less</i> contributions from Govern- ments of New South Wales and Queensland towards 1930-31 expenditure | 288 | | |
| | | | |
| (i) Pregnancy Disease in Lambs and Twin Lamb Disease, Tasmania | 172 | | |
| <i>Less</i> contributions from the Aus- tralian Pastoralists' Research Trust and the Empire Marketing Board, England | 172 | | |
| | | | |
| (j) Erection of McMaster Laboratory (pro- gress payment) | 13,000 | | |
| <i>Less</i> instalments of donation of £20,000 made by F. D. McMaster, Esq. | 13,000 | | |
| | | | |
| (k) Erection of sheep and calf pens at Sydney University | 350 | | |
| <i>Less</i> contribution from New South Wales and Victoria Meat Exporters' Associations | 350 | | |
| | | | |
| (l) Central Office Salaries, &c. | | 1,450 | |
| (m) Miscellaneous | | 319 | |
| | | | 8,750 |
| (ii) Plant Problems—Division of Plant Industry— | | | |
| (a) Central Laboratory— | £ | | |
| Salaries, &c. | | 5,848 | |
| Capital | 27,697 | | |
| <i>Less</i> contribution from Commonwealth Bank towards erection of plant house | 7,983 | | |
| | | 19,714 | |
| | | | 25,562 |
| (b) Experimental Plots | | | 600 |
| (c) Plant Pathology | 1,877 | | |
| <i>Less</i> contributions from Empire Marketing Board, England | 13 | | |
| | | 1,864 | |
| (d) Plant Genetics | | 1,530 | |
| (e) Plant Introduction | | 1,252 | |
| (f) Plant Physiology | | 48 | |
| (g) Noxious weeds | | 396 | |
| (h) Experimental farm, Duntroon | 795 | | |
| <i>Less</i> contributions from the Empire Marketing Board, England | 303 | | |
| | | 492 | |
| (i) Tomato wilt | 544 | | |
| (j) Arid flora | 592 | | |
| (k) Catalogue of fungi | 496 | | |
| (l) Bitter pit in apples | 76 | | |
| (m) Miscellaneous | 106 | | |
| | | | 33,558 |

| | | | | £ | £ | £ |
|-------|--|--|--|-------|--------|--------|
| (iii) | Entomological Problems—Division of | | | | | |
| | Economic Entomology— | | | | | |
| | (a) Central Laboratory— | | | | | |
| | Salaries, &c. | | | 7,211 | | |
| | Capital | | | 3,714 | | |
| | | | | | 10,925 | |
| | (b) Noxious weeds | | | | 1,728 | |
| | (c) Blowfly and buffalo fly | | | | 4,836 | |
| | (d) Orchard and fruit pests | | | | 525 | |
| | (e) Field crop and pasture pests | | | | 807 | |
| | (f) Forestry problems | | | | 1,054 | |
| | (g) Scouting work abroad (Farnham Royal, &c.) | | | | 72 | |
| | | | | | | 19,947 |
| | Less contributions received as under :— | | | | | |
| | Empire Marketing Board | | | 9,410 | | |
| | Commonwealth Bank | | | 1,861 | | |
| | | | | | 11,271 | |
| | | | | | | 8,676 |
| (iv) | Animal Nutrition—Division of Animal Nutrition— | | | | | |
| | (a) Central Laboratory— | | | | | |
| | Salaries, &c. | | | 7,207 | | |
| | Capital | | | 139 | | |
| | | | | | 7,346 | |
| | (b) Waite Institute | | | | 1,457 | |
| | (c) Field Station, Beaufort, Victoria | | | | 158 | |
| | (d) Field Station, Young, New South Wales | | | | 274 | |
| | (e) Field Station, Moree, New South Wales | | | | 257 | |
| | (f) Field Station, Springsure, Queensland | | | | 383 | |
| | (g) Field Station, Mount Gambier, South Australia | | | | 298 | |
| | (h) Field Station, Kangaroo Island, South Australia | | | 335 | | |
| | Less contributions from the Australian Pastoralists Research Trust and the Empire Marketing Board, England | | | 335 | | |
| | (i) Drought feeding experiments at Waite Agricultural Research Institute, Glen Osmond, South Australia | | | 90 | | |
| | Less contributions from the Australian Pastoralists Research Trust, and the Empire Marketing Board | | | 90 | | |
| | At Waite Institute in co-operation with E. M. B. and Adelaide University— | | | | | |
| | (j) Mineral deficiencies in pastures | | | | 999 | |
| | | | | | | 11,172 |
| (v) | Horticultural Problems of the Irrigation Settlements— | | | | | |
| | Citricultural— | | | | | |
| | (a) Research Station, Griffith— | | | | | |
| | Salaries and incidentals | | | 3,152 | | |
| | Capital | | | 242 | | |
| | | | | | 3,394 | |
| | Less contributions by New South Wales W.C. and I.C. | | | 1,500 | | |
| | | | | | 1,894 | |

| Viticultural— | | £ | £ | f |
|--|----|-------|--------|-------|
| (b) Research Station, Merbein— | | | | |
| Salaries and incidentals | .. | 3,389 | | |
| Capital | .. | 743 | | |
| | | <hr/> | | |
| | | 4,132 | | |
| Less contributions by Dried Fruits Control Board .. | .. | 498 | | |
| | | <hr/> | 3,634* | 5,528 |
| (vi) Soil Problems— | | | | |
| (a) Investigations at Waite Institute and Irrigation Areas— | | | | |
| Salaries, &c. | .. | 4,386 | | |
| Capital | .. | 1,084 | | |
| | | <hr/> | | 5,470 |
| (vii) Food Preservation and Transport— | | | | |
| (a) Banana Investigations (Queensland University) | | .. | 159 | |
| (b) Banana Investigations (Melbourne University) | | .. | 339 | |
| (c) Cold Storage of Meat and Fish | | .. | 417 | |
| (d) Citrus Preservation | | 332 | | |
| Less contribution by Board of Trade .. | .. | 49 | | |
| | | <hr/> | 283 | |
| (e) Meat Export Survey (Overseas) | .. | 1,033 | | |
| (f) Adviser on Food Preservation | .. | 356 | | |
| | | <hr/> | | 2,587 |
| (viii) Prickly Pear— | | | | |
| (a) Grant for Investigations | .. | | | 6,000 |
| (ix) Forest Products— | | | | |
| (a) Central Laboratory— | | | | |
| Salaries, &c. | .. | 7,768 | | |
| Capital | .. | 1,063 | | |
| | | <hr/> | 8,831 | |
| Less contributions— | | | | |
| Australian Wood Pipe Co. .. | .. | 11 | | |
| Western Australia Department of Forests (Sandalwood Oil Investigations) .. | .. | 250 | | |
| Western Australia Department of Forests (Wallboard Tests) | .. | 61 | | |
| New South Wales Forestry Commission (Wallboard Tests) | .. | 30 | | |
| | | <hr/> | 352 | |
| | | <hr/> | | 8,479 |
| (x) Mining and Metallurgy— | | | | |
| (a) Mineragraphic Investigations | | 874 | | |
| Less contribution by Australasian Institute of Mining and Metallurgy | .. | 400 | | |
| | | <hr/> | | 474 |
| (xi) Fuel Investigations | .. | | | 161 |
| (xii) Radio Research— | | | | |
| (a) Melbourne University | .. | 2,232 | | |
| (b) Sydney University | .. | 2,624 | | |
| (c) Adviser on Radio Research | .. | 83 | | |
| | | <hr/> | 4,939 | |
| Less contributions by Postmaster-General's Department | .. | 3,704 | | |
| | | <hr/> | | 1,235 |

* £737 was received for sale of produce and credited to Trust Fund receipts.

| | £ | £ | £ |
|---|-----|-----|---------------|
| (xiii) Library | .. | .. | 1,065 |
| (xiv) Contributions to Imperial Agricultural Bureaux and to British Woollen and Worsted Association | .. | .. | 3,125 |
| (xv) Miscellaneous— | | | |
| (a) Wood Taint in Butter Investigations .. | 226 | | |
| Less contributions by Australian Dairy Council | 200 | | |
| | | 26 | |
| (b) Various | .. | 325 | |
| | | | 351 |
| Total of Item 3 | | | 96,631 |

2. *Contributions.*—As a result of the increasing financial support given to the Council by outside bodies, it is considered desirable that the receipts and expenditure of such moneys should be recorded in a special account. The Council approached the Commonwealth Treasury on the matter and obtained the approval of the Treasurer to the opening of an account to be known as the Specific Purposes Trust Account.

The following statement shows the receipts and disbursements of the funds provided by the contributors during the year :—

| | Receipts. £ | | Expenditure. £ |
|--|----------------|----|-------------------|
| Empire Marketing Board, England (Entomological Investigations) | 10,377 | .. | 9,558 |
| Empire Marketing Board, England (Animal Health and Animal Nutrition Investigations) | 500 | .. | 500 |
| Empire Marketing Board, England (Plant Industry Investigations) | 1,000 | .. | 316 |
| Commonwealth Bank (Erection of Plant House) .. | 10,000 | .. | 7,983 |
| Commonwealth Bank (Entomological Investigations) .. | 3,000 | .. | 1,861 |
| F. D. McMaster, Esq. (Erection of McMaster Laboratory) | 13,000 | .. | 13,000 |
| Postmaster-General's Department (Radio Research) .. | 4,067 | .. | 3,704 |
| Australian Pastoralists Research Trust (Animal Health and Animal Nutrition Investigations) | 1,800 | .. | 1,330 |
| New South Wales Water Conservation and Irrigation Commission (Maintenance of Griffith Research Station) | 1,500 | .. | 1,500 |
| Dried Fruits Control Board (Dried Fruits Investigations) | 520 | .. | 498 |
| Board of Trade (Storage and Transport of Citrus Fruit .. | 500 | .. | 49 |
| Department of Agriculture, New South Wales (Cattle Tick Dip Investigations) | 500 | .. | 288 |
| Department of Agriculture, New South Wales (Flying Fox Investigations) | 130 | .. | 125 |
| Department of Agriculture, Queensland (Flying Fox Investigations) | 130 | .. | 125 |
| New South Wales and Victorian Meat Exporters Associations (Erection of sheep and calf pens at Sydney University for Animal Health Investigations) .. | 350 | .. | 350 |
| Australian Dairy Council (Wood Taint in Butter Investigations) | 200 | .. | 200 |
| Australian Wood Pipe Co. Ltd., (Forest Products Investigations) | 11 | .. | 11 |
| Australasian Institute of Mining and Metallurgy (Mineragraphic Investigations) | 400 | .. | 400 |
| Western Australia Department of Forests (Sandalwood Oil Investigations) | 250 | .. | 250 |
| Western Australia Department of Forests (Testing of suitability of certain Australian timbers for manufacture of wallboards) | 61 | .. | 61 |
| New South Wales Forestry Commission (Testing of suitability of certain Australian timbers for manufacture of wallboards | 30 | .. | 30 |
| | 48,326 | .. | 42,139 |

3. *Staff*.—The following is a list of the staff of the Council as at the 30th June, 1931. The list does not include typists, laboratory assistants and labourers, &c.

1. HEAD OFFICE STAFF.

Chief Executive Officer—A. C. D. Rivett, M.A., D.Sc., F.A.C.I.

Secretary—G. Lightfoot, M.A.

Assistant Secretary—G. A. Cook, M.Sc., B.M.E., A.A.C.I.

Chief Clerk and Accountant—H. P. Breen.

Library—

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

Assistant Librarian—Miss K. Ramsay (to 30th September, 1930).

Miss A. L. Kent (from 1st October, 1930).

Accounts, Staff, Stores—

M. G. Grace, L.I.C.A.

J. Derum.

D. J. Bryant.

Orders—

R. W. Constable.

Records—

P. Domec Carre.

H. T. Chadwick.

W. Gillespie.

Clerical Assistant to Chief Executive Officer—Miss A. Slattery, B.A.

Clerical Assistant to Chairman—Mrs. N. Roberts.

Local Secretary, Canberra—R. F. Williams.

2. SECRETARIES OF STATE COMMITTEES.

New South Wales—

Brigadier-General I. G. Mackay—University of Sydney (to 3rd October, 1930).

Mrs. N. Roberts (from 4th October, 1930), 906 Culwulla Chambers, Castlereagh-street, Sydney.

Victoria—

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

Queensland—

Miss H. Todd, corner Ann and Edward Streets, Brisbane.

South Australia—

E. V. Clark, B.Sc., University of Adelaide (to 31st October, 1930).

J. Ward Walters, Division of Animal Nutrition, University of Adelaide (from 5th November, 1930).

Western Australia—

L. W. Phillips, M.Sc., A.A.C.I., Box K766, General Post Office, Perth, Western Australia.

Tasmania—

F. J. Carter, Box 631 B., General Post Office, Hobart.

3. AUSTRALIA HOUSE, LONDON.

Representative in Britain—F. L. McDougall, C.M.G. (part-time).

Scientific Assistant—A. S. Fitzpatrick, M.Sc., Ph. D. (part-time) (to 31st December, 1930).

Clerical Assistant—A. W. Stuart Smith (part-time) (to 31st December, 1930).

4. DIVISION OF PLANT INDUSTRY.

At Canberra—

Chief—B. T. Dickson, B.Sc. (London), B.A. (Ontario), Ph.D. (Cornell).

Senior Plant Pathologist—H. R. Angell, B.Agr.Sc., Ph.D.

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

Senior Plant Introduction Officer—A. McTaggart, B.S.A. (Toronto), M.S.A. (Cornell); Ph.D. (Cornell).

Botanical Assistant—C. Barnard, B.Sc.

Assistant Plant Pathologist—W. L. Geach, B.Sc. (Bristol).

Junior Plant Pathologist—Miss P. H. Jarrett, B.Sc.

Junior Plant Introduction Officer—W. Hartley, B.Sc. (Cantab.).

Assistant Plant Geneticist—H. F. Smith, B.Sc. (Edin.) M.S.A. (Cornell).

At Canberra—continued.

Assistant Botanist (Weeds)—J. Calvert, M.Sc. (Belfast), F.L.S.
 Biometrician—Miss F. E. Allan, M.A., Dip. Ed.
 Chemist—E. H. Kipps, B.Sc.
 Librarian (part-time)—Mrs. L. M. Willings, B.A.

At Head Office, Melbourne—

Mycologist—C. C. Brittlebank.

At Waite Agricultural Research Institute, South Australia—

Assistant Plant Pathologist—J. G. Bald, B.Agr.Sc.

At Department of Agriculture, Western Australia—

Senior Plant Pathologist—W. M. Carne, F.L.S.

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

Research Officer—T. B. Paltridge, B.Sc.

5. DIVISION OF SOIL RESEARCH.

At Waite Agricultural Research Institute—

Chief—Professor J. A. Prescott, M.Sc., A.A.C.I. (part-time).
 Soil Survey Officer—J. K. Taylor, M.Sc., M.Agr.Sc., B.A.
 Assistant Field Officer—T. J. Marshall, B.Agr.Sc.
 Assistant Chemist—H. G. Poole, M.Sc., A.A.C.I.
 Assistant Chemist—J. S. Hosking, B.Sc.
 Assistant Field Officer—P. D. Hooper.

At Commonwealth Research Station, Griffith—

Assistant Soil Chemist—H. N. England, B.Sc., A.A.C.I.

At University of Tasmania—

Assistant Soil Chemist—C. G. Stephens, B.Sc.

6. 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 (part-time)—D. Chalmers.
 Orchard Superintendent—B. H. Martin.
 Field Assistant—E. F. Mackenzie, D.A.
 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.
 Technical Assistant—D. V. Walters, B.Agr.Sc.
 General Assistant—J. E. Giles.
 Research Officer (part-time)—A. C. Ingerson.

7. DIVISION OF ANIMAL HEALTH.

At Head Office, Melbourne—

Acting Chief—J. A. Gilruth, D.V.Sc., M.R.C.V.S., &c.

At Melbourne University Veterinary Research Institute—

Veterinary Officer—A. W. Turner, D.V.Sc.
 Veterinary Officer—D. Murnane, B.V.Sc.
 Technical Assistant—Miss C. Eales, B.Sc.

At Adelaide Hospital Pathological Laboratory—

Veterinary Officer—C. G. Dickinson, B.V.Sc.
 Chemist—A. T. Dann, M.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. (to 26th November, 1930).
 Chemist—F. F. Allsop, B.Sc., A.A.C.I. (to 4th May, 1931).

At University of Sydney—

Parasitologist—I. Clunies Ross, D.V.Sc.
 Bacteriological Technician—E. Parrish.
 Field Officer—N. P. Graham, B.V.Sc.

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 to 16th January, 1931, then with Division of Economic Entomology at Canberra).

Abroad—

Veterinary Officer—W. A. Carr Fraser, B.V.Sc. (in Great Britain engaged in post-graduate work in animal nutrition).

8. DIVISION OF ANIMAL NUTRITION.

At the University of Adelaide—

Chief—Sir Charles J. Martin, Kt., C.M.G., M.B., D.Sc., F.R.S. (3rd January, 1931).
 Acting Chief—H. R. Marston (to 2nd January, 1931).
 Senior Biological Officer—H. R. Marston (from 3rd January, 1931).
 Chief Assistant—J. Ward Walters.
 Chemist—R. G. Thomas, B.Sc.
 Assistant—J. D. O. Wilson.
 Assistant Chemist—J. W. H. Lugg.
 Statistical Recorder—G. W. Bussell.
 Chemical Assistant—F. C. Farr.
 Typiste-Secretary—Mrs. E. V. Wilson.

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, Moree, New South Wales—

Field Assistant—O. K. Samuel.

At "Dismal Swamp" Sheep Station, near Mt. Gambier, South Australia—

Field Assistant—A. S. Pannell.

At "Wambanumba" Field Station, Young, New South Wales—

Field Assistant—W. Haddon Cave (to 6th December, 1930), R. Tout (from 8th December, 1930).

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.
 Deputy Chief—A. J. Nicholson, D.Sc.
 Senior Entomologist—G. F. Hill.
 Senior Systematic Entomologist—A. L. Tonnoir.

At Canberra—continued.

Senior Entomologist—I. M. Mackerras, M.D.
 Senior Entomologist—G. A. Currie, B.Sc., B.Agr.Sc.
 Entomologist—J. W. Evans, B.A.
 Entomologist (Blowfly Investigations)—F. G. Holdaway, M.Sc., Ph.D. (from 2nd January, 1931).
 Junior Entomologist—H. Willings, B.A.
 Junior Entomologist—Miss M. Fuller, B.Sc.
 Junior Entomologist (Blowfly Investigations)—Mrs. J. Mackerras, B.Sc., M.B.
 Junior Systematic Entomologist—Miss W. P. Kent-Hughes, M.Sc.
 Junior Systematic Entomologist—Miss L. F. Graham, B.A.
 Field Assistant—T. Greaves.
 Junior Museum Assistant—Miss H. M. Barnes, B.Sc.
 Librarian—Mrs. L. M. Willings, B.A. (part-time).

At Farnham House Laboratory, England—

Entomologist—F. G. Holdaway, M.Sc., Ph.D. (to 24th October, 1930).
 Entomologist—S. Garthside, M.Sc.

At Buitenzorg, Java—

Investigator (Buffalo-fly)—Professor E. Handschin.
 Junior Entomologist—G. L. Windred, B.Agr.Sc.

In Northern Australia—

Junior Entomologist—T. G. Campbell, B.Sc.

In Western Australia—

Assistant Entomologist—H. Womersley.

At State College, Manhattan, Kansas, U.S.A.—

Junior Entomologist—S. G. Kelly, M.S. (Agr.).

11. DIVISION OF FOREST PRODUCTS.

At Head Office, Melbourne (temporarily)—

Chief—I. H. Boas, M.Sc., A.A.C.I.
 Senior Seasoning Officer—S. A. Clarke, B.E., A.M.I.E. (Aust.).
 Senior Chemist—W. E. Cohen, B.Sc., A.A.C.I.
 Assistant Seasoning Officer—C. S. Elliot, B.Sc.
 Preservation Officer—J. E. Cummins, M.Sc., A.A.C.I.
 Chemist—H. E. Dadswell, M.Sc.
 Assistant Chemist—L. Baldock.
 Assistant Chemist—Mrs. I. W. Dadswell, M.Sc. (to 28th February, 1931).
 Assistant Wood Technologist—Miss M. D. Burnell, B.Sc.
 Librarian and Records Clerk—Miss I. Hulme.
 General Assistant—S. G. McNeill.

12. COLD STORAGE INVESTIGATIONS.

At University of Melbourne—

Advisor 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.

In England—

Investigator—J. R. Vickery, M.Sc., Ph.D. (Returned to Australia 28th March, 1931).
 Assistant Investigator—N. E. Holmes, B.E.E.

13. RADIO RESEARCH.

At University of Melbourne—

Senior Investigator—G. H. Munro, M.Sc.
 Investigator—R. O. Cherry, M.Sc.
 Investigator—D. F. Martyn, B.Sc., Ph.D.

13. RADIO RESEARCH—*continued.**At University of Sydney—*

Senior Investigator—A. L. Green, M.Sc., A.M.I.R.E.

Investigator—L. G. H. Huxley, M.A., Ph.D.

Investigator—W. G. Baker, B.Sc., B.E.

14. OTHER INVESTIGATIONS.

Mineragraphic Investigations—

Investigator—F. L. Stillwell, D.Sc.

Flying-fox Investigation—

Investigator—F. N. Ratcliffe, B.Sc. (Investigation completed 19th March, 1931).

Wood Taint in Butter Investigations—

Investigator—W. J. Wiley, M.Sc.

XIV.—ACKNOWLEDGMENTS.

The Council desires to acknowledge the very valuable assistance so freely afforded by many organizations and individuals. 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. In addition to those who have been specified in the main part of this report, mention must also be made of many other private individuals who have taken a keen interest in the work of the Council and afforded it much help, both financial and otherwise.

| | | |
|--------|--|------------------------|
| (Sgd.) | G. A. JULIUS, Chairman | } Executive Committee. |
| | A. C. D. RIVETT, Deputy Chairman and Chief Executive Officer, | |
| | A. E. V. RICHARDSON, Member | |

G. LIGHTFOOT, Secretary.

APPENDIX.

A.—PERSONNEL OF THE COUNCIL AND OF ITS VARIOUS COMMITTEES.
COUNCIL (AS AT 30TH JUNE, 1931).

EXECUTIVE.

Sir George A. Julius, Kt., B.Sc., B.E. (*Chairman*).
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