1937–38.

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA.

TWELFTH ANNUAL REPORT

OF THE

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH,

FOR

YEAR 1937-38.

Presented pursuant to Statute; ordered to be printed, 4th November, 1938.

[*Cost of Paper.*—Preparation, not given; 750 copies; approximate cost of printing and publishing, £98.]

Printed and Published for the GOVERNMENT of the COMMONWEALTH OF AUSTRALIA by
L. F. JOHNSTON, Commonwealth Government Printer, Canberra.
(Printed in Australia.)

No. 99.—F.6386.—PRICE 4s.

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COMMONWEALTH OF AUSTRALIA.

Council for Scientific and Industrial Research.

TWELFTH ANNUAL REPORT FOR YEAR ENDED 30TH JUNE, 1938.

I. INTRODUCTORY AND GENERAL.

1. *General.*—The Council for Scientific and Industrial Research was established in 1926 by the re-organization of the existing Institute of Science and Industry. The powers and functions of the Council are defined by the *Science and Industry Research Act* 1920–37, and include the initiation and carrying out of research in connexion with, or for the promotion of, primary and secondary industries, the training of research workers, the making of grants in aid of pure research, and the establishment of a bureau of information relating to scientific and technical matters.

The important development in connexion with the Council's activities during the financial year 1937–38 was the decision of the Government to extend the Council's work to the secondary industries; mainly for that purpose the Government appropriated the sum of £250,000 for capital expenditure. The whole matter is discussed in greater detail in Section XI. of this report.

2. *Death of Sir David Masson.*—On 10th August, 1937, the Council suffered a great loss owing to the death of Sir David Masson, who had been a member of it since it was first constituted. In 1916, at the invitation of the then Prime Minister, the Rt. Hon. W. M. Hughes, P.C., K.C., he became Chairman of the Committee appointed to advise the Government on the establishment of a research body to investigate national problems. Immediately that body—the Advisory Council for Science and Industry which, in turn, gave rise to the Institute of Science and Industry and then the present Council—was formed, he was appointed its Chairman. He was closely associated with the formation of other Australian scientific bodies, for example, the Australian National Research Council, and was a much loved and respected member of the whole scientific community of the country, a community on which his influence was profound. At the first meeting of the full Council subsequent to his death, it was resolved to record the Council's gratitude for, and deep appreciation of, the outstandingly valuable services and wise guidance Sir David Masson had afforded throughout the many years of his association with the Council and its predecessors.

3. *Co-option of Mr. N. K. S. Brodribb.*—During the year, Mr. N. K. S. Brodribb, O.B.E. F.I.C., Inspector-General, Works and Supplies, Defence Department, was co-opted as a member of the Council. For some time past, it has been felt that a greater measure of co-operation was desirable between the Council and the Department, insofar as research work having an industrial bearing was concerned.

4. *New Laboratories.*—During the year, two central laboratories for work of the Council were completed. The first of these was the laboratory, in the grounds of the Veterinary Research Institute at the University of Melbourne, which is now housing much of the Victorian work of the Division of Animal Health and Nutrition; in particular, the laboratory is accommodating the investigations on mastitis and certain aspects of pleuro-pneumonia.

The second laboratory was that at the Homebush Abattoir for the Council's Section of Food Preservation and Transport. The building has been rendered possible by the generous assistance of the New South Wales Metropolitan Meat Industry Commission and the New South Wales Department of Agriculture.

5. *New Experimental Station at Cunnamulla, Queensland.*—As a result of the financial contribution of £17,500 by the Australian Wool Board mentioned in the previous report—a grant since increased to £20,000—and the action of the Queensland Government in making the land available at a nominal rental, an experimental sheep station is now available to the Council in the Cunnamulla district, Queensland. The Station has been named "Gilruth Plains" after the late Dr. Gilruth, the first Chief of the Division of Animal Health, so that its complete address is: The National Field Station, "Gilruth Plains", Cunnamulla, Queensland. It comprises an area of 40,000 acres, which was formally handed over to the Council in September, 1937. The Wool Board grant has been used to cover the cost of the necessary residences, shearing sheds, laboratory, fencing, &c., and also for the purpose of the necessary stock. The Station will be of considerable value in connexion with work on the blowfly and other problems of the pastoral industry; it will also be a valuable centre for work on pasture grasses for the drier regions of the continent.

6. *Reports by Mr. G. Lightfoot.*—In the previous report it was mentioned that the Secretary of the Council, Mr. G. Lightfoot, had left Australia in June, 1937, on a visit to the United States of America, Canada, and Great Britain, the greater part of that expense being met by a grant from the Carnegie Corporation, in order that he might collect data on the organization and work of information services in science and technology.

Mr. Lightfoot returned to Australia early in 1938, and then submitted two reports—one dealing with the proposed establishment of an Information Service by the Council, and the other dealing with Standards Laboratories and Testing Houses. The action which has been taken in regard to the former is discussed in Section XI. of this present report dealing with secondary industries work. The information contained in Mr. Lightfoot's report on standards and testing is proving of considerable value in the organizing of the Council's work in this particular field. The Council is the means of liaison between the Commonwealth Government and the Standards Association of Australia, and as a result of discussions which Mr. Lightfoot had in London, arrangements have been made for Mr. P. Good, the Deputy-Director of the British Standards Institution, to visit Australia this year.

7. *Visit of Dr. John Hammond.*—During the year, Dr. John Hammond, F.R.S., M.A., D.Sc., of the Animal Nutrition School, University of Cambridge, paid a visit to Australia (subsequent to a similar visit to New Zealand). The object of the visit was to make himself conversant with local conditions and then furnish a report containing his ideas regarding the future development of the animal industry in Australia. After receiving much valuable assistance from the various State Departments of Agriculture, and from organizations such as the Australian Dairy Produce Board, the Australian Meat Board, and from many individual interests, he presented a report which has been published by the Council as its Pamphlet 79. His recommendations are now being followed up.

8. *Appointment of Dr. A. E. V. Richardson.*—During the year, Dr. A. E. V. Richardson, who for many years was the Director of the Waite Agricultural Research Institute of the University of Adelaide, and who has been a member of the Executive Committee of the Council since 1927, was appointed as Deputy Chief Executive Officer of the Council on a full-time basis. He will continue to be a member of the Executive Committee and is now located in Melbourne.

II. PLANT INVESTIGATIONS.

1. *General.*—It is a pleasure again to acknowledge the cordial co-operation in all the work of the Division of Plant Industry, of officers in other Commonwealth Departments, in State Departments of Agriculture and of Lands, and in Universities. While it is somewhat difficult to suggest that in one field this co-operation is more marked than in another, it is worthy of mention that, in connection with tobacco investigations, the results of a long period of collaborative work are evident in the Australian-wide attack on the problems and in the improvement in the tobacco-growing industry. In the case of weeds investigations also, close co-operation with the Department of Agriculture in New South Wales has materially changed the outlook on skeleton weed and made more hopeful the prospects of ultimate economic control.

In the previous report, it was noted that the Division had not yet been able to undertake investigations into pasture management problems despite their acknowledged importance to the Commonwealth. It is possible that work may be initiated in this field during the coming year. Other phases of pasture problems have been studied unremittingly. Plant introduction trials have been continued and some very promising types brought to light. Particularly is this the case with a legume suitable for the monsoonal areas; it is known as *Stylosanthes guyannensis* and is attracting the attention of graziers in Queensland.

During November, 1937, a conference of horticultural officers of the Commonwealth and States was held in Melbourne under the aegis of the Council, to review the work done under the Commonwealth grant made for further technical and advisory work on apple and pear problems. The opinion was expressed that the results obtained from the work undertaken so far constitute one of the most important advances in the industry during recent years, and that this opinion is shared by all branches of the industry. It was held that, while a satisfactory beginning had been made, permanent benefits could only be attained by a continuation of the work over a period of years; the conference was, therefore, of the opinion that the grant should be continued, if possible, over a period of at least five years. Professor O. S. H. Reinecke of the University of Stellenbosch, South Africa, was a visitor to the conference, and the opportunity was taken to compare fruit culture problems in the two countries.

Dr. C. Barnard, the senior officer in horticultural investigations, is looking into the problems and methods of dealing with them, which obtain in California, the eastern United States of America, Canada, and South Africa. He will represent the Commonwealth at the Twelfth International Horticultural Congress to be held in Berlin, August 12th–17th, 1938.

During July, 1938, a conference of Commonwealth and State tobacco officers was held in Melbourne; the work done since the inception of the present Commonwealth grant in aid of research and advisory programmes was reviewed and the future requirements outlined. The need for steady development in suitable areas—a development involving the greatest care in determining which are suitable areas for stable production of good quality leaf—was stressed by all delegates. At present, the approximate proportions of the total crop by States are Victoria and Queensland, 36 per cent. each, New South Wales and Western Australia, 12½ per cent. each, South Australia and Tasmania, 1½ per cent. each.

At the instance of the Standing Committee on Agriculture, a survey of virus diseases of potatoes was undertaken and it is now in its third year. It is evident, as was suspected, that virus diseases are widespread in our potato areas, and the survey shows that four are of major importance. In addition, the Standing Committee on Agriculture asked for a general enquiry into the problems of the potato industry to be undertaken by the Council and the Department of Commerce jointly. A small Committee representative of the two bodies has now, with the assistance of State officers, gathered much evidence in all States on diseases, pests, cultural methods, production costs, &c.

2. *Plant Introduction.*—(i) *General.*—Four hundred and twenty-six additional plants were introduced during the year, the total introductions to the 30th June, 1938, now being 6,253, from 67 countries.

Average yields over three years obtained at Duntroon from a third group (230) of introduced wheats, showed the superiority in this respect of wheats from England, Syria, Portugal, Crete, and Spain to four out of six standard Australian wheats, and at least the equivalent yielding power of other wheats from India, Asia Minor, and Greece in comparison with two other standard Australian wheats. The highest-yielding introduced wheat (V 50–3, from Cambridge, England) yielded 46.8 bushels per acre as against 43.8 bushels from Nabawa, the highest-yielding check.

The highest-yielding introduced oat in a five-year test at Duntroon was Red Algerian No. 61 (from Algeria) with 73.4 bushels per acre. Other good yielders were Legacy (68.3), Kherson (65.3), Iowa No. 3 (64.5), Prolific (62.1), and Victory 118 (62.0). All six yielded higher than the two checks, Sunrise (58.7) and Mulga (58.6).

In a four-year test of introduced barleys, Swedish Gold (53.5 bushels per acre) and Charlottetown 80 (53.2) outyielded Trabut (51.7) the check, while Danish Island (52.1), Hannchen (52.1), and Club Mariout (52.0) at least equalled, if not exceeded, it. Other good yielders were Peruvian (50.2), of particular interest from malting standpoint, Bay Brewing (48.5), Orge Caree de Algerie No. 42 (47.9), California Feed (46.1), and Mariout (45.7).

Tests of introduced forage plants, extended during the year, at Canberra revealed upwards of 100 grasses remaining green or showing rapid recovery during, or following, the prolonged dry weather which characterized the season. Some 48 grasses and 26 legumes showed winter growing capacity.

Grasses of stoloniferous or rhizomatous habit of growth have been adjudged excellent soil-binders, these being augmented during the year by the introduction from America of special creeping types of *Elymus* of Mongolian origin.

(ii) *Tests at Lawes, Queensland,* revealed *Brachiaria brizantha, Panicum maximum* (strain), *Urochloa trichopus, Paspalum scrobiculatum, Brachiaria dictyoneura, Sporobolus virginicus, Digitaria pentzii, Digitaria valida,* and *Eragrostis superba* as being the most promising grasses so far tested there, and as beings uitable pasture species for south-eastern Queensland. Other promising grasses are *Phalaris stenoptera* and *Agropyron intermedium* (winter-growing), *Urochloa bolbodes, Urochloa pullulans* (summer growing), and *Sehima nervosa* (for drier areas). Grazing tests favoured the first nine grasses. The first two outyielded Rhodes grass (check) by 200 per cent.

Promising pasture legumes at Lawes included strains of *Lespedeza striata* and *L. stipulacea, L. daurica, L. juncea* and *L. sericea, Phaseolus semi-erectus, Crotalaria usaramoensis, Cicer arietinum,* and *Alysicarpus rugosus.*

Promising green manure legumes were *Stizolobium atterimum, S. pachylobium, Dolichos lablab, D. debilis, Phaseolus ricciardianus, Phaseolus radiatus* and *Phaseolus trinervius,* and also, under special circumstances, *Canavalia ensiformis, Sesbania aculeata, S. paulensis, Crotalaria usaramoensis,* and *C. goreensis.*

(iii) *Tests at Fitzroyvale, Central Queensland.*—Despite the exceptionally dry season (dry December to March inclusive), the following species are capable of producing satisfactory growth: *Bothriochloa decipiens* (2301), *Bothriochloa* sp. (5526), *Sehima nervosa* (3759, 5529),

Pennisetum ciliare (1848), *Ischaemum glaucostachyum* (2668), Perennial Soudan grass (6581), *Urochloa mosambicensis* (6559), *Centrosema pubescens* (16671, 5772), *Stylosanthes guyannensis* (5630, 5631, 6058), and *Cajanus indicus* (6053, 4 and 5).

Species considered outstanding at Fitzroyvale in a normal season included : *Brachiaria brizantha, Chloris gayana* (Javan strain), *Pennisetum ciliare, Urochloa bolbodes, Panicum maximum* var. *trichoglume*, Perennial Soudan grass, and *Stylosanthes guyannensis.*

The outstanding feature of the 1937–38 tests at Fitzroyvale was the performance of *Stylosanthes guyannensis* which showed itself to be drought-resisting, palatable, quick in recovery following rains, remarkably productive under favourable conditions, a source of feed during the normally dry winter and early spring, and a perennial of early flowering and early seeding habit which is not likely to be eaten out. A second important feature of the tests was a demonstration by *Cajanus indicus* (pigeon pea) of its possible usefulness in dry time as a plant the branches of which can be " lopped " for feeding starving stock.

Tests with strains of subterranean clover, in the hope of finding a legume which will grow in the normally dry winter-spring period in Central Queensland, revealed that the " Dwalganup " early strain of this clover will regenerate itself as far north as the Tropic of Capricorn. Other early strains will be tested during 1938–39.

(iv) *Tests at Moss Vale, New South Wales.*—Tests begun in October, 1937, on an area at Moss Vale, New South Wales, revealed the following introduced plants as apparently possessing definite promise for good rainfall conditions on the Southern Tablelands :—strains of perennial rye grass from New Zealand; strains of cocksfoot from New Zealand, Denmark and Russia; strains of red clover from New Zealand and Russia ; a Lodino clover from Russia ; a strain of *Medicago lupulina* from Denmark ; a strain of *Trifolium lupulina* from Denmark ; a strain of *Trifolium montanum* from Europe ; *Phalaris stenoptera* (C.P.I. 1305) from California.

(v) *Other Tests.*—Some 1,077 plots representing seedings of introductions have been laid down in the Wagga, Bathurst, Orange, Glen Innes, Maitland, and Narrabri districts of New South Wales and at Wollongbar Farm, New South Wales, under a co-operative arrangement with the State Department of Agriculture. During 1937–38 seed of 476 introductions was sent out to individuals for testing in different parts of Australia and seed of 181 species and varieties was sent by request to other lands. Reports to hand indicate that 47 introduced plants or about 10 per cent. show promise in the opinion of the experimenters.

(vi) *Sward and Plot Studies.*—Sward studies extending over two to three years with 34 introduced grasses at Duntroon, Australian Capital Territory, were concluded during the year ; the results were published in the Council's Pamphlet 77. The grasses so studied were classified according to (1) the most productive species and varieties, (2) the most persistent, (3) the palatable, and (4) the grasses found productive, persistent, and palatable at one and the same time. Under (4) were included *Dactylis glomerata* (2145, 2127), *Bromus inermis* (5545), *Festuca varia* (2387), *Festuca spadicea* (2363), *Festuca pratensis* (5712, 5713), *Arrhenatherum erianthum* (2283), *Arrhenatherum avenaceum* (2306), and *Hoeleria eriostachya* (2118), using *Danthonia semi-annularis* as the basis for comparison.

On an area of 100 additional plots laid down in March, 1937, at Duntroon, a number of the grasses were successfully established despite periodic drought, and have been adjudged suitable for culture in the " Mediterranean " zone. These include : *Agropyron caninum* (2179 and 2492), *Agropyron cristatum* (C.P.I. 2179 and 2492), *Agropyron cristatum* (1296, 6607), *Agropyron intermedium* (1358), *Bromus arduennensis* (2382), *Bromus inermis* (1297, 1967, 5545), *Bromus polyanthus* (2360), *Dactylis glomerata* (2145), *Festuca elatior* (1144), *Festuca Mairei* (1499), and *Phalaris stenoptera* (1305).

(vii) *Other Studies.*—Detailed studies of introduced grasses and clovers were continued during the year. In strains of cocksfoot, germination of seed was favoured by alternating temperatures of 20°–30° C., except in the case of C.P.I. 2145 (southern France strain) which germinated better with constant temperature. Increasing age did not greatly affect germination up to five years, but there was an indication that freshly harvested seed requires a resting period before satisfactory germination is obtainable.

In strains of *Bromus inermis* (awnless brome), best germination results were obtained from alternating temperatures of 20°–30° C. Germination diminished slightly with increasing age, but five-year-old seed still germinated 60 per cent. A " resting period " in new seed did not appear to be necessary.

Trifolium canescens Willd. was found to flower abundantly, but seed-setting is poor due to the absence of suitable insect pollinators. The clover is long-lived, producing a good bulk of nutritious foliage, and remains green and healthy in summer when many other species have

wilted. Its utility in Australia appears to be limited by its inability to set sufficient seed in the absence of suitable insect vectors, but there is some evidence that strains more satisfactory in this respect might be selected.

Trifolium ochroleucum Hudson (sulphur clover) is a perennial, pubescent-leaved clover with a creeping or oblique, rather thick rootstock. It is fairly widespread in western, southern and central Europe, and in Asia Minor. While it flowers profusely, it sets very little seed, insect pollination being retarded by its long corolla tube. It is self-sterile if artificially tripped. It appears to be rather short-lived, is less drought-resistant than *T. canescens*, and is very susceptible to damage by aphis. The clover forms a fair bulk of foliage for a lengthy period each season, and strains of it differ considerably, but owing to its failure to set enough seed, it can have little value in Australia. Selection of a strain with a shorter corolla tube might, however, be attempted.

Trifolium tumens Stev., a perennial, is distributed on mountain slopes and pastures in Transcaucasia, Armenia, and north-west Persia. Scarification, owing to a high percentage of hard seeds, is necessary, and then germination occurs readily at 20° C., and at alternating temperatures of 20°–30° C. It flowers profusely over a long period and forms abundant fertile seed through uninterrupted pollination from the frequent visits of honey bees and other insects. The clover is long-lived, is well adapted to Canberra conditions, and is very healthy, but produces a somewhat low yield of foliage. Its ability to persist under grazing and prolonged dry weather makes it appear to have a place where white and subterranean clover, in particular, do not do well.

3. *Pasture Plant Breeding.*—(i) *At Canberra.*—Plant breeding has been continued at Canberra with the object of producing improved strains of certain species for Canberra or similar districts. The species being investigated include cocksfoot, prairie grass, and white clover. In each case several thousands of plants are raised and observed under field conditions. The past season, being particularly dry, enabled most useful observations to be made under such conditions. The best plants in each group were selected, broken into tillers, and set out as swards for further testing. The tests for determining reaction of prairie grass to smut showed that one strain was immune, while others varied from high resistance to complete susceptibility. Unfortunately, the immune type does not appear to be very good agronomically. The investigations on annual legumes for drier areas have been continued. The legumes being used are medics and subterranean and other clovers. Some 380 samples of seed have been collected from various parts of Australia, and these are being compared at Canberra. Striking differences in seedling growth are evident in these strains. The interspecific crossing programme has been continued.

(ii) *At Lawes, Queensland.*—The pasture plant breeding at Lawes, Queensland, is being undertaken co-operatively with the Queensland Departments of Public Instruction and of Agriculture and Stock. The object of the investigations is the production of improved grazing types. The species on which the work is concentrated are lucerne (for grazing), Rhodes grass, and *Phalaris* spp. Individual plants of many strains in each species have been examined and have shown vast differences in type. This work is being supplemented by other at Caboolture and Westbrook.

(iii) *At Moss Vale, New South Wales.*—The object of the work at Moss Vale is the production of better strains of pasture plants for high rainfall with a summer-winter distribution. The species being used are perennial rye grass, cocksfoot, white clover, red clover, and subterranean clover. The work is in its second year. Several thousands of plants of each species are under individual observation.

4. *Fruit Investigations.*—These comprise studies of non-parasitic diseases and storage problems of apples conducted in Tasmania, of vine and citrus problems under irrigation conditions, and of stock and scion relations centred at Stanthorpe, Queensland.

(i) *General.*—The work carried on during the year under the Commonwealth Apple and Pear Grant was reviewed in November, 1937, at the conference of horticulturists previously mentioned (Section I (i)). While only a short time had elapsed since the inception of the work, it was evident that a marked advance in advisory and demonstration services had been made by the various State Departments concerned. Particular attention had been paid in New South Wales to instruction in packing and re-working, in Victoria to black spot and codlin moth control, in Queensland to general advisory work, in South Australia to instruction in packing and re-working and to black spot and codlin moth control, in Western Australia to investigations into " dieback ", and in Tasmania to instruction in packing and re-working and to control of black spot, &c.

A proposal for the centralization of packing sheds and a reduction in the number of marks was considered desirable by the conference. Following the submission of a report on the " dieback " group of problems, it was concluded that more evidence should be accumulated on delayed foliation, little leaf, &c., with the climatic and soil moisture conditions, mineral deficiencies, &c., which obtain in the areas where these troubles occur.

Considerable attention was given to the problem of rootstocks, particularly concerning the use of Northern Spy and the importance of woolly aphis. It was the consensus of opinion that selection of local stocks of promise for experiment was desirable.

Proposals for a continuation of the programme of advisory, demonstrational, and investigational work were made in the belief that the achievement in so short a time justified the grant being continued for several years. The opportunity was also taken to review the problem of the canning fruits industry in Australia, especially in view of a suggestion from Mr. A. R. Townsend, Chairman of the Fruit Industry Sugar Concession Committee; it was finally recommended that, as the provision of a laboratory in the field was essential for the study of the problems, such facilities be provided at Tatura, Victoria.

(ii) *In Tasmania.*—The paragraphs that follow cover storage experiments on fruit picked last season (February–June, 1937), and field experiments up to June, 1938.

(*a*) *Storage Experiments.*—Experiments were continued with the varieties Cleopatra, Jonathan, Democrat, Scarlet Pearmain, French Crab, Sturmers, &c., but the season 1937 was one of low incidence of field and storage disorders, so that, while better for growers, it was more difficult for the elucidation of storage problems. With Cleopatras, the work confirmed previous results correlating larger fruit size with lower keeping quality. Experiments for the past five years with Jonathans have aimed at determining the effects of seasonal climate, maturity, storage temperatures, &c., on storage disorders. The practice of holding this variety beyond the optimum picking time in order to develop colour is possibly responsible for poor out-turn in some years.

Tests were made of the use of maleic acid in paraffin oil wrappers for retarding ripening. Preliminary trials showed better looking out-turn of fruit, but there was not any marked difference in the incidence of storage disorders or in colour effect.

Experiments were continued on storage in artificial atmospheres; it was found that Sturmer is very susceptible to brown heart, French Crab susceptible, and Jonathan relatively not susceptible. Respiration studies were continued, and a weekly chemical examination was made on samples from various plots in order to obtain data for storage tests and to develop the forecasts on export keeping quality.

(*b*) *Field Experiments.*—The recognition of boron deficiency symptoms and a knowledge of its treatment are now common in southern Tasmania, so no further plots have been established. Attention has been focussed on how long the trees will remain free from deficiency symptoms with the present treatment. Trees treated with a soil dressing of 1 lb. per tree have remained healthy for three years, but this quantity is too large for small trees and a check in growth occurs.

" Dimple " of Cleopatra and Granny Smith, although superficially very like the symptoms of boron deficiency, failed to respond to treatment with boron salts. A roughening and cracking of the calyx end of the fruit of Beurre Bosc pears was found to respond to treatment with boron, but " crinkle " of pears, which looks like internal cork of apples, again was not affected by boron applications.

(iv) *In Irrigation Areas.*—The progress of investigations on citrus and vine problems is recorded under the respective reports from the Viticultural Research Station, Merbein, Victoria, and the Citricultural Research Station, Griffith, New South Wales (Sections VII., A. and B.).

(v) *In Queensland.*—The propagation of imported and local root stocks for apples, pears, and plums has been continued at Stanthorpe, but again the season was one of less than average rainfall, being very dry in late summer and autumn. Thus the rooting response of those stocks, which normally are only moderate, was adversely affected. Two new locally selected apple stocks are under trial.

Woolly aphis infestations have increased in stool and layer beds of apple stocks and, in some cases, sufficiently to make it necessary to substitute propagation from root cuttings. The immunity of Merton stocks (Malling II. x Spy) to woolly aphis has been maintained, and stock trials have been laid down to them budded with Granny Smith and Jonathan.

A large nursery trial with 48 trees of Granny Smith on 18 different stocks of local and imported origin has been commenced. Six and a half acres have been cleared and fenced, and the area is now being planted with two-year-old trees of Granny Smith and Jonathan on Malling I., Malling XII., Malling XVI., Northern Spy, and Seedling stocks. The guard rows are of the same varieties on Malling II., French Crab seedlings of commercial origin, and root-grafted Granny Smith on Malling XIII. roots. These latter trees were donated by the New South Wales Department of Agriculture. Differences in blossom production on one-year-old unpruned apple trees were noted as follows: 30 Jonathans on Malling XVI. bore no blossoms, 24 Jonathans on Northern Spy carried 58 clusters, and 24 on Merton 789 carried 98 clusters. Treatment of hardwood apple cuttings with growth-promoting substances was not successful in inducing root formation.

Imported pear stocks yielded their first crop of shoots from the layer beds giving from three to six shoots per layer. One stock was eliminated because of its susceptibility to crown gall. The rooted stocks were budded to Beurre Bosc and Williams Bon Chretien for compatability trials. Bud take was satisfactory, and planting out losses only about one per cent.

5. *Wheat Investigations.*—(i) *Flag Smut.*—The previous year's experiments dealing with the reduction of the root system of young wheat plants infected with flag smut were repeated, and as before, the results were statistically significant. The extent of reduction is almost the same in susceptible and resistant varieties. Experiments made to determine the effect of high and low soil temperatures on the extent of manifestation of the disease in certain varieties have given conflicting results.

With the object of facilitating the breeding of varieties of wheat resistant to flag smut, investigations have been conducted on the mode of inheritance of reaction to this disease. Many difficulties have been encountered in this work, and efforts have been made to determine the cause. Last year it was shown that plants from small seeds, on the average, produced many more diseased plants than plants from large seeds. This occurred with Canberra, Yandilla King, Nabawa, and the F_2 of Canberra x Nabawa. Such behaviour is amply sufficient to render the mode of inheritance most difficult to determine.

(ii) *Root Rot of Wheat.*—According to the results of a field experiment, the pathogenicity to wheat of *Ophiobolus graminis*, and also the amount of seedling blight associated with sterilized inoculum increased markedly with depth of seeding. In pot experiments it was found that this organism had little or no effect on the growth of flax, though it was capable of penetrating the superficial tissues of the roots.

Arrangements have been made for co-operative work with the Waite Agricultural Research Institute and the Department of Agriculture of South Australia on an area of 20 acres on a farm in the Murray Mallee. The disease destroyed the last crop of wheat grown on the area which has again been seeded with the object of obtaining thorough infestation. When this is done, methods aiming at control will be tried. *Pari passu* Mallee soil is being used in experiments in Canberra. Ascertaining the role of the replaceable bases and soluble salts of Mallee soils in predisposing wheat to the disease, is the present objective of this work.

(iii) *Yield.*—The experiment being conducted to determine the characters of wheats associated with high yield, was continued at Canberra in 1937. The best yielding varieties were :—Carlisle,* 78.31 bushels ; Mallan, 77.14 ; Bargina, 73.79 ; Wandilla, 73.35 ; Exquisite, 73.10 ; Gluclub, 72.17 ; Dundee, 71.79 ; Bobin,* 71.08 ; Yandilla King, 69.65 ; Morley, 69.35 ; Nabawa (Group (II.), 69.16 ; Caliph,* 68.11 ; Waratah (Group I.), 59.34 ; Waratah (Group II.), 60.12 ; Waratah (Group III.), 55.72 ; Waratah (Group IV.), 58.68 ; Waratah (Group V.), 50.29.

At Wagga, further experiments were carried out with the object of determining the mode of inheritance of yield attributes, and of methods to be employed in selection.

Overseas workers have shown that, in a wheat field, small areas with the greatest number of plants yield best, and they have therefore suggested the improvement of wheat drills to provide for more uniform seeding. Repeating this work in Canberra, similar results were obtained, but additional analysis of the data showed that the increase was really due to competition with neighbouring areas of low plant density. The true correlation between yield and plant density may be positive, negative, or zero according to the circumstances. This does not warrant any improvement in the drill from the point of view of uniformity of seeding.

(iv) *Physiology.*—Work is in progress to determine the cause of drought resistance in wheat, and simple methods of measuring it. These investigations are mainly concerned with a study of the physico-chemical factors of expressed sap from wheat leaves. Determinations are being made on the quantity of a colloid, known as xylan, in wheat leaf tissue. Evidence is available to show that there are seasonal changes in the amount of this colloid per unit of dry matter, and there may also be varietal differences in xylan content.

6. *Tobacco Investigations.*—In 1934, the Commonwealth Government made provision for a grant of £20,000 per annum for a five-year period, and it was arranged that tobacco work would be a co-operative function of Commonwealth and State organizations. For its part, the Commonwealth undertook responsibility through the Council, for research into disease problems, including work on disease resistant varieties, and for work on smoking quality. Much progress has been made in the study of diseases, the most outstanding achievement being the development of a simple and economical means of controlling downy mildew (blue mould) in seedbeds. This is recognized as a most important contribution toward the development of the tobacco-growing industry. The study of Cercospora leaf-spot in Queensland was concluded and control measures recommended. Satisfactory progress has also been made with investigations of the big bud and yellow dwarf virus diseases.

* Calculated from 7 plots.

Smoking tests have shown that the increasing production of Australian tobacco in recent years has been accompanied by improvement in quality, practically all of the very poor grades having been eliminated. Our knowledge of fundamental aspects of the chemistry and physiology of tobacco grown under Australian conditions has been extended, and curing processes, maturation, and processing methods investigated.

Active co-operation between the States, and between the Commonwealth and the States, is shown by the successful annual conferences of tobacco officers, the half-yearly exchange of progress reports, and by the acceptance of joint responsibility for the determination of smoking quality of tobacco produced anywhere in the Commonwealth.

(i) *Diseases.*—The seedbed experiments involving the use of various hydrocarbons for the control of downy mildew (blue mould) have now been carried on for three years. During this season the work was confined to the north-east district of Victoria. The work on yellow dwarf and big bud virus diseases was also done in the same State.

(*a*) *Downy Mildew.*—Seedbed experiments involving the use of various hydrocarbons, seedbed treatments, and dressings for the calico covers were made at Eurobin, Victoria, from early August to 6th December. Benzol, toluol, X3 solvent, and X300 special boiling point spirit, were compared at different evaporation-surface areas. The effects of reducing the number of centres of evaporation, of a trough system for the distribution of benzol, and of the use of benzol on alternate nights, were also investigated. Calico covers treated in five different ways were compared with untreated. Hessian was used as a covering material on one bed, and some of the previous season's covers were again used. All seedbeds were uncovered daily, independent of weather conditions.

The disease occurred early in the untreated bed in adjoining grower's seedbeds, under hessian, and in one of the beds in which X300 special boiling point spirit was used. In other seedbeds, even where comparatively low evaporation surface ratios were used, very few seedlings became diseased until after inoculation with conidia of the organism was resorted to, late in the season. The best results were again obtained with benzol. More effective control of the disease was obtained with many centres of evaporation than with few. The trough system of distribution was effective but used more benzol than cans. The use of benzol on alternate nights gave promising results; this modification may prove satisfactory in districts where the disease is seldom serious. Shirlan compounds were satisfactory as cover dressings.

(*b*) *Yellow Dwarf.*—Brief mention of the serious nature and distribution of this disease was made in last year's report. During the year, the occurrence and spread of the disease was studied in seven fields in representative areas in three districts in Victoria. In each field, 2,400–3,200 individual plants were examined weekly and the results recorded on progress sheets for subsequent statistical examination. The data on the occurrence of the disease in a number of variety and fertilizer plots conducted by the Victorian Department of Agriculture indicated that neither of these factors had any significant influence on the occurrence of the disease.

(ii) *Disease Resistance.*—The genetic work with tobacco has been concentrated along two main lines—

(*a*) Varietal reaction of varieties to mould in the field, with a view to using the more resistant types for breeding.

(*b*) Production of types with a combination of the field resistance to mould of Dungowan, and the desirable features of such varieties as Hickory Pryor, Cash, Bonanza, Adcock, White Stem Orinoco, &c.

The seedlings, for both the varietal tests and the crosses, were raised at Canberra under benzol. When ready for transplanting they were forwarded to Briagolong, where they were grown to maturity. Unfortunately, this year was similar to the previous one as far as mould was concerned at Briagolong. Very little mould developed in the crop, and it was, therefore, impossible to distinguish any difference in varietal or individual (in the crosses) response. Seed is being procured from each variety for further tests. In the crosses, which are in the F_2 stage, selections were made of the most desirable plants for F_3 tests next year. Much of the material has been harvested and cured, so that it should be possible to obtain a fair idea of the quality.

(iii) *Chemical Investigations.*—The complex chemical composition of tobacco leaf has necessitated the investigation of the effect of many constituents on smoking quality. It is hoped that, ultimately, the general quality of tobacco, expressed numerically, will be determined by chemical means. Chemical tests on cigarette, medium pipe, and heavy pipe tobaccos, on samples regarded by the manufacturers as of good, fair, and bad quality, in each of the three types, have been continued. Further attention has been given to nitrate nitrogen, cellulose, and sulphur. When the curing process is prolonged a fairly uniform product is obtained, but chemical examination shows a general decrease in the sugars and polyphenols and thus the tobacco is somewhat different from the ordinary flue-cured type.

(iv) *Physiological Studies.*—From the results of the 1935-36 experiment, it appears that the effect of phosphorus treatment has been to decrease the reducing sugar content. As it also reduces the nitrogen and the organic acid content, phosphorus, when used alone, is not likely to be of much value in improving the quality of the high nitrogen content tobacco.

The main objectives of the experiment commenced this year are—(*a*) to compare the composition and quality of leaves from plants grown in light sandy and in heavy soil, (*b*) to observe the effects of high and low water supply and high and low potassium supply, and (*c*) to estimate the quality and composition of leaves of a variety reputed to be low in nitrogen. It was apparent that low potassium or water supply resulted in reduced yields and delayed ripening of the leaves ; moreover, the ripe leaves were much darker and greener in colour than normal.

(v) *Smoking Tests.*—Leaf representative of the 1936-37 crop has been forwarded by all States for testing. Two hundred and thirty-six tobaccos, representative of all States, were made into cigarettes and forwarded to all State Departments of Agriculture for smoking tests. The correlation of the results with soil type, variety, fertilizers, &c., will provide much valuable data on the suitability of the different areas for tobacco growing.

(vi) *Curing Experiments.*—Further work on the curing of tobacco grown in three clay soil types in the Ovens Valley district of Victoria has confirmed the results obtained in previous years. It appears that good quality tobacco, of somewhat darker colour than is usually desired and possibly slightly different chemically from the ordinary flue-cured tobacco from most sandy soils, can be produced on such soil types.

7. *Potato Problems.*—(i) *Survey of Potato Virus Diseases of Australia.*—Although virus diseases were known to be causing heavy losses to the farming community in many districts and increasing the minimum price at which the farmers could sell potatoes at a profit, it was not known which viruses were producing the diseases, or how their incidence affected the different varieties and the different potato-growing areas. Facts of this sort are necessary before a thoroughly sound programme of control measures can be outlined.

A survey which is being made in collaboration with State Departments of Agriculture has combined inspectional visits to different potato districts with the gathering of typical diseased material and its subsequent examination in the laboratory and greenhouse at Canberra. By these means, data indicating that four virus diseases are of importance have gradually been accumulated in the last three seasons. The most important disease, mild mosaic or crinkle, is due to a combination of two viruses (X + A), the manifestations of which are so varied on different varieties that they have been regarded as quite distinct diseases. The next most important, leaf roll, mainly attacks the varieties which are more or less resistant to mild mosaic. The third is also a disease of the mosaic type, rugose mosaic, due to two viruses, X + Y ; its symptoms are more severe than those of mild mosaic, but it is of much less frequent occurrence in the common Australian varieties. The presence of the fourth virus disease, spindle tuber, has been proved, but its importance and distribution are still matters for speculation. It may be causing widespread damage previously attributed to other causes, e.g., to the fungus Rhizoctonia.

There is another virus problem yet to be studied. Most of the commoner varieties are almost universally infected with virus X which causes slight symptoms or none under field conditions. It may be causing a serious reduction in yield of which the farmer is quite unaware. It might be profitable to establish virus-free stocks for general distribution to farmers ; on the other hand, stocks containing virus X might be just as profitable to grow and easier to maintain. Attempts are being made to obtain completely virus-free stocks to compare with stocks containing virus X. As yet, apparently virus-free plants of only two common Australian varieties have been found.

(ii) *Survey of Problems.*—In addition to the survey of virus diseases, an officer of the Division, in conjunction with an officer of the Department of Commerce, has taken part in a general inquiry into the problems of the potato industry. The inquiry was undertaken at the instance of the Standing Committee on Agriculture (*see* Section (I)).

8. *Diseases of Pine Trees.—Needle Fusion.*—Further evidence was obtained that, in most species of *Pinus* studied, the percentage of affected trees remains constant or decreases after the trees reach a certain age, and that this disease is not a limiting factor in the growth of pines in central or southern New South Wales. *P. taeda* is the only species in which needle fusion is common when the growth of the trees appears satisfactory in other respects ; it exhibits a higher percentage of affected trees and a more constant rate of increase of the disease than other species studied.

About 20 per cent. of a number of diseased trees treated with either superphosphate or boron compounds have shown signs of recovery, but it is not yet established that these substances influence the disease. Spectrographic examination of diseased needles and twigs by the Soils Division revealed a deficiency of silver as compared with healthy material, but treatment of affected trees with silver salts has not yet had any visible effect on the disease.

Die-back.—Diplodia pinea was found in association with extensive dying back of several species of *Pinus* near Canberra. Inoculation experiments showed that the fungus readily established itself in terminal growths but usually did not spread far from the point of inoculation in otherwise healthy trees.

9. *Diseases of Peas.*—Field trials made last year in co-operation with the Tasmanian Department of Agriculture showed that increasing the amount of soluble manganese in the soil had no effect on the severity of root rot. Another experiment is being made this season to determine the effect of other elements.

10. *Fungal Discolouration of Paint.*—Panels painted with paints in which fungicides were incorporated, are still being exposed in Brisbane.

III. ENTOMOLOGICAL PROBLEMS.

1. *General.*—The Division of Economic Entomology is concerned primarily with the control of insect and weed pests. Originally, it was intended that it should restrict its attention to the method of biological control by means of insect natural enemies, but it was soon found that other methods also demanded attention, and especially that a great deal of detailed knowledge, both biological and practical, was necessary if control of any pest was to be developed efficiently. Thus grew the general plan, which is now followed in most of the Division's activities, namely, basic research to define the problem and to elucidate its precise nature, field studies to bring the scientific knowledge into relation with the practical experience and needs of the grower, and application of both fields of knowledge to the development and improvement of those methods of control which are shown to be of most use in that particular problem.

Biological control is still an important part of the work. In the case of noxious weeds, it is the only method used in the Division, other methods being studied in the Division of Plant Industry; and its use against insect pests is well exemplified in later sections of this Report. Biological control is attractive, because it requires no effort on the part of the grower, and its few successes abundantly compensate for its many failures. Nevertheless, it is now clear that some problems, for example the sheep blowfly and probably also the grasshopper problem, cannot be solved in this way. For these problems, the next method of choice is what may be termed the ecological attack—an attempt to make the environment unfavorable for the pest. Thus, much attention is being paid to the conditions which render sheep resistant to attack by the maggots; the definition of grasshopper outbreak centres opens up the hope that changes in vegetation and stocking may make them unsuitable as breeding grounds; the red-legged earth mite in Western Australia is being attacked by cultural methods; and so on. If both biological and ecological control fail, we are forced back to the relatively laborious and costly methods of chemical and mechanical control. These are never the ultimate aim, but they are a valuable palliative during the usually long period of investigation required for other methods, and some problems will very probably prove to be insoluble by any other means. They are consequently receiving close attention, both from the point of view of immediate practical application and from the purely scientific aspect, for elucidation of the principles governing their operation will help enormously in applying them.

The accounts that follow illustrate all these developments, but individually, being the record of a single year's work, they give only a partial picture of the plan of attack on any one problem.

2. *Noxious Weeds.*—These investigations, which are shared jointly by the Divisions of Plant Industry and Economic Entomology are described in a separate section (IV.) of this Report.

3. *The Sheep Blowfly Pest.*—(i) *General.*—Last year it was reported that, with the completion of much of the more fundamental work, the blowfly investigations were showing a definite trend into the field of practical application. This trend has continued during the year under review, attention being concentrated mainly on three problems:—the study of attractiveness, the development of standard methods of testing poisons, and investigations of dressings.

(ii) *Losses due to the Blowfly.*—A re-examination of the available information has indicated that the losses due to strike in sheep are probably about £4,000,000 per annum, a figure which has been widely used but for which no definite evidence has hitherto been adduced.

(iii) *The Study of Attractiveness.*—The primary purpose of this study was to discover why the fly is attracted to lay its eggs on the sheep. Secondary objects were to improve methods of testing traps, baits, and repellents, and, if possible, to discover better baits and repellents than those already known. Three methods of investigation have been followed:—field and laboratory studies with traps on turn-tables, laboratory studies with a specially designed tropometer, and insectary studies with sheep, using a method devised by R. P. Hobson in England.

The turn-table has been described in previous reports (*vide* Pamphlet No. 71). Its purpose is to eliminate the effects of external variables, such as wind, sunlight, &c., by ensuring that each trap in turn passes through precisely the same situations as every other trap, and there is no reason to believe that it does not do this effectively. Nevertheless, in spite of improvements in the design of the traps, it has remained extraordinarily difficult to obtain comparable results. The question of reliability has been re-examined, and evidence has been obtained to suggest that any chance variation in the number of flies close to a trap may be magnified by a tendency of the flies to congregate in groups. This " aggregation factor " has still to be examined closely, but it may mean that the turn-table method is incapable in practice of measuring other than broad differences in attractiveness.

The tropometer has also been described previously (*J. Coun. Sci. Ind. Res.* 10 : 271). During the past year, numerous small improvements have been made, and standards of variability have been established. This instrument has the advantages that it can be used all the year round, that it is possible to work with known numbers of flies of known age and history, and that it gives reliable results quickly and with relatively few replications. Preliminary studies have shown that young flies of both sexes respond to highly attractive odours more readily than old flies which have fed on liver, and that starved flies are more reactive than flies that have been recently fed. It has also been found that distilled water is hardly at all attractive, and that (in this instrument) indole is less attractive than liver-sulphide but more attractive than indole + ammonium carbonate. Some experiments on colour responses were also carried out, and the results published (*J. Coun. Sci. Ind. Res.* 10 : 275). They indicated that yellow was the most attractive of the colours tested, followed by blue and pink, with green least.

R. P. Hobson in England found that certain products of putrefaction were unattractive when exposed by themselves, but were decidedly attractive and stimulated the flies to lay their eggs when exposed on the living sheep. He therefore postulated that attractiveness of the susceptible sheep was due to the combined effect of two factors, a putrefactive (" P ") factor and a specific sheep (" S ") factor. This work has been repeated and extended at Canberra, with the following results :—

(1) The " P " substances were attractive away from the sheep, but their attractiveness was greatly enhanced by exposing them on the back of the sheep, thus broadly supporting Hobson's contention.

(2) Of the " P " substances tested on the sheep, indole + ammonium carbonate was the most attractive, followed by indole, with other preparations much further down the scale.

(3) The relative attractiveness of these " P " substances when exposed away from the sheep was not always the same as on the sheep. A point of special interest in connexion with the study of repellents was that the addition of acetic acids reduced the attractiveness of indole on the sheep, but not when the mixture was exposed away from the sheep.

(4) The amount of oviposition, and consequently the apparent attractiveness, was a direct function of the population of active, fertile flies used.

(5) Any degree of artificial attractiveness, from the equivalent of a struck sheep downwards, may be produced at will by treating sheep by appropriately selected " P " substances. There is as yet, however, no evidence to indicate whether these artificially attractive sheep are specifically attractive to gravid female *L. cuprina*, as was found to be the case with struck sheep.

(6) The factor supplied by the sheep varied on different parts of the sheep, the wither being twice as attractive as the mid or posterior parts of the back. This greater attractiveness of the wither is inherent in the fleece or skin, for it was shown even by rugged sheep on which the whole length of the back was equally protected from weathering.

(7) The attractiveness of the sheep (" S " factor) did not vary greatly with sex or age, but may have been slightly greater in lambs than in old sheep.

(8) The presence of fold fleece rot increased the attractiveness of the area on which it occurred.

(9) Sheep that had been rugged were less attractive than those that had not been rugged.

(10) Apart from these conditions, sheep showed individual differences in attractiveness the reasons for which have not been elucidated.

(iv) *Studies of Maggot Nutrition.*—A considerable amount of useful information has been collected about substances which poison maggots, but it was recognized that more precise methods were necessary if an accurate survey was to be made of all possible stomach poisons. The first need was a simple, standard medium, on which uniform growth could be regularly obtained, and

in which the poison could be incorporated. Maggots were reared in sterile culture in all experiments, and comparison of growth rate on different media was greatly facilitated by the development of a photographic method, which permits the increase in sectional area or volume of the maggots to be recorded without interfering with the culture.

At first a medium recommended by other workers was used. It contained casein, yeast, cod liver oil, cystine, and a complex salt mixture, incorporated in an inert agar basis. It was soon found that the cystine and cod liver oil could be eliminated, then that the casein was unnecessary if the yeast were presented in a finely divided form that could be assimilated by the maggots, and finally that the salt mixture could be reduced to the single compound, sodium chloride. Thus an extremely simple basal medium was evolved, containing only yeast and salt on an agar basis. This mixture gave adequate growth, but that it was very close to the basal limit is shown by the fact that the addition of various mildly toxic agents seriously interfered with development. Consequently, for certain parts of the work, an enriched medium was used, consisting of the basal medium with the addition of egg albumen.

From the nutritional point of view, the most interesting features of this work are that blowfly maggots have been reared in the absence of animal protein, and that it confirms previous observations that the materials present in normal fleece, whether urine-soiled or not, do not assist the growth of maggots.

In association with this work, preliminary studies of digestion and absorption have also been commenced. Hydrogen-ion concentration influences both the action of enzymes, several of which were already known, and absorption of mineral substances, including inorganic poisons. It was therefore examined, and it was found to vary from distinctly acid to slightly alkaline in various parts of the gut, with a particularly acid section in one localized portion of the mid-gut. For studies of absorption, iron was chosen, as it can be readily detected by microchemical methods, and it was found to be concentrated in the cells of the particularly acid section of the mid-gut. Whether it is only absorbed there, or whether that part of the gut acts as a storage organ, remains to be proved, as also whether other minerals are similarly concentrated.

(v) *Toxicity Studies.*—Two methods have been employed: tests of stomach poisons, using the basal medium described above, and tests of contact poisons on full-grown maggots, using a standard period of immersion in the poison and a standard conditions for the subsequent emergence of the flies. The results obtained may be summarized as follows:—

(1) Of 49 substances tested for stomach toxicity to newly hatched maggots, only 8 proved poisonous at a concentration of 0.01 per cent. or less, namely, salts of cadmium, arsenic, and selenium, potassium cyanide, napthaline, nicotine, chloracetamide, and phenothiazine. Several others, including boric acid, were toxic at a somewhat higher concentration. Among the surprising features of this work was the low toxicity found for such well-known poisons as zinc sulphate, formalin, anabasine, and pyrethrum. Various derivatives of phenathiazine were tested but were found to be less toxic than the parent compound.

(2) Tests for contact toxicity of 159 organic compounds showed the following to give a reasonably quick kill:—hydrocarbons with six or more carbon atoms, halogenated compounds, certain aldehydes and sulphur compounds, and essential oils containing benzaldehyde, alkyl disulphides, carvone, or carvacrol.

(3) Dilution experiments, both with stomach and contact poisons, suggest that the action of larvicides may be governed by similar laws to those governing the action of disinfectants on bacteria.

(4) There is evidence to suggest that stomach toxicity may be related to the nutritive value of the medium, being higher in the medium of low nutritive value than in a higher nutritious one.

(5) Resistance to poisons increases with age, apparently reaching a maximum when the maggots enter the third instar, i.e., when they are about 30 hours old. This point is of practical importance in the study of dressings.

(vi) *The Study of Repellents.*—The investigation of possible repellents has been continued using the trap and crucible technique previously described (Pamphlet No. 74), but no highly repellent substance has been found. Observations on struck sheep, however, suggest that some dressings have a repellent action over a very short range (a few inches), and these may possibly be useful. The great need in this work is a more reliable method of testing, and this is being sought both in the tropometer studies and in those on the attractiveness of the sheep.

(vii) *Trapping.*—No better bait than sulphide-treated offal has been discovered, and attention was concentrated during the past year on the problem of preventing maggots from developing in the bait. Recent studies have confirmed the importance of this, for it has been shown that the maggots that develop in, and escape from, the bait-pan may produce as many flies as are caught by the trap. Further work has also confirmed the usefulness of borax in preventing maggot development without interfering with the attractiveness of the bait. It has, however, shown the limitations of the method, for the borax becomes ineffective if the bait becomes flooded by rain. Nevertheless, no other preparation proved as useful, although nicotine sulphate gave fairly good results.

(viii) *Dressings.*—A great deal of attention has been given to the search for an efficient dressing, the plan of work being: (*a*) to examine all existing dressings, whether proprietary or not; (*b*) to search for a cheaper and better vehicle for boric acid, of which the maggot-killing virtues are already well-known; and (*c*) to search for an alternative maggot killer, which will be as effective as boric acid, but quicker in action and easier to incorporate in a cheap, penetrating, fluid vehicle. Some of this work has been reported above, the following being a summary of all tests carried out during the year: skin tests with 127 preparations, toxicity tests with 223, repellency tests with 9, and tests on strikes (including re-strikes) with 39.

Of those that qualified for test on strikes, only two showed decided promise, a proprietary dressing containing calcium arsenate, and a boric acid emulsion devised in the McMaster Laboratory. The latter is preferred because it gets rid of the maggots more quickly, but both are being examined further.

(ix) *Lamb Marking.*—The search for an efficient repellent to use in a lamb-marking dressing has so far proved ineffective, but one point of interest was confirmed during the year. The lambs were divided equally into two groups, one being marked at three weeks old and the other at eight weeks old. Healing was much more rapid in the younger group, and there was only one-fifteenth as many strikes as in the older group (5 to 73). This confirms an observation commonly made by graziers; it also emphasizes the desirability of making the mating period as short as possible, and marking as soon as possible after lambing finishes.

(x) *The Mules Operation.*—Work on this operation is reported in Section V.

4. *The Buffalo-fly Pest* (*Lyperosia exigua*).—In last year's report, mention was made of the predatory beetle, *Hister coenosus*, found by Dr. Myers in the West Indies. Arrangements have been made for this beetle to be collected and sent to Australia to be tested, but so far no consignments have been received.

5. *Blood Parasites of Cattle.*—Pure strains of the various species have been maintained at Canberra as in past years, and supplies have been sent to Queensland from time to time, *Anaplasma centrale* for use as a vaccine, and *A. marginale* and *Babesia argentinum* for experimental study.

6. *Parasites of Cattle Ticks.*—The survey of cattle ticks in Australia has been continued, but no indigenous parasites have been discovered. Steps may therefore be taken to introduce the widespread parasitic wasp, *Hunterellus hookeri*, from abroad, in the hope that it may possibly be useful here.

7. *Ephemeral Fever of Cattle.*—The virus of this disease has now been maintained artificially for sixteen months by serial inoculation of cattle, and it has now reached its 61st passage. During the earlier passages the incubation period lengthened to an average of about four days, and the disease became somewhat milder, but after about the 20th passage it became stable, and has varied little since. The filterability of the virus and its localization in the white-cell fraction of the blood have been confirmed. It is not present, however, in high concentration in either splenic or lymphoid cells, so it would seem that it is not a parasite of the reticulo-endothelial system.

The virus only persists in infected cattle for five days after the onset of symptoms, but blood taken at the height of the fever will remain infective up to 22 days if kept in the refrigerator at 2°C. These facts have greatly helped to simplify maintenance by passage. Evidence supporting the suggestion that natural transmission is probably by means of a biting insect in which the virus undergoes some cyclical development has come from experiments, which demonstrated that the blood-borne organism is not usually transmissible either by subcutaneous or intradermal inoculation but only by direct intravenous inoculation. Studies of immunity have shown that the immunity which follows an attack of the experimental disease persists for at least seven months and probably more than a year. As the experimental disease is mild, this fact may have a practical usefulness, should another epidemic occur.

8. *Orchard and Fruit Pests.*—(i) *The Oriental Peach Moth* (*Cydia molesta*).—The estimated loss of peaches due to this pest in the Goulburn Valley district, Victoria, during the 1937–38 season, was five to ten per cent.; it was the lightest for the last four seasons. The outbreak in

a circumscribed district in the Murrumbidgee Irrigation Area, New South Wales, remained light in 1937–38. Throughout the Goulburn Valley, there was a high initial population of moths in the spring of 1937, and moth emergence occurred ten days earlier than had been recorded previously. The abundance of moths increased in the first and second generations until January, 1938, when the peak of numbers was reached. The life-cycle of the pest, however, was ahead of the development of the trees, so that harvest took place at a time when there was little larval activity. This, combined with the very heavy crop, was mainly responsible for the very light infestation of fruit.

In 1936–37, the spray programme which was confined to an intensive campaign against the eggs and larvae at a time when the peaches of the main crop were becoming susceptible to attack, has failed to give satisfactory control in the orchard. During 1937–38, the reasons for this failure were investigated, and evidence was obtained that it was due to—

(*a*) the failure of sprays to penetrate the clusters of fruit and cover the stem end of the peach where 90 per cent. of entries are made ;

(*b*) the profuse growth of young peach twigs, particularly on young trees, which rapidly grow away from any cover spray and leave the tips unprotected ;

(*c*) the habits of the moths which deposit their eggs on unsprayed parts of leaves and stems in close proximity to the tips of young twigs and the fruit ; and

(*d*) the ability of many newly hatched larvae of recovering from the effects of the nicotine bentonite over which they have crawled from the point of hatching to the point of entry into the host.

Satisfactory control of the pest by spraying is therefore not likely to prove practicable.

Last spring, two shipments of the Oriental peach moth parasites, *Macrocentrus ancylivorus*, *Glypta rufiscutellaris*, *Bassus diversus*, *Dioctes molestae*, and *Ascogaster carpocapsae*, which had been reared in the United States of America, were successfully introduced and bred in the special insectary at Mooroopna. A total of some 4,000 parasites was liberated in the orchards. Recoveries of *Bassus diversus* and *M. ancylivorus* were made from moth larvae collected subsequently in the orchards, but towards the end of the season *B. diversus* appeared to die out. Recoveries of three subsequent generations of *M. ancylivorus*, however, were made, showing that this species has been breeding successfully in the orchards during the summer. A small number of recoveries made early in the spring suggest that it also overwintered in the field. The results of the season show that *M. ancylivorus* is the most promising parasite of the Oriental peach moth, and additional consignments will be introduced next spring to ensure that it is given every opportunity of becoming established.

(ii) *The Codling Moth* (*Cydia pomonella*).—Work on this problem is co-ordinated by a Committee representative of the State Departments of Agriculture and the Council, the Council's share being a study of certain chemical problems relating to insecticides, with the particular object of finding an efficient alternative to lead arsenate. Starting on the basis of work that had been carried out abroad, attention has been concentrated on two main problems : (*a*) to fix nicotine to that it will remain potent for an adequate time after being sprayed on the tree ; and (*b*) to overcome some of the objectional features of phenathiazine, one of the promising new insecticides.

Fixation of nicotine has already been achieved in America by combining it with bentonite clay, and the first work was to discover whether local clays or other substances would serve the purpose. It was found that nicotine could be combined with New Zealand and Western Australian bentonites and with brown coal and peat. The proportion absorbed was not always as high as with the American bentonites, but it was still high enough to warrant further trial. Nicotine-bentonite suffers from the disadvantage that the deposit adheres so strongly to the fruit and foliage that it delays ripening, retards growth, and is difficult to remove. This property was unfortunately found to be even more strongly developed in the Australasian than in the American bentonites. Further work is required to determine if it can be reduced.

The disadvantage of phenathiazine is that, when applied in spray form, it rapidly oxidizes, forming a black, unsightly deposit which delays ripening and may accentuate scald. Substitution products which do not oxidize readily on exposure to the weather have been developed. It remains to be seen whether they will prove to be still sufficiently toxic.

A subsidiary piece of work has been the preparation of thiuram sulphides for use as repellents to oviposition. These, however, did not give good results when tried against peach moth, and work on them was discontinued.

9. *Field Crop and Pasture Pests.*—(i) *Grasshopper Investigations.*—(*a*) *General.*—By general agreement, work on the grasshopper problem has been distributed among various bodies, the Waite Agricultural Research Institute and the Council undertaking basic research, and the States investigating control measures. The main object of the Council's work has been to determine whether outbreaks of grasshoppers in Australia originate in comparatively circumscribed outbreak

centres, as is the case with migratory species in other countries, and if so, where these outbreak centres are located. The next step is a detailed study of the outbreak centres with a view, ultimately, to determining the best means to control grasshoppers within them. As a preliminary to the main investigation, it has been necessary to study the systematics of the injurious species, so that the pest species could be accurately identified, and work has also been undertaken on phase phenomena, and on the conditions most favorable to rapid increase in grasshopper numbers.

(*b*) *Systematics.*—The correct names of the economic species have been determined, and material has been identified at various times for the States. It has also been possible to determine which species were involved in all but the earliest of the past outbreaks of grasshoppers in Australia.

(*c*) *The Regional and Seasonal Incidence of Grasshopper Plagues in Australia.*—Once the question of species had been disposed of, attention was turned to a study of all the available information relating to outbreaks of grasshoppers in Australia, in the hope of discovering regularities in their regional and seasonal incidence, and perhaps indications of the existence of outbreak centres. This work, which was mentioned in the report for last year, has been completed, and the results published in the Council's Bulletin No. 117.

The species responsible for nearly all important outbreaks in eastern Australia was found to be *Chortoicetes terminifera*. Under favorable conditions, it can pass through three complete generations and a partial fourth in a single season. Swarming occurs in certain permanent outbreak centres, whence extensive migrations occur over the southern part of Queensland, most of New South Wales west of the Dividing Range, and parts of Victoria. Forests and mountain ranges appear to be the only barriers to migration. No regular periodicity of outbreaks could be established.

In South Australia and Western Australia, the main outbreaks are due to *Austroicetes cruciata* (formerly known as *A. jungi*). It has only one generation a year, and, although it swarms, it does not spread far from its breeding grounds. Nine other species have sometimes been recorded as reaching pest proportions in various parts of Australia, but they are of minor importance.

Recognition of the distinction between the major pest species of the eastern and western halves of the continent led to a division of the investigational work, the Council concentrating its attention on *C. terminifera* and the Waite Institute on *A. cruciata*.

(*d*) *Information Service and the* 1937–38 *Outbreak of C. terminifera.*—During the outbreak of 1936–37, arrangements were made with the New South Wales Department of Agriculture, for direct correspondence between the Council and the district Stock Inspectors. It became clear, however, that even better results would be achieved if a regular Information Service could be organized, each Stock Inspector submitting monthly maps indicating the movements and stage of development of the swarms in his district. The Department readily agreed to this scheme, which has been in very successful operation throughout the present outbreak in New South Wales. These maps have provided a great deal of information which may be of immediate practical value. For example, they indicated a renewal of activity in outbreak centre No. 1 late in the season, thus giving warning of a danger which would otherwise not have been anticipated.

(*e*) *Ecology of the Outbreak Centres of C. terminifera.*—These studies are in their early stages, and the conclusions reached are still only tentative. All the regular outbreak centres are, however, situated between the 17 and 25 inch rainfall isohyets in the zone between the summer and winter rainfall regions, but within these rather wide limits the precise location of the outbreak centres appears to be determined by conditions of soil and vegetation rather than by climatic factors. They are all located in open country of high pastoral value, in which areas of heavy soil capable of supporting good perennial pasture alternate with comparatively bare areas of lighter soil. Probably the tracts of lighter soil serve as breeding grounds, and those of heavy soil as feeding grounds, the relationship between the two determining whether a high population density of grasshoppers is favoured and the stimuli for swarming are provided.

(*f*) *Phase Investigations.*—A great deal of attention has been focussed on phase phenomena in Acrididae in other parts of the world, but Australian species have not hitherto been studied. Measurements have now been made of over 1,000 specimens from field populations belonging to four species, as a result of which the existence of definite phase differences between solitary and swarming individuals has been demonstrated for *Chortoicetes terminifera*, *Austroicetes cruciata*, and *Gastrimargus musicus*. No phase differences were discernible in the material of *Oedaleus australis* which was studied.

(*g*) *Experimental Work in the Laboratory.*—The conditions under which stocks of *C. terminifera* can be maintained permanently in the laboratory have been determined, and a certain amount of general information on the biology of this species and of *A. cruciata* and *A. pusilla* has been obtained. Preliminary breeding work with certain outstanding colour varieties of *C. terminfera* has shown that these varieties, homologues of which are found in most species of *Austroicetes*, represent definite genetic types. Tests have been carried out with various types

of cages in an attempt to arrive at the best type for breeding experiments under accurately controlled conditions of temperature, humidity, soil, &c. Progress has been made, although the cages cannot yet be considered completely satisfactory.

(*h*) *Parasites and Other Associated Insects.*—Various parasites have been observed in the course of the grasshopper work. These include a number of species of *Scelio* (Hymenoptera) which are parasitic upon Acridid eggs, the Bombyliid, *Cyrtomorpha flaviscutellaris*, whose larvae are predaceous on the eggs of *Austroicetes cruciata*, the Nemestrinid, *Trichopsidea oestracea*, whose larvae live in the bodies of several species, including *C. terminifera* and two species of parasitic Sarcophagidae, *Sarcophaga depressa* and *Locustivora pachytili*. Another Sarcophagid, *Melicobia australis*, which was at first thought to be a parasite, proved only to be a scavenger, living on the bodies of dead grasshoppers.

(ii) *Underground Grass Grubs* (*Oncopera*).—The attempt to establish the parasitic fly *Hexamera*, has been continued, three consignments being received from New Zealand during the season and liberated at Leongatha, Victoria. The chief difficulty is that the grubs in Australia are not in a suitable stage to be attacked until near the end of the period when the fly is active in New Zealand. As it is impracticable to import any but the adult stage of the fly, plans are being made to collect the earliest moths at Leongatha next season, and prepare areas of early grub infestation by sowing their eggs artificially in selected situations. It is hoped in this way to provide favorable conditions for liberation of the fly, which, once established, may possibly be able to adapt itself to local conditions.

Following the inquiries reported last year, arrangements have been made to study the parasitic wasp, *Alomyia*. Already, a considerable number of parasitized grubs have been collected in England, and a trial shipment is being made to Australia. In the course of this work, another wasp parasite has been discovered, and it also is being examined. The scope of possible biological control has been appreciably widened by this work.

(iii) *Red-legged Earth Mite* (*Halotydeus destructor*).—Work on this problem in Western Australia is at present designed mainly to discover whether reduction of mite damage may be achieved by agricultural methods. At the same time, attention is being given to certain aspects of the biology of the mite, and to a search abroad for natural enemies.

A survey of the damage caused by the mites indicates that subterranean clover and oats suffer most, and that, in general, the better a plant is as a fodder the more susceptible it is to mite attack. Some species of clover are, however, relatively resistant, and these are being studied, as also are particular strains of subterranean clover which have been reported as resistant. Similarly, top-dressing with superphosphate has not proved helpful, for, although the pasture gets a good start, the abundance of shelter and succulent food that develops enables the mite quickly to catch up again. The effects of other fertilizers are being examined, but so far none appears particularly promising from the point of view of mite control. Subterranean clover appears to suffer as severely in mixed pastures as in pure stands.

As previous work had shown that the mite population is a function of available shelter and food, it is doubtful whether methods of increasing the cover can be successful. Experiments were therefore set up to test the reverse process. It was found that grazing or mowing had to be pushed so far as seriously to damage the pasture before significant control of the mite was obtained. Burning, too, proved unsatisfactory and uneconomical on ordinary pastures, although the burning and cultivation associated with harvesting clover seed decidedly reduced the abundance of mites. Clean fallowing is very effective, but is rarely practicable on grazing land and it does not give lasting protection, for re-invasion soon occurs. It was hoped that this might be prevented by maintaining a permanently fallowed strip around a cleaned pasture, but it was found that a strip even 60 feet wide was not an effective barrier.

(iv) *Shelter Bag Moth* (*Ochrogaster contraria*).—Damage to the Boree tree by this moth is fairly extensive in parts of western and south-western New South Wales, and the problem is of some importance as the tree is a useful drought reserve. Control, however, is difficult, because the damage occurs in districts where grazing is extensive rather than intensive. Observations on the native parasites have been continued. The life cycle of the egg parasite, *Eupelmus flavicallus*, is normally completed in a few weeks in spring; but it has been found that a proportion of its larvae have a long diapause, and do not emerge until the following spring, thus ensuring the survival of the species from one season to the next. A similar diapause has been observed in the caterpillars of the moth, *Titanoceros themoptera*, which preys on the eggs, some only pupating the following spring, to emerge soon after the bag moth eggs have been laid.

A programme of mechanical control has been carried out, consisting of:—(1) spraying the whole foliage with an arsenical mixture, (2) spraying foliage surrounding the bags with the same mixture, (3) drenching the bags with kerosene, and (4) burning the bags with a blowlamp. Subsequent reports indicate that the first method gave the best results, but its actual efficiency cannot yet be assessed.

(v) *Cabbage Moth* (*Plutella maculipennis*).—A consignment of the parasite, *Angitia fenestralis*, was obtained from New Zealand during the season, and liberated at Richmond, New South Wales. The numbers available were, however, few, and arrangements are being made for further introductions next year.

10. *Termite* (*White Ant*) *Investigations*.—Owing to changes in the staff, and the absence of one of the Sectional officers who has been studying termite problems in California, the investigational programme has been somewhat interrupted during the year.

The technique of testing the resistance of materials (e.g., treated and untreated timber samples) to attack by *Eutermes exitiosus* has now been brought to a stage at which further experimentation in method seems unnecessary. Two methods have been evolved, namely: (i) *field testing*, in which samples are installed in the ground round *Eutermes* mounds, the inner face of each touching a " connecting strip " of susceptible timber, which ensures that the termites are brought into contact with every sample in the ring ; and (ii) *laboratory testing*, using standard colonies of termites maintained in glass jars under constant temperature and humidity conditions. The particular advantages of these testing methods are the rapidity with which results are obtained, and, in the case of the laboratory-colony testing, the accurate quantitative measure of the resistance that is provided.

Before initiating a research programme based on these improved testing methods, it was considered advisable to analyse the available information regarding termite damage, and to carry out field surveys in certain areas from which first-hand data were lacking. Such surveys have so far been confined to Adelaide and its environs, parts of inland Victoria, the coastal belt between Newcastle and Brisbane, and a limited area in North Queensland. With the fresh information provided by these surveys, it has been possible to assess, more accurately than hitherto, the relative economic importance of the different species of termites. The position may be summarized as follows :—

The varieties of termites which attain economic significance in Australia are limited and hardly exceed a dozen. They comprise species of the following genera:—*Mastotermes* (family Mastotermitidae) ; *Calotermes* and *Porotermes* (Calotermitidae) ; *Rhinotermes*, *Coptotermes*, and *Heterotermes* (Rhinotermitadae) ; *Eutermes*, *Microcerotermes*, and *Hamitermes* (Termitidae). The majority of these species only attain local importance. In a list of the economic species of Australian termites, arranged in order of their importance and destructiveness, *Eutermes exitiosus* (the species used for field and laboratory testing at Canberra) must be ranked third.

Within the confines of its limited range (it is found only in the tropics), the large *Mastotermes darwiniensis* provides a more acute problem than does any other single species of termite. It forms immense colonies which can operate considerable distances from their central nests ; it is also exceedingly fast-working, enterprising, and voracious, while the variety of it depredations includes almost every type of damage for which termites are responsible.

Largely by virtue of its almost Australia-wide distribution, *Coptotermes acinaciformis* is undoubtedly the most important economic termite in this country. In addition to being responsible for the greater part (probably by far the greater part) of the sum of the damage done by termites to buildings, poles, construction timber, &c., it sometimes attacks fruit trees and crop and garden plants, and it is the most important pest of commercial hardwood forests in northern New South Wales. Two other species of the genus *Coptotermes*, *C. raffrayi* and *C. frenchi*, do considerable damage in restricted areas, the latter, like *C. acinaciformis*, being a pest of growing timber in parts of New South Wales.

As the food preferences of the various wood-eating termites exhibit marked differences, the results of tests carried out with *Eutermes exitiosus* cannot be safely applied generally ; and it is clear that the testing programme should be extended to include at least the two most important economic species, *Coptotermes acinaciformis* and *Mastotermes darwiniensis*. A beginning has already been made in this direction. As was mentioned in the last report, preliminary experiments with *Mastotermes darwiniensis* have indicated that this species can be used successfully for laboratory testing. Although additional work is still required to determine the optimum conditions for the maintenance of *Mastotermes* in laboratory colonies, the chief difficulty now to be overcome is that of supplies. An experimental field test in North Queensland was also installed during the year. A modification of the " connecting strip " method of installation was employed, and the results indicate that field testing against *Mastotermes* should be as rapid and reliable as that against *Eutermes*, provided that the sites are carefully selected.

Methods of testing the resistance of samples to attack by *Coptotermes acinaciformis* will have to be developed almost *ab initio*. Termites of this genus are less easy to maintain under artificial conditions than are *Mastotermes* and *Eutermes*. *Coptotermes lacteus* was used for testing samples in the field at Canberra until it was demonstrated that the incidence of attack was lower and less regular than in the case of *Eutermes exitiosus*. In an effort to discover the reason for this, a study of the underground galleries radiating from the nests has been attempted. All the galleries from a mound of *C. lacteus* were traced out. Most of them led to logs and dead stumps

within 50 yards of the mound; but one large gallery served a food supply well beyond this limit. Adverse weather conditions interfered with the study of the galleries of *Eutermes*. It was, however, possible to determine that the gallery system differed in important respects from that of *C. lacteus*, the galleries being more numerous and showing a greater tendency to anastomose in the immediate neighbourhood of the mound. This difference would explain the lower incidence of attack on samples installed round mounds of *Coptotermes*.

Field testing with *C. lacteus* was discontinued prior to the development of the " connecting strip " method of installation. An experiment has therefore been set up in order to determine whether the use of a connecting strip of a susceptible timber will raise the incidence of attack on the samples sufficiently to give reliable results when testing against this species. It is hoped that these studies with *Coptotermes lacteus* will assist in the development of methods of testing against *C. acinaciformis*, which in North Queensland builds mounds similar in structure to those of *C. lacteus* and exhibits habits very similar to those of the latter species.

Satisfactory progress has been made in the preparation of a monograph on Australian termites, the need for which, as an authoritative reference work, is becoming increasingly apparent. A draft revision of four of the eleven genera (*Mastotermes*, *Stolotermes*, *Porotermes*, and *Calotermes*) has been completed, and a similar revision of the important genus *Coptotermes* is well advanced.

Termite investigations, particularly the taxonomic studies, have benefited greatly by the visit of Professor L. R. Cleveland of Harvard University. His work on the intestinal protozoa of termites is proving of considerable assistance in elucidating the status of certain variable forms which have been very difficult to determine specifically on morphological grounds.

11. *Pine Chermes* (*Pineus boerneri*).—The importation of predatory insects which attack Chermes has been continued, but conditions were unfavorable for collecting material in England this year, and few consignments were received. The work has received a fresh direction by the discovery that the Australian Chermes is not the same as *Pineus pini* of Europe, but is identical with *Pineus boerneri*, which is restricted to *Pinus radiata* in America. It is apparently not a pest there, so arrangements are being made for a survey of its natural enemies.

12. *Oak Aphis* (*Myzocallis annulata*).—Several consignments of parasites of this pest were introduced during the year but failed to become established in insectary culture at Canberra. Further attempts will be made next season.

13. *Oak Scale* (*Asterolecanium variolosum*).—This scale was found to have invaded the plantations of *Quercus robur* in Canberra, so consignments of the parasite, *Habrolepis dalmanni*, were obtained from Tasmania and New Zealand. These were liberated during November, and field recoveries have already been made, but it is too early to predict what degree of parasitism may be attained.

14. *Greenhouse White-fly* (*Trialeurodes vaporarium*).—Further reports from the various States confirm the outstanding success of the parasite, *Encarsia formosa*.

15. *Garden Snails* (*Helix aspera*).—The English glow-worms, *Lampyris noctiluca*, so far introduced, have apparently failed to become established at Canberra. Conditions in England were unfavorable for sending consignments last season, but it is hoped that further introductions can be made next year.

16. *Systematic and General Entomology*.—About 3,500 specimens have been added to the museum during the year, the chief acquisition being the Froggatt collection of Coccidae, which has now been sorted, systematically arranged, and labelled. In addition, insects have been identified for individual workers and institutions in Australia and abroad, and advice or practical assistance in treating insect pests has been given in response to various enquiries.

17. *Beneficial Insects sent Overseas*.—This work, which is the most practical way by which the help received from overseas institutions can be reciprocated has been continued. It is satisfactory to note that the Egyptian authorities have been able to establish a colony of *Leis conformis* from consignments recently sent them, and that the American workers are hopeful that *Gambrus stokesii* will become established in the United States of America as a result of the Council's co-operation.

IV. WEEDS INVESTIGATIONS.

1. *General*.—During the year under review, work in the fields of research outlined in the report for 1936–37 has been continued, and results are now coming to hand in the form of progress in certain investigations and definite economic results in others.

(*a*) *Co-operation*.—The necessity for co-operation with State Departments and other authorities on weeds investigations has become increasingly obvious as work has proceeded, and at a recent meeting of the Standing Committee on Agriculture a resolution was passed which will lead to the formation of a weeds committee in each State to co-ordinate work of the Council and that of State officers. A committee of this type has been in operation for three years in New South

Wales, with the result that co-operative work on skeleton weed and St. John's wort has been more extensive and more effective than if the two organizations had been working separately. Co-operation with the Irrigation Commissions of New South Wales and Victoria has lead to successful control of the bulrush (cumbungi) in irrigation channels in the Murrumbidgee Irrigation Area, and co-operation with the Commonwealth Prickly Pear Board has made possible a great extension of the work on the control of Noogoora burr by means of insects.

(*b*) *Control by Means of Insects.*—This form of control is in great favour with the community largely because of the success attained by the Commonwealth Prickly Pear Board, and continual calls are being made for further work to be done along these lines. Investigations on insects for the control of several weeds have been continued. Many species have been imported and tested, and a few have been established in the field ; but whether they will be successful or not still remains to be seen. The search for suitable insects abroad has been extended to cover a wider geographical and climatic range than was possible in the past.

A very necessary part of the work of the Section is to determine how far control of weeds by means of insects is likely to be applicable to the weed problems confronting Australia. It is hoped that, as time goes on, principles will ermerge which will assist scientists in deciding which types of plants are most likely to be controlled by means of insects, and which types of insects are most likely to control plants. Until these principles have been discovered, it is impossible to say whether this method of control will have a wide or a limited application.

(*c*) *Cultural Methods.*—As work progresses, it becomes evident that cultural methods have a special significance for the control of certain weeds in agricultural areas. For weeds such as nut grass, it seems necessary that systems of rotation should be devised, by which heavily infested areas can be farmed economically when chemical and other means of control have failed.

(*d*) *Weed Killers.*—The Section has devoted much time during the year to two phases of weed destruction by means of chemicals. The first phase is the testing of known weed killers in the field under different conditions and at various strengths. The second phase is the more detailed study of the reasons why certain chemicals are toxic, and a study of the problems of wetting, penetration, and translocation of these poisons.

(*e*) *Competing Plants and Pasture Management.*—For weeds of pastoral areas, the two most promising lines of attack are the introduction of aggressive competing plants under conditions which will allow them to compete with weeds (and this includes proper manurial treatment), and the proper management of pastures. A variation in the intensity of grazing may lead to a better pasture cover and a consequent diminution in the infestation by the weed. The former method has been applied to St. John's wort with promising results.

A recent survey has shown that interesting methods of controlling weeds in sown pastures have been developed recently in England. The underlying principle is to control the weeds by plant competition, but the method of encouraging that competition is to use grazing animals to feed on those plants which are to be discouraged, at the time when they are most vulnerable, and to decrease or remove the grazing altogether at that period when the plants to be encouraged make their fastest growth. How far such methods are applicable to Australian conditions remains for determination in the future.

(*f*) *Tour Abroad.*—During the year, the Officer-in-Charge of the Section, Dr. G. A. Currie, made a tour abroad. A survey of work being done on weeds in France, England, America, and in Hawaii, showed that control of weeds by means of chemicals was on the increase in all these countries in special situations in which hand labour could not be employed. Perhaps the biggest increase has taken place in the use of sulphuric acid and sodium chlorate, but arsenic has also been increasingly used and so also has ammonium thiocyanate. A new organic weed killing chemical has been developed in France, and is being tried out in Australia. Dr. Currie also took the opportunity to become acquainted with the Section's work and workers on the entomological control of St. John's wort in France and in England, and of Noogoora burr in the southern States of America. As a result, closer co-ordination of the work has been made possible. A study was also made of the control of weeds in semi-arid pasture lands in the southern and western States of America.

(*g*) *Life History Studies.*—In the glasshouses at Canberra, a very complete life history study is being made on each weed under investigation ; it has proved very valuable in indicating the stage at which the various weeds are most vulnerable. Routine analysis, particularly to determine the position of the food store at different stages of growth, has led to an increase in chemical work ; it is accordingly proposed that another worker will be attached to the Section to assist in this work and in investigations concerned with the chemical side of weed control.

(*h*) *Field of Work.*—The programme of work covers the weeds considered to be of greatest importance from the national point of view. Requests are constantly being received for work to be carried out on other weeds, but it has been necessary, in the interests of effectiveness, to confine the activities of the Section to intensive work on a limited number of problems.

2. *Entomological Control.*—(i) *St. John's Wort* (*Hypericum perforatum*).—The study and testing of insects attacking this weed have been continued at Farnham Royal, England, and in the south of France at Le Lavandou. The insects studied include the following.

Chrysolina (*Chrysomela*) *spp.*—Breeding stocks of the three species *C. varians, C. brunsvicensis,* and *C. hyperici* have been maintained in England in case material should be required for further attempts to establish these insects in Australia. Careful searches in the field in the Bright district, Victoria, where these insects were liberated in previous years, failed to discover any survivors. The species *C. germinata* from the south of France was thoroughly tested in England and has been proved innocuous to plants of economic importance. This beetle was introduced into Australia during the year, 2,200 eggs being sent from England to Canberra where breeding under Australian conditions has commenced. In both England and France, genetical studies have been conducted with the various strains of this species.

Agrilus hyperici.—Work on the life history and habits of this stem and root borer were continued in France. Tests carried out in England showed that the insect will not harm valuable plants. Its initial introductions into Australia were successfully made by shipping plants infested with over-wintering larvae. Three hundred and ten plants were introduced, 70 per cent. containing one to three larvae. A small number of these emerged as adults soon after arrival in Canberra and were used for food tests. The remaining dormant larvae will probably emerge next spring.

Anaitis plagiata and A. efformata.—In both England and France, over-wintering larvae were again scarce in the field. From a mixed consignment of over-wintering larvae of *A. plagiata* and *A. efformata* imported from England, 224 arrived alive. From the subsequent generation reared in the insectary at Canberra, 5,000 larvae, 1,000 eggs, and 20 adults were liberated near Bright, Victoria. Three different species of ants were seen to attack them :—*Iridomyrmex nitidus, I. nitichiceps,* and *Calcoponera metallica.* These ants completely removed all larvae and moths within a fortnight.

The life history and habits of the following insects have also been studied in the south of France :—the gall midge, *Zeuxidiplosis giardiana* ; the moths, *Aristotelia atrelia, A. morphochroma Cacoecia pronubana, C. rosana,* and *Actinotia hyperici ;* and the leaf-miner, *Leucoptera lustratella.*

(ii) *Noogoora Burr* (*Xanthium pungens*).—Extensive work has been continued with this weed during the year in co-operation with officers of the Commonwealth Prickly Pear Board, both in America and in Queensland. Work has extended from Uvalde, Texas, to California in the west and south into Mexico, to see if insects attacking the burr are to be found there though not present in Texas. Officers of the Board have carried out the greater part of the work on burr insects during the year ; all the starvation and oviposition tests on *Dectes spinosus* have been carried out at Sherwood, Brisbane, while supplies of insects have been collected by the officers of the Board (to which Mr. Kelly, an officer of the Council, has been seconded in America) and shipped to Australia. The work in Canberra has been concerned mainly with holding material from America in quarantine, allowing the insects to emerge in quarantine, and consigning emerging adults to Sherwood.

Euaresta aequalis.—Large shipments of burrs containing *Euaresta aequalis* haveb een sent from America during the present year. The material received from Texas last season, and which failed to give rise to adult flies during that year, was carried over in the insectaries until the present year, when adult flies emerged in fair numbers. It is somewhat peculiar that the material sent from Texas should have failed to give rise to adult flies in the first season after shipment, as previous experience had shown that material from Kansas gave rise to adult flies in the same season in which it was sent. Five thousand eight hundred adult flies were sent from Canberra to Sherwood during the year for liberation in the field.

Dectes spinosus.—Work on this insect has been carried out wholly at Sherwood, and after a large number of tests it has been decided to ask the quarantine authorities for permission to liberate it in Australia. Feeding tests showed that *Dectes* adults would feed to a slight extent on certain economic plants including the leaves of potatoes and carrots, but they did not lay eggs on any plants except burrs, and a few other Compositae not economically important, notably, marigold, sunflower, cosmos, and artichoke.

Baris.—Large quantities of roots containing *Baris* were received in Canberra from America, and adults were sent weekly to Sherwood where starvation tests have now been almost completed.

Ataxia hubbardi.—As this insect had been shown to be somewhat more catholic in its feeding than other burr insects, it has been decided for the present to discontinue work on it. This is unfortunate, as in the field in America it is one of the most destructive insects feeding on burrs.

Extensive work has been continued on the other burr insects, including, *Cylindrocopterus adspersus, Baris inculta,* and *Mecas saturnina.*

A survey of Mexico was not very productive so far as *Xanthium* insects are concerned, but a short survey of California made it clear that insects which were found there were worthy of further study. An officer of the Board has been sent to India to survey the possibility of obtaining insects there for the control of burr.

(iii) *Lantana* (*Lantana camara*).—Breeding stocks of the lantana bug *Teleonemia lantanae*, derived from the original material imported into Australia from Fiji in 1935, have been maintained in the heated insectary at Canberra. About 2,200 insects were sent to Rockhampton by air mail with practically no mortality. Liberation and subsequent observations of the bugs in the field have been conducted by officers of the State Department of Agriculture and Stock, Queensland. The lantana bug is now firmly established on lantana at Fairy Bower near Rockhampton and has passed through many generations in the field. Working in co-operation with officers of the Forestry Commission of New South Wales, approximately 2,000 lantana bugs have been liberated at Wiangaree in the Toonumbar State Forest in the Casino district. The insects have commenced to breed in this district and are now becoming established. Further liberations will be made in both States in these localities as material becomes available at Canberra.

A further consignment of 1,500 bugs was despatched to Norfolk Island, as the colony sent there last year disappeared.

Biological studies of *Teleonemia* have been conducted at Canberra, and special attention has been given to the method of damaging the leaves and to the nutritional requirements for growth and reproduction. It has been shown that the females need to feed on flowers for normal egg production.

(iv) *Ragwort* (*Senecio jacobaea*).—Insects of this weed have been studied and collected in England for shipment to Australia.

Tyria jacobaeae.—About 9,000 pupae of the cinnabar moth were sent from England to Canberra. From the next generation reared in the insectary, 5,000 larvae, 1,000 eggs, and twenty adults were liberated near Toora, South Gippsland, Victoria. The moths and larvae were again attacked and removed by large numbers of scorpion flies (*Harpobittacus* sp.). These flies are so abundant in South Gippsland and Beech Forest areas that it is considered unlikely that *Tyria* can be established there.

(v) *Nut Grass* (*Cyperus rotundus*).—Trial consignments of insects attacking nut grass have been sent to Canberra by entomologists of the Hawaiian Sugar Planters' Association. About 300 corms of nut grass infested with larvae of the moth *Bactra truculenta* and the weevil, *Athesapeuta cyperi* arrived in Canberra in fairly good condition, about 50 per cent. mortality having occurred in transit. Arrangements have been made for the despatch of a large consignment of these insects from Hawaii to be used for feeding tests on various useful plants.

It has been established that, although one species of nut grass (*Cyperus rotundus*) is a very serious weed pest in farming districts, other species of the same genus are of considerable value as grazing plants in pastoral areas. Consequently, it is necessary to test insects introduced to attack the pest species (*C. rotundus*) on the valuable pasture species, *C. bifax*, &c. If the insects will feed on the useful species, permission to release them from quarantine will not be sought.

3. *Other Forms of Control.*—(i) *Skeleton Weed* (*Chondrilla juncea*).—A life history study of the plant in the second year of growth has been conducted in the glasshouses at Canberra and has yielded information on the production of leaf and stem, fluctuations in dry weight of the perennial root-stock, set of seed, and water requirement of the established plant. A report on growth characteristics of the seedling plant is being prepared for publication. Skeleton weed and wheat competition studies in pots are in progress to determine the factors involved in the strong competition effect of established skeleton weed on wheat in the field.

At Wagga, New South Wales, the experiments on the use of weed killers conducted in collaboration with officers of the New South Wales Department of Agriculture have been continued, and show that, excluding common salt because of the high cost involved in its use, sodium chlorate is the most effective chemical for use with skeleton weed. The results of the first series of experiments have been published. Further work on total amounts of chemicals required and on time and frequency of application is planned. The next series of experiments will complete the review of available weed killers for skeleton weed control and their effect on the subsequent productivity of wheat-growing soils at Wagga. Work with competing plants has been intensified, and the investigation of control by means of crop rotations and mixed farming has been continued. An experiment to determine from what depth roots of the weed can send up new shoots to the surface of the soil has been laid out at Wagga. After three months no new shoots have appeared from depths lower than 1 foot.

(ii) *Nut Grass* (*Cyperus rotundus*).—The work on this weed at Lawes in the Lockyer Valley, Queensland, has been continued. Pot culture investigations into the effects of chemical sprays and manurial treatments have yielded information of value. Further work with weed killers

in the field indicates that none of the available materials are effective, unless used in amounts large enough to produce complete soil sterilization. The costs involved in this are very high. Studies with competing plants suggest interesting possibilities, but emphasize the need for more knowledge concerning suitable species for use in this work. Continuous cultivation for two seasons at three-weekly or weekly intervals reduced the density of the nut grass infestation very definitely, killing all plants within the cultivated surface zone. The development of rotations involving the use of fallow periods, winter crops, and sown pastures in conjunction with the ordinary cash cropping of the district is being investigated in the field.

(iii) *Wild Turnip* (*Brassica tournefortii*).—In collaboration with the Western Australian Department of Agriculture an experiment was carried out this year to attempt control of this weed with sulphuric acid or copper sulphate. Climatic conditions made the results difficult to interpret, so the experiment will be repeated.

(iv) *Cape Tulip* (*Homeria collina*).—No further work on this weed has been done in the laboratory at Canberra, but the results of the completed life history study have been prepared for publication and the report is in the press. Indications are that weed killer and mechanical treatments aimed at control can best be applied to this weed at the flowering stage. The pasture species trial at Clare, South Australia, has yielded some interesting results which are being prepared for publication.

The competing plants experiment, begun in 1935, is being carried on, but no evidence is available yet to indicate that pasture plant competition will be effective in controlling Cape tulip. A further experiment with competing plants, based on the results obtained from the species trial, was commenced this season. A critical experiment with weed killers, selected on the evidence of their effectiveness at Wagga, was laid down during the year; it is proposed to extend this work during the coming season. It is known that Cape tulip can be controlled by cultivation on arable country, but an effective weed killer is required for use among rocks, under trees, and along fence lines, localities which serve as centres of re-infestation. A trial of frequency of cultivation is planned in order to obtain information about the actual amount of cultivation necessary to control the weed.

(v) *St. John's Wort* (*Hypericum perforatum*).—Experiments which were commenced near Tumbarumba, New South Wales, in 1936, were continued and extended during this year, in collaboration with officers of the New South Wales Department of Agriculture. A second and more critical weed killer trial was laid down. The results so far obtained suggest that common salt, sodium chlorate, and arsenic pentoxide are the best materials for use on this weed, and that November is the best time to spray. The competing plants work is already of interest. The indications are that a well worked fallow as preparation, and the early establishment of a pasture plant cover, will give practical control of St. John's wort in the first year in the Tumbarumba district. It is apparent that a standard bare fallow is essential in attaining this result. A life history study of the plant in the seeding year has been conducted, and the study is being carried on over the second year of growth to obtain a complete picture of the growth characteristics of the plant. Seed germination and the capacity of the weed to respond to manuring are also being investigated in the laboratory.

(vi) *Galvanized Burr* (*Bassia birchii*).—The experiments concerned with the control of this weed in the St. George district, Queensland, are proceeding. One complete year's observations on the intensity of grazing experiment are not sufficient to allow conclusions to be drawn on the effects of differential grazing, but they do suggest that stocking at a conservative rate and grazing systematically are beneficial for the development of the herbage plants present. A change in balance of useful and weed species cannot be expected immediately. A good deal of information has been obtained on the species present, their times of growth, and on their ecological relationships, and some thought has been given to the development of a satisfactory sampling technique for use with weeds under conditions of restricted and irregular rainfall. Attempts to establish competing plants on the burr-infested red soils of this area have not been successful, although Rhodes grass shows some promise for this purpose. No work has been done with weed killers during this year.

(vii) *Bulrush or Cumbungi* (*Typha spp.*).—Work on this plant is carried out by an officer of the section, financed jointly by the New South Wales and Victorian Irrigation Commissions. Valuable results have obtained in the Murrumbidgee Irrigation Area during the year. A cutting programme, followed by a proper system of patrolling the channels to prevent regrowth, has led to the successful elimination of *Typha* over large sections of the channels. It was found that if the bulrush is cut under water, and the water level in the channel kept high, then all of the plants actually in the channel, except those at the water's edge, are killed. More than one cutting is necessary in order to reduce the infestation to about 3 per cent. of the original, and then the remaining plants on the channel edge can be removed by mechanical means. The

successful application of this method of control in the irrigation areas has been due to the vigorous efforts of the channel administration in co-operation with the Council's investigator, and it is highly satisfactory that a single authority is able to carry out means of control which have proved so satisfactory.

Further study of seedling development in the channels has shown that colonization by *Typha* in new channels, particularly in drains, is extraordinarily rapid. In shallow water, at times when the wat ertemperature is high, *Typha* seedlings establish themselves in patches of silt on the channel bottom. Having established themselves there, the plants rapidly colonize the whole channel, moving up-stream by vegetative reproduction in silt which they themselves actually cause to be deposited by slowing down the rate of water flow.

Further studies on plant competition at the water's edge are in progress to determine if a close community of *Juncus* along the water's edge is able to prevent the establishment of *Typha*. Chemical control of *Typha* either by spraying or by sterilizing the channel bottom has not proved to be effective.

(viii) *Water Reed* (*Phragmites communis*).—The investigator whose work on bulrush appears to be reaching a satisfactory solution has taken up the problem of controlling the large water reed, *Phragmites communis*. Only a preliminary survey has been carried out so far, but a programme of work is in process of preparation.

(ix) *Mint Weed* (*Salvia reflexa*).—This weed is becoming increasingly important on the Darling Downs, and has spread northward through Queensland and southward into New South Wales. The position has been represented to the Council as so urgent that it has been decided to commence investigations in the coming year. This work will be carried out in collaboration with the Department of Agriculture and Stock in Queensland. Inquiries have already been made in America to see if insects exist which are likely to control the weed, and experiments for control by means of competing plants, by the use of chemicals, and by cultural methods are being planned.

4. *Chemical and Physiological Investigations.*—(i) *Analysis of Material from Life History Studies.*—Skeleton weed plants in their first year of growth were analysed to determine available carbohydrates, total carbon, nitrogen, and phosphate. These analyses were carried out at four stages of growth to study the position and character of the food store, so that the period when the plant is most susceptible to poisoning might be determined.

The carbon content of the plant tissues was found to be approximately 40 per cent. of the dry weight whatever the stage of growth. The carbon assimilation rate is, therefore, 40 per cent. of the growth rate. Carbohydrate analysis showed that while the seed, stems, and leaves are poor in carbohydrate the root becomes rich in this material at an early stage of growth. In twelve weeks old seedlings, the amount of carbohydrate in roots was 32 per cent. of the dry weight. Interesting figures, to be discussed in a publication later, were obtained in determining the nitrogen and phosphorus content of the material.

(ii) *Translocation of Sodium Chlorate.*—A satisfactory qualitative test has been obtained for the detection of chlorate in plant tissues. Using this method, it was found that sodium chlorate sprayed at 10 per cent. concentration on the leaves had penetrated at least eleven inches into the rootstock of sweet briar (*Rosa rubiginosa*).

(iii) *Translocation of Arsenic.*—A spray containing 7 per cent. sulphuric acid and 1 per cent. arsenic trioxide sprayed on the leaves killed the roots of skeleton weed to a depth of 33 inches in 8 days. This test showed that the acid did not prevent the translocation of the arsenic in the plant although it did coagulate the latex. Experiments to determine the conditions which influence the depth of penetration and effectiveness of poisons are in progress.

Certain organic compounds of arsenic (dimethyl arsinic acid and phenyl arsonic acid) were tried but found to be less toxic than arsenic pentoxide and arsenic trioxide.

Difficulty has been experienced in estimating the concentration of arsenic necessary to cause death in tissues owing to the minute quantities concerned. The lethal concentration of arsenic in root material is of the order of 0.0015 per cent. of the dry weight of the root. A quick laboratory method for testing toxicity would be of great value in the work, so attention is being given to the possibility of developing such a method. Highly promising results are already to hand, but some time will elapse before the details can be worked out.

V. ANIMAL HEALTH AND NUTRITION INVESTIGATIONS.

1. *General.*—During the year, progress has been made in the organization and general development of the work of the Division.

There was some delay in the completion of the Animal Health Laboratory in Melbourne, but portion of the building was occupied in January, 1938, and the whole building in April.

The field station near St. Mary's, New South Wales, was established as the F. D. McMaster Field Station, and the Memorial Laboratory erected upon it by the family of the late Daniel Buffier was formally presented to the Council by Mr. Norman Buffier on 30th June, 1938. The building programme was finalized in June by the completion of a dwelling for the Officer-in-Charge. A programme for the improvement of the pastures has been drawn up and some progress made with this development; the carrying capacity has been increased from 800 to 1,100 sheep. Eighty acres were cultivated and sown down with permanent pasture, and 12 acres with lucerne; 72 acres of natural pasture were renovated and subterranean clover seed and superphosphate were broadcast.

A lease from the Queensland Government of the property in the Cunnamulla district was taken over on 20th September, 1938. The property was established as the National Field Station and named "Gilruth Plains" in memory of the first Chief of the Division. The development of the property was made possible by the financial assistance generously given by the Australian Wool Board.

Mr. H. R. Marston, Officer-in-Charge of the Nutrition Laboratory, Adelaide, was abroad for the greater portion of the year and returned to the laboratory in April, 1938. Before leaving Australia he had been invited to work at the Biochemical Institute, Cambridge; he spent several months there investigating certain aspects of cellulose digestion. During his absence, Professor M. L. Mitchell, whose able assistance the Council is pleased to acknowledge, acted as Officer-in-Charge.

In addition to the work carried out in the three main centres of Sydney, Melbourne, and Adelaide, the Division has continued to carry out investigational work in Tasmania, Queensland, and Western Australia, in co-operation with the officers of the respective Departments of Agriculture.

The work of the Division has been greatly facilitated by the generous financial assistance of the Australian Pastoral Research Trust, the Australian Wool Board, the Australian Dairy Cattle Research Association, and the Queensland Government.

2. *Animal Health Research Laboratory, Melbourne.*—(i) *Pleuro-pneumonia in Cattle.*—Further observations on the reproduction of pleuro-pneumonia by subjecting cattle to finely atomized cultures have confirmed the value of this technique. The experimental disease is in all respects similar to the naturally acquired disease, and, furthermore, is infectious by contact to susceptible cattle.

Using the inhalation technique, the immunity produced as a result of tail inoculation with culture vaccine has been investigated. It was found that a high degree of resistance is evident as little as three or four days after vaccination, that this resistance is very solid thereafter, and persists for at least twelve months. The observations on single versus double inoculation, recorded in last year's report, were not confirmed in later work: no significant difference was observed between cattle vaccinated in the normal manner and those that received a further reinforcing vaccination behind the shoulder.

Evidence indicated that a virulent strain, which was apt to produce a small proportion of "bad tails", gave a more solid and persistent immunity than a less virulent, "safer" strain. However, "bad tails" produced by the virulent strain amounted only to 1.03 per cent. of 51,000 cattle, and only 0.18 per cent. ended fatally.

Approximately 163,000 doses of vaccine were issued during the year, bringing the total to approximately 650,000 doses issued during the last three years.

In the diagnosis of infection, the complement-fixation test proved much superior to the agglutination test which often becomes negative before clinical signs subside, even sometimes before they appear, and is always negative after the clinical phase passes. The agglutination test has no value whatever in detecting chronic cases, and its only value is as a confirmatory test to the complement-fixation test during the early stages of the disease.

No satisfactory method of accurately standardizing the virulence of the vaccine has yet been found. No conclusive evidence of the existence of distinctive varieties of the causal organism, incapable of completely immunizing against each other, has yet been obtained.

(ii) *Entero-toxaemia.*—Work on the typing of the strains of *Cl. welchii* isolated from cases of entero-toxaemia and from soils has shown the presence of only Types A and D in Victoria and Tasmania. This work is being continued to determine if a correlation exists between the absence of *Cl. welchii* Type D from the soil and the freedom of properties from the disease and vice versa.

A vaccination test in Tasmania demonstrated the great superiority of a formolized vaccine, to which ammonium sulphate precipitated toxoid and potassium alum had been added, over the plain formolized vaccine. The experiment at Lismore, Victoria, mentioned in the last report, failed to give useful information.

(iii) *Black Disease.*—The work reported last year is still in progress.

(iv) *Caseous Lymphadenitis.*—Work has been continued on the subject of resistance to infection by the Preisz-Nocard bacillus. Endeavours have been made to extract from the bacillus those fractions which cause immune responses in inoculated animals, in order to determine if they produce greater responses than inoculations of the whole bacillus. This work will also help to determine whether different types or sub-types of the bacillus exist. This study has also involved the preparation of pure anti-bacterial and anti-toxic sera. Further experiments on the immunization of guinea-pigs with bacterial vaccine prepared by treating the bacillus in various ways have given promising results.

The study of the relationship of the causal organism of caseous lymphadenitis to soil has been concluded. The results suggest that the presence of the organism in the soil is related to the presence of sheep on the same area, and that when the sheep are removed the organism eventually disappears from the soil.

The effect of protecting shearing wounds in sheep from soil contamination is being studied on several properties in New South Wales and on one in South Australia.

(v) *Bovine Haematuria.*—The observations on the effect of top-dressing pastures with gypsum on the prevention of the disease have been continued in the Mount Gambier district, South Australia. Of the six heifers placed on the untreated pasture in September, 1933, four have died and the two remaining have shown clinical evidence of the disease for some time. All of the six heifers grazed continuously on the gypsum top-dressed area are still alive, although two of them have passed obvious blood in the urine and the others small amounts detectable only by microscopic examination.

The observations on the effects of top-dressing pastures with gypsum and superphosphate are being continued in Gippsland, Victoria. So far, the animals on this property, which was previously a notoriously bad " red-water farm ", have remained quite normal.

The experimental animals receiving soil from " red-water " areas added to their diet have remained normal; the observations are being continued. Geochemical observations and chemical analyses are being continued at the Nutrition Laboratory, Adelaide.

(vi) *Myxomatosis of Rabbits.*—The second colony experiment which was commenced in February, 1937, has been continued. In this experiment the disease was introduced into an established colony of 30 rabbits living in a wire-netted enclosure of 400 square yards. Normal rabbits have been added to the colony at the rate of twelve each week. From the commencement of the observations on 6th February, 1937, up till 30th June, 1938, 863 rabbits have been put into the colony. Of these, 583 have been picked up dead of myxomatosis and 75 have died from other causes. Approximately 20 per cent. have died underground in the warrens and have not been recovered. During this time there has been no variation in the manifestations of the disease, no recoveries have taken place, nor has there been any natural increase in the population. Approximately 90 per cent. of the animals added to the colony have died of the disease within 30 days of being introduced.

Observations have been carried out in a larger area to determine the capacity of the epizootic to spread from colony to colony. An area of 90 acres on Wardang Island was enclosed by a double fence of wire netting. In this area, there were fourteen well defined colonies of rabbits, and the total population was estimated at between 400 and 500 rabbits. On 16th November, 1937, twenty rabbits caught on other areas on the island were infected and liberated at the extreme south-west corner of the enclosure. Of these twenty rabbits, only two became accepted into the colonies. Eighteen days after their introduction, the first enclosure rabbit to contract the disease was found dead. From this time onwards, rabbits dead from myxomatosis were picked up in increasing numbers. The height of the wave of the epizootic occurred at about 50 days after the introduction, after which the number of rabbits dead from myxomatosis became fewer. The last death occurred on 22nd February, 98 days after the introduction. In all, 238 rabbits dead of the disease were picked up, and it is probable that another 20 per cent. would have died underground. The disease did not spread to the scattered colonies in other portions of the enclosure but remained confined to those in the south-west corner. The disease died out in the enclosure as the population became more sparse and the opportunity for spread less. There was no evidence of recovery in any of the affected animals.

Another experiment in the same enclosure was started on 28th June, 1938. In addition, laboratory experiments have been continued.

(vii) *Mastitis in Dairy Cattle.*—The investigation has proceeded according to plan during the past twelve months, and it is considered that satisfactory progress has been made. With the exception of the appointment of an additional laboratory assistant, the scientific team engaged upon the work remains unaltered. At the experimental farm at Berwick, the usual routine work (cropping, pasture treatment, top-dressing, and fodder conservation—oaten hay, meadow hay, maize, and grass ensilage) has been continued. The season has been much below average on account of extremely low rainfall during late spring, summer, and autumn.

The experimental herd now numbers 70 head, of which 51 are milking, the remaining 19 being young stock. Of the 51 milking cows, 15 are on their third lactation, 24 on their second, and 12 on their first. The herd has remained free from tuberculosis, but contagious abortion made its appearance during the year.

Regular and frequent clinical examinations of each quarter of every cow and intensive bacteriological examinations of milk samples from each quarter (now totalling several thousand) have been continued. Particular attention has been paid to the streptococci isolated from these milk samples, and they are classified biochemically and serologically by recognized methods. During the year the so-called mastitis streptococcus, *Strep. agalactiae*, has been isolated from time to time from the milk of the majority of the cows, actually from 43 of the 55 animals. In the majority of cases, the streptococcus has been isolated only once from one or more quarters, but in other cases the organism has established itself for longer periods. In the 43 cows from which *Strep. agalactiae* has been recovered, it has been recovered from 104 out of the possible 172 quarters. In general, it can be said that these organisms found in the experimental herd, while belonging to the group *Strep. agalactiae*, differ somewhat in type from the organisms causing mastitis in other countries.

As was the case last year, staphylococcal infections have been more common and more persistent than streptococcal. During the year, 12 cases of mastitis occurred in the experimental herd, 4 of which were due to streptococci, 7 to staphylococci, and 1 to a diphtheroid organism.

Certain animals continue to excrete *Streptococcus agalactiae* intermittently, or continuously over long periods, without any clinical evidence of mastitis or any visible alteration in the milk. Conversely abnormalities such as the presence of blood, blood clots, and white fibrin clots have been observed frequently in milk unassociated with high bacterial counts or any clinical signs of mastitis. Thus it would appear that the onset of mastitis depends not only upon the entry of the casual organism into the udder but also upon the presence of some other factor.

Observations have been extended to cows in the herd of the State Research Farm, Werribee, and shortly will be widened further. The first phase of the investigation is at present being written up in detail for publication.

(viii) *Toxaemic Jaundice.*—During the year, in co-operation with the Veterinary Research Institute of the University of Melbourne, and the Department of Agriculture of Victoria, the investigation into the occurrence of a disease in sheep grazed on an irrigation area was continued. The disease is characterized by the development of jaundice and haemoglobinuria. It has been established without reasonable doubt that the disease is a manifestation of copper poisoning. These results have given promise that toxaemic jaundice, as it occurs in the Murray Valley and elsewhere, may be found to be also a manifestation of copper poisoning. A joint investigation with which the Department of Agriculture of New South Wales is also associated has now been organized.

3. *The McMaster Animal Health Laboratory.*—(i) *Parasitological Investigations.*—(*a*) *The Effect of Administration of Iron, Copper, and Cobalt on Haemonchosis (Wire Worm Infestations).*—A second experiment, on similar lines to those mentioned in the last report, was commenced in October, 1937, with the object of obtaining further evidence on the influence of these supplements on the course of haemonchosis. Complete haematological examinations have been carried out throughout this second trial, in order to study the anaemia that is associated with haemonchosis and if possible to correlate its degree with the onset and decline of haemonchus infestation. The experiment is still in progress, but, up to the present, the promising results obtained in last year's trial have not been confirmed.

(*b*) *Treatment of Haemonchosis.*—Field enquiries in instances where copper sulphate and carbon tetrachloride were alleged to fail in the treatment of haemonchosis suggested that the reason lay in the refractory state of the immature worm in the abomasum. The alleged failures of treatment occurred under conditions in which a heavy and constant intake of infective larvae could be expected with a resultant heavy infestation with the pre-adult stages of the worm. Tests with copper sulphate and carbon tetrachloride against immature haemonchus were instituted at the laboratory, and it was found that neither was effective to any appreciable degree until at least 17 days after the sheep had been dosed with infective larvae. These results indicate the necessity for providing clean ground for the sheep, in addition to periodic treatment, in order to avoid heavy reinfestation.

Tests on the relative efficiency of varying concentrations of copper sulphate for the treatment of haemonchosis in young sheep indicated that neither 0.5 per cent. nor 10 per cent. solutions were suitable, but, that 2 per cent. solution was quite satisfactory. The successful treatment of haemonchosis in adult sheep is a matter of great importance for, if the residual infections of adult sheep could be removed, it should be possible to eradicate *Haemonchus contortus* from certain affected areas. Trials have shown that the usual dose prescribed for an adult, namely, 1 oz. of 4 per cent. solution of copper sulphate, is unsatisfactory, whereas double that dose is highly efficient.

(*c*) *Longevity of Haemonchus contortus on Pastures in Winter.*—A trial was commenced in the winter of 1937 using the one acre paddocks in the parasitology block at the McMaster Field Station. The experiment was unsatisfactory owing to the very slight extent to which these paddocks were infected at the commencement.

(*d*) *Treatment of Trichostrongylosis.*—A limited test suggested that the administration of tetrachlorethylene following a preliminary dose of copper sulphate may show a satisfactory degree of efficiency, but further trials are required and will be undertaken.

(*e*) *Pathogenic Importance of Nematodirus spp.*—This investigation has been hindered by the difficulties encountered in establishing heavy infestations approaching those sometimes encountered in the field. The work is still proceeding.

(*f*) *Treatment of Oesophagostomiasis by Monnig's Method.*—The inconsistent results obtained with the powder mixture recommended by Monnig in South Africa were commented on in the last report. It was then thought that the failures might result from the drug having failed to pass direct to the abomasum. Experiments were therefore carried out in which the powder was given in a suspension of barium sulphate and X-ray examination utilized to determine whether it had passed to the abomasum or to the rumen and reticulum. This test showed that the suggested explanation of the failures was incorrect.

(*g*) *Identification of Cysticercus ovis.*—Material from mutton carcasses containing suspected *C. ovis* cysts was submitted to us for examination by the Meat Inspection authorities. After a prolonged search of several specimens, a few fertile cysts were found. Many others were present but were degenerated. The fertile cysts were fed to a dog which was successfully infested thereby with *Taenia ovis*. Eggs from this tapeworm were fed to two experimental lambs, both of which developed numerous *C. ovis* cysts. The sheep which provided the original specimens all appear to have come from a fairly clearly defined area.

(*h*) *The Baermann Technique for Isolation of Parasitic Larvae from Soil and Pasture.*—Carefully planned trials have shown that the results obtained by this technique are highly inconsistent. Some reliable method for this purpose is urgently needed and would be of the greatest value in field studies on the ecology of the nematodes which infest livestock. Consequently, much time has been, and will be, spent in testing and modifying Baermann's technique, but, while certain modifications have resulted in a high percentage recovery when very large numbers of larvae are involved, the recovery rate rapidly falls when the number of larvae is reduced.

(i) *Parasitological Field Trial at the F. D. McMaster Field Station.*—The area at the field station that has been set aside for parasitological work has not been as yet fully utilized. A trial, however, was commenced there, in which the degree of infestation resulting from the normal rate of stocking is being compared with that which develops when the stocking rate is doubled. Data from this experiment are being used in an attempt to determine the number of animals which should be used in order to sample a flock adequately when determining the degree of parasitic infestation.

(*j*) *Wool Board Grant for Field Parasitological Studies.*—The officer appointed under this grant commenced duty in August, 1937, and spent some months at the McMaster Laboratory studying and devising the methods which his field studies would involve. He subsequently commenced work in the New England district where, by arrangement with the University College of New England at Armidale, he has been provided with laboratory facilities. Work commenced in New England under this scheme includes (i) attempted eradication of *Oesophagostamum columbianum* and *Haemonchus contortus*. Both these trials depend on the use of treatments at a time when seasonal conditions are inimical to the survival of the eggs and larvae on the pastures ; (ii) studies on the fluctuation in parasite populations as influenced by seasonal conditions, and (iii) studies on *Limnea brasieri*, the intermediate host of the liver fluke.

(*k*) *Parasitic Control by Drenching in Sheep Run under Rotation on Improved Pasture.*—This trial was carried out at " Frodsley " in Tasmania. Two groups of comparable sheep were used ; one group was drenched monthly and the other was not. Each group contained 55 lambs of one line (No. 1) and 30 of another flock. Each group was rotated through a set of four plots of improved pasture, at varying periods of rotation according to the state of the pasture. Unfortunately, as the trial progressed, it became increasingly evident that the two sets of plots were not comparable. From May onwards, half the drenched animals were run with half the undrenched on each set, in an attempt to overcome this difficulty, but it was felt that the arrangement was not satisfactory. The results at shearing showed a slight superiority for the drenched animals among the No. 1 line lambs in body weight and fleece weight, but not among the flock lambs. No other differences were observed. The results were not conclusive, and another trial was commenced in February, 1938, with two groups of 80 ewe weaners, each group being maintained in rotation on four plots of five acres each. Considerable care was taken to ensure uniformity in the groups and in the grazing available to them. One group is being drenched regularly and the other left undrenched. It is proposed to continue this trial for three

or four years, using the same sheep and the same areas, for the purpose of studying the effects of continuous intensive grazing of improved pastures on parasitic infestation, general health, and productivity. The Tasmanian Department of Agriculture is providing local supervision of the trial, and, in conjunction with the Department, it is hoped to include a study of the economics of intensive sheep husbandry, utilizing the data which this trial will provide.

(ii) *The Effect of Grazing Superfine-Woolled Sheep on Improved Pasture.—(a) "Merryville", New South Wales.*—An experiment was commenced in October, 1935, on this property, which is near Yass, New South Wales, and the results of the first year's observations were published in the Council's Pamphlet No. 71. The outstanding features were that the improved pasture (subterranean clover) carrying three sheep to the acre, produced 102 lb. more body weight and 24 lb. more greasy wool per acre than the natural pasture, carrying one sheep per acre. The wool from the improved pasture was one-third of an inch longer in staple than that from natural pasture and one grade coarser in spinning count (the majority of fleeces from the improved pasture group fell in the 70-74 and those from the natural pasture in the 74-80 class). Otherwise, there were no differences. Subsequent to drenching in summer and autumn, the improved pasture group showed a lighter parasitic infestation than the natural pasture group. This trial was continued through a second year. Originally, each group had contained 55 hoggets, but, after the first year's shearing, half of each group was transferred to the other type of pasture. This gave four groups—the first on improved and the second on natural pasture throughout, the third on improved for a year and then on natural, and the fourth on natural for a year and then on improved. Both groups were drenched in January, 1937, parasitic infestation thereafter being negligible throughout. At the shearing in October, 1937, the group on improved pasture throughout was still the heaviest, but the group transferred from natural pasture to improved had nearly caught up to it, the difference being only $7\frac{1}{2}$ lb. instead of 20 lb. per head. The group on natural pasture throughout was still the lightest, but the group transferred from improved to natural pasture had actually lost weight and was only 5 lb. per head above the continuous natural pasture group. The two groups on improved pasture cut about the same amount of greasy wool ($11\frac{1}{2}$ lb.) irrespective of previous pasture, as did the two groups on natural pasture (10 lb.), so that the improved pasture at three sheep to the acre produced $24\frac{1}{2}$ lb. more wool per acre than the natural pasture at one sheep per acre. The differences in wool characteristics, including spinning count, were negligible. The trial is being continued for a third year, the two groups which were changed over during the second year being returned to their original pastures. It is interesting to note that, although the dry conditions have seriously interfered with pasture growth at Merryville, the sheep on the improved pasture have nevertheless maintained their advantages over those on natural pasture.

(*b*) *Valleyfield, Tasmania.*—Co-operation has been afforded by the Tasmanian Department of Agriculture in a trial run on "Valleyfield", a property in the Tasmanian midlands. Two groups of sheep, each containing 25 two-tooths and 35 hoggets, were used, one being run on improved pasture (subterranean clover and perennial rye) at three sheep to the acre and the other on natural pasture at one sheep to the acre. During the twelve months of the trial, ending in December, 1937, the sheep on improved pasture gained approximately $11\frac{1}{2}$ lb. more per head than those on natural pasture. The mean yield of greasy wool per head was approximately $10\frac{1}{2}$ lb. on improved and $8\frac{1}{4}$ lb. on natural pasture. The improved pasture thus produced approximately 60 lb. more body weight and $23\frac{1}{2}$ lb. more wool per acre than the natural. There was no difference between the two groups in staple length or character of wool, but the natural pasture fleeces tended to be slightly brighter and to be one grade finer in spinning count. Most fleeces among the improved pasture sheep were in the 66's or 70's class, while most among the natural pasture sheep were 70's or 74's. Parasitic infestation was no greater among the sheep on improved than among those on natural pasture, despite the heavier stocking on the former.

(iii) *Studies in Fleece Chemistry, Yield, and Fibre Measurement.—(a) Chemical Studies.*—Chemical studies have been continued to determine how the fleece reflects the nutritional and physiological state of the animal. All of the fleece constituents were included in this study, viz., the wool wax, suint, epithelial debris, fibre, and dirt. The definitions of suint and wax have been found to be insufficiently clear cut to specify definite groups of chemical constituents within the fleece. The composition of either of these constituents will depend to a certain extent on the method by which it has been prepared.

It has been shown that one animal cannot be compared with another by simply collecting and analysing fleece samples from both. Very careful sampling methods are required to allow such comparison of animals. The methods which have been used in fleece analyses have been reviewed and compared. None lacks disadvantages, but which is the most satisfactory for any purpose depends entirely upon the objects of the work itself. It has been found that there were

large differences between the iodine and acid values of the wax at the tip and that at the base of the staple. The possibility of these large differences being due to physiological changes has been ruled out completely, and it is clear that oxidation subsequent to secretion is the chief factor causing the changes.

The distribution of the fleece constituents in samples from five areas of the body has been studied. The wax ratio—the proportion of wax to clean dry fibre—was found to be fairly constant for one animal, i.e., some relation existed between these two constituents, but the suint ratio was highest on the belly, though this area produced the least weight of suint. The distribution of the fleece constituents along the fibre have been studied, and tendencies for the wax to migrate to the tip have been noted. For any individual, however, the distribution of the fleece constituents depends so much on the nutrition and physiological state of the animal during the period of growth that no general normal distribution along the staple can be specified. However, similar distribution tendencies are noted for each of a number of sheep grazed together as one flock. Leaching of suint has been detected in one flock of sheep.

The area which was found to approximate closest to the average for the five areas for weights, ratios, and yields of the constituents was the mid-top area, i.e., the area in the mid-side at the level of the shoulder.

The fleeces of sheep kept in the field on good pastures for the whole of one year were analysed and compared with those produced by animals on good pastures for six months and then on poor pastures for six months. The latter group in the second period produced suint, wax, and wool in lesser amount than during the earlier period, whilst the former group produced these constituents evenly throughout the year. The effect of nutrition on these portions of the fleece is apparent from these results.

Fleece samples from animals of varying degrees of recorded and estimated susceptibility to fly attack on breech and body and to fleece rot, and with fleece characteristics which have been presumed to influence susceptibility to all of these, have been analysed.

The fleeces of the animals with the most wrinkled breeches were found to contain greater amounts of wax than those with plain breeches and those which were body struck had a higher suint content than those not body struck. These results, however, cannot be regarded as established generalizations but need further investigation.

(*b*) *Studies in Yield.*—A study of yield has been made. Raw wool varies in weight, owing to absorption or loss of moisture, when it is exposed to atmospheres of which the relative humidity varies. Thus, if the estimated yield is based on the variable air-dry weight, the percentage of wool in it would appear to vary. It was found that in the field on a hot dry summer day a fleece sample might contain as little as 3 per cent. of moisture, but on a warm moist day, such as is frequently experienced in Sydney, the moisture content might be over 20 per cent. of the dry fleece weight. Based on the air-dry weight, the percentage yield of a sample under the humid conditions might be 5 per cent. or more lower than under the dry conditions. The commercial significance of these differences has not been investigated, but a mathematical discussion of yield has been submitted to the *Journal of the Textile Institute* for publication.

(*c*) *Fibre Measurement.*—A considerable number of measurements have been carried out on samples derived from various field trials and from other sources. A study is now being made of possible faults that may be inherent in the present technique. For this study a set of specially prepared slides, that have already been examined by certain overseas workers, have been kindly lent by Mr. H. B. Carter, Walter and Eliza Hall Veterinary Research Fellow, in co-operation with whom this study is being made.

(iv) *Physiological Studies.—The Passage of Fluids through the Ruminant Stomachs.*—These studies have been continued and include radiological observations, made on the same animals over a relatively long period of time, on the passage of fluids (*a*) taken by the animal of its own volition, and (*b*) when administered to the animal. These observations have been supplemented by those made with the aid of fistulae. The results obtained cannot be discussed at this time when the investigation is in an incomplete stage.

(v) *Bacteriological Investigations.*—(*a*) *Foot-rot of Sheep.*—In the early part of the year under review, an organism was isolated from foot-rot lesions that is of a different type from any which had previously been studied. Lesions typical of foot-rot have been set up with pure cultures of this organism—which has been designated " K " for the time being. This observation has been repeated and confirmed on many occasions during the year. The position now is that " K " is the only organism known with which foot-rot lesions can be artificially initiated, but whether it is the invariable primary etiological agent, and what part is played by the inevitable secondary infections which become established rapidly in the lesions that " K " initiates, is still in doubt. Work is proceeding and has been given a new and valuable impetus by this discovery.

The field trials of foot-rot control, based on the finding that the infection appears to survive for a very short time away from the sheep's foot and that consequently infected paddocks should quickly become safe for non-infected sheep, have been continued, but, owing to the prolonged drought in the areas concerned, most of the trials have been abortive. At Werribee (Victoria), however, the trial that was instituted in 1936, on irrigated pasture that had previously resulted in a high incidence of the disease, has been completely successful, the non-infected sheep placed on the selected area having remained free of foot-rot for nearly eighteen months. An additional trial has been instituted in western Victoria on a property whereon foot-rot is endemic, but it has not been under way long enough for results to be conclusive. On the same property, another observation is being carried on dealing with the recurrence of lesions in sheep which have been allegedly cured by paring of the hoof and treatment with the commonly used baths of copper sulphate or formalin.

(*b*) *Caseous Lymphadenitis.*—The experiment on prophylactic vaccination, which commenced in 1934 using wether lambs at " Noondoo ", kindly made available by Mr. E. Young, is now nearing its conclusion. The experimental animals were given two inoculations during their first year of life followed by two further inoculations at yearly intervals. Some 1,500 of the sheep involved in this trial have been carefully examined after slaughter at the Brisbane Abattoir and the remainder will be slaughtered later. The results obtained so far are encouraging, there being approximately two and a half times as many affected sheep among the controls as among the vaccinated, but conclusions must await the completion of the trial.

Observations on prevention of the disease by placing newly-shorn sheep on well-grown and spelled paddocks till shear cuts have healed have been continued. Two trials of this sort were instituted in 1936, but, owing to the drought, it has been impossible to procure paddocks with the most desirable covering of pasture. Both trials are still in progress, but it is doubtful whether they can usefully be continued.

Observations on prevention of the disease by rugging the newly-shorn sheep till shear cuts have healed have been initiated. One trial was commenced in 1936 and a further one during the present year. Results will not be available until the experimental animals are slaughtered in two to four years' time.

(vi) *The Sheep Blowfly Problem.*—(*a*) *The Mules Operation.*—In July, 1937, an extensive trial to determine the efficacy of the Mules operation was instituted on a property near Walgett. A flock of over 600 stud ewe weaners that had just been crutched was made available for the trial. These were carefully classified according to the degree of breech fold development and randomized into two groups, one of which was subjected to the Mules operation, the other serving as a control. The whole flock has been grazed as a single unit throughout, and careful records have been kept of all strikes that have occurred, each sheep bearing a numbered ear tag for identification purposes. A preliminary account of this trial, with results strongly supporting the benefit derived from the operation, was published in February, 1938, in the Council's Journal. Since that date the results have been equally satisfactory. In view of the excellent opportunity afforded by this trial, with the individual sheep records it has provided and the very high degree of co-operation forthcoming from the manager of the property and his staff, the trial will be continued throughout the first mating, pregnancy, and lactation periods of these ewes, in order that data may be procured on the indirect effects of fly strike on the productivity of the sheep. In addition, data regarding its effect on wool production and quality will be procured at the forthcoming shearing. Unfortunately, the drought conditions that have prevailed in the district have necessitated delays in shearing and mating, but the data from this trial should be of very real value, nevertheless.

(*b*) *Blowfly Dressing.*—Owing to the greatly increased price of glycerine, the cost of the glycerine diboric dressing has become almost prohibitive. An attempt was therefore made to devise a dressing that might be effective and yet of reasonable cost. Preliminary trials of a dressing, which would be cheaper and easier to apply than glycerine diborate, have been carried out at the McMaster Laboratory and by the Division of Economic Entomology at Canberra. The preparation shows considerable promise, and field tests have been arranged.

(vii) *Pregnancy Toxaemia Investigation.*—In January, 1937, an investigation of this problem was commenced in conjunction with the University of Sydney. The workers engaged in the investigation comprise a biochemist and a pathologist. A flock of 100 crossbred ewes is being studied, their grazing and facilities for examination being provided by the F. D. McMaster Field Station and the adjoining McGarvie Smith Animal Husbandry Farm (of the University of Sydney). These ewes are being subjected to various nutritional conditions during pregnancy, and a proportion of them sampled at short intervals for blood and urine analysis. It is hoped to induce artificially a condition that is identical with the disease as it is encountered in the field. If this is successful, induced cases will be used in detailed studies of the exact etiology, predisposing factors, prevention, and cure of the disease. Through the helpful co-operation of the New South

Wales Department of Agriculture it has been possible for the pathologist concerned in this work to visit outbreaks of the disease that have occurred this autumn, and so to procure data and specimens for laboratory examination, besides familiarizing himself with the conditions associated with outbreaks. An extensive review of the literature on pregnancy toxaemia of ewes has been compiled.

(viii) *Sheep-dips Investigation.*—This investigation was initiated during the year; it involves studies of dipping fluids and of the parasites against which dipping is aimed, namely, sheep lice and "ticks". The available literature on both phases has been thoroughly reviewed. A series of experimental dippings in known arsenicals has indicated that the soluble forms are more effective parasiticides than are the insoluble, and that the pentavalent form is less effective than the trivalent. Further experiments of this type will be carried out. Samples of dipping fluid are being analysed before and after dipping, in an effort to obtain more exact knowledge on the actual effect of dipping sheep on the efficacy of the active agents in the dipping solution. Studies of the life history of the sheep tick have proved exceptionally difficult owing to the fact that these parasites rapidly die when removed from the sheep, and even when caged in the fleece of the living sheep they seldom survive. It is apparent from the literature that other investigators have encountered similar difficulties. Close observations of tick-infested sheep maintained for the purpose at the laboratory suggest that there is a marked decline in the degree of infestation during the hotter months of the year. Further observations will be made on this phenomenon, and a commencement has been made, from records kindly made available by the New South Wales Department of Agriculture, to survey the relative distributions of sheep ticks and lice in New South Wales.

(ix) *Rugging Trial.*—This trial is being conducted in the Albury district using 96 carefully selected pairs of wethers, one of each pair being rugged and the other serving as a control. The information that was gathered from the first year's observations, particularly a consideration of the body weights, quantity, and quality of wool, has been compiled for publication. Under the conditions obtaining, namely, freedom from dust and burrs together with a low rainfall and moderate temperature, rugging was not economical. As an outcome of this trial, which is now approaching its termination, it is thought desirable to carry out an investigation of the effects of rugging under the more rigorous conditions of the New England tableland. If this is done, the benefits derived from rugging for special purposes, such as protection from low temperatures and consequent diversion of the energy intake into more useful channels, will be taken into account when planning the trial.

4. *The F. D. McMaster Field Station.*—(i) *Fertility in Sheep.*—The Council's Bulletin 112 deals with the results of the six studies referred to in the previous report. Though no final conclusions were drawn, the clinical histories of the ewes and other evidence indicated that there were three principal causes for the observed infertility. Further, when the frequencies of similar diagnoses among ewes which failed to bear a lamb to any mating were tested for significance, it was found that no class occurred more often than was compatible with a dispersal by chance. The three probable causes for infertility among the ewes under observation were (*a*) absent, aberrant, or irregular oestrus, (*b*) some pathological condition subsequent to coitus which precluded conception, and (*c*) early abortion or resorption of the foetus.

For the elaboration of these hypotheses, work has been directed principally upon an investigation of the factors governing the occurrence of oestrus. This *inter alia*, has disclosed that oestrus has a cyclic occurrence, even in Merino ewes, and that its periodicity does not appear to be strongly associated with either the body weight or the rainfall when used as a guide to the nature of the vegetation.

The months of most frequent occurrence of oestrus are from January to August, while those having few and in some cases no occurrence of heat are from September to December. Further, observations have disclosed that, among Merinos of pure lineage but from different strains, the level of occurrence varies; thus, though all the observed strains supported the foregoing statements, the period of anoestrus (September to December) was more complete for some than for others. It is hoped to publish the results of these and allied studies towards the end of 1938.

(ii) *Inheritance of Colour in Sheep.*—Complaints have been received that coloured fibres are discovered by scouring Australian wool which, in the grease, is apparently wholly white; accordingly, a series of experimental matings are being made to investigate the inheritance of coloured wool. These have been made possible by close co-operation with pastoralists on the Monaro and particularly with Mr. E. G. Shaw of Bombala. In all, the progeny from 25,000 ewes upon various properties are being observed, while 66 coloured individuals selected from among these sheep are being mated at the Field Station. The object is not only to determine the nature of the inheritance but, if possible, to evolve progeny tests by which stud animals could be examined for such characters.

(iii) *Inheritance of Wrinkling.*—Though it is generally conceded that plain bodied sheep are less susceptible to fly-strike than those with a high degree of wrinkling, some development is considered, equally generally, to be a necessary association of fleece density. However, before such a nice balance of wrinkling can be maintained accurately, it is necessary to determine the manner in which wrinkles are inherited. Accordingly, preliminary matings are being made between Border Leicester ewes, which have no wrinkles, and excessively wrinkly Merino rams. Later, it is intended to cross and back cross the progeny and thus investigate the method by which this character is inherited.

(iv) *Zebu Hybridization.*—All the imported animals are alive and well, and breeding activities have been continued. During the year, one of the original co-operators (Messrs. Winter Irving and Allison) disposed of their herd of pure and hybrid Zebus to another co-operator, Mr. C. W. Wright of Waverley, St. Lawrence, Central Queensland. Also Messrs. Frank Fraser Pty. Ltd. of Ingham, North Queensland, have purchased hybrids, becoming co-operating members in the breeding project by signing the original undertaking and placing their matings and cullings under the direction of the Council. Messrs. Frank Fraser Pty. Ltd. have extensive dairying interests on the Herbert River, and, by their entry into the experimental group, observations with regard to Zebu cross dairy cattle within the Tropics will become possible. Already, two progress reports upon the Zebu hybridization experiments have been prepared, and it is intended to compile from them and additional material a publication which may be expected to appear shortly as one of the Council's Pamphlet series.

(v) *Breed Analysis of Jersey Cattle in Australia.*—Every breed of animal has, within it, many " blood lines ", some of which have been intensified more than others. Further, production levels vary, sometimes as the result of higher planes of nutrition and sometimes as the result of " new blood ". Before these trends can be attributed to particular " blood lines ", however, it is necessary first to analyse the pedigrees, not only of individuals, but of the breed as a whole, and to determine coefficients of in-breeding and relationships which can be associated with such trends. For these purposes a commencement has been made upon a study of the Jersey breed in Australia.

5. *Observations Centred in Queensland.*—(i) *Peg-leg Disease.*—The experiment described last year is continuing. The work will not be completed until March, 1939, but to date no significant differences in weight gains have been recorded between groups receiving phosphatic supplements and the control groups.

(ii) *Tick Fevers.*—Continued observations have failed to give evidence that *Anaplasma centrale* or *A. marginale* are carried at Townsville by winged insects.

6. *Dairy Products Research.*—The studies of the Dairy Research Officer, who is located at the Dairy Research Institute, Palmerston North, New Zealand, have been directed, during the past year, to various factors influencing the keeping quality of butter. An experiment conducted to determine the effect of acidity on the keeping quality of unsalted butters showed that butters from creams acidified by the addition of lactic acid to pH 5 kept rather better than those from creams ripened to the same acidity. The fat of butters from ripened cream (pH 5) showed notable oxidation after cold storage, whereas that of butters made from acidified cream did not. This question is being investigated further.

It has been found that high acidity of itself does not result in the butter being degraded for acid flavour, but that what is generally termed an acid flavour is caused by products of bacterial action other than lactic acid. Other matters investigated during the past year have included fat losses in butter-milk, and the manufacture of butter from feed tainted and mastitis cream.

The Dairy Research Officer visited Australia in May and June and made contact and discussed problems with butter factory managers in several States.

7. *Investigations in Western Australia.*—Co-operation with the officers of the Western Australian Department of Agriculture has continued during the year.

(i) *Botulism (Toxic Paralysis of Sheep).*—This investigation has been brought to a satisfactory conclusion. Field applications of the results, particularly the protection of sheep and cattle by vaccination, have proved entirely satisfactory.

(ii) *Gingin Disease (Ataxia in Lambs).*—The investigation has demonstrated that ataxia in lambs is associated with a copper deficiency in the ewes. The disease can be prevented by making small quantities of copper available to the ewes. These results have been confirmed in Victoria and in South Australia.

8. *Investigations in Tasmania.*—Co-operative investigations have been continued with the officers of the Department of Agriculture. The progress of the investigations has been dealt with under 3 (i) (*k*) and 3 (ii) (*b*).

9. *The National Field Station, "Gilruth Plains".*—From September, 1937, when the lease of the property was obtained from the Queensland Government, developmental work has been proceeding on the property which is situated 20 miles east of Cunnamulla and comprises 39,022 acres of good mixed country. The old fences have been put in repair, and new sub-divisional fences for the experimental paddocks have been erected. Yards have been built and additional bore drains for the more efficient watering of the property have been put down. A residence for the officer-in-charge and men's huts have been erected, and contracts have been let for the erection of a residence for the manager, a store and office, and other minor buildings.

The early part of the season was far from good, but some rain fell in January and good rains in May and June. Stock had been purchased locally as opportunity offered, and at 30th June, 1938, there were 5,600 sheep on the property, consisting of 3,800 ewes, and 1,800 wethers. In addition, station horses and milking cows have been purchased.

It is anticipated that field trials in the control of fly strike will be initiated immediately. Problems in nutrition and wool production will be studied in the near future.

10. *The Animal Nutrition Laboratory, Adelaide.*—(i) *Phosphorus Metabolism of the Sheep.*—(*a*) *"Wambanumba", Young, New South Wales.*—The field experiment which was critically designed to determine whether sheep grazed on pastures produced on markedly phosphorus-deficient country do, in fact, benefit from an additional supply of phosphorus has yielded the following results during the first 18 months of observation. No significant increase was observed in the rate of growth of sheep during their first 18 months of life by supplementing the natural fodder with approximately a gramme extra of phosphorus a day, in spite of the fact that this treatment brought about an almost continual increase in the concentration of blood phosphate in the dosed animals. The wool grown over the year subsequent to weaning at six months was not significantly increased in weight or altered in quality. The experiment is being extended for a further period, when the effect of the extra stress of pregnancy and lactation will be investigated.

(*b*) *Penola, South-eastern South Australia.*—The comprehensive experiment situated on the property of Mr. R. R. Rymill, at "Penola" Station, which is being conducted to extend investigations into the alleged benefit of phosphatic licks, is proceeding satisfactorily. Although its duration is not long enough for any useful prediction to be made of the possible results, it would seem that no significant benefit has been brought about by providing 7 gm. of phosphorus as dicalcic phosphate per head each week or by offering dicalcic phosphate and salt *ad lib.* as a lick. This experiment will be continued for at least two years further.

(*c*) *"Manuka", Winton, Western Queensland.*—The phosphatic lick experiment undertaken in co-operation with the Australian Estates Co. Ltd. on their property at Winton is progressing satisfactorily.

(*d*) *The Influence of High Concentration of Calcium and Magnesium on the Assimilation of Phosphorus by Growing Sheep.*—The results of these investigations will appear shortly as a Bulletin, in which their significance will be discussed.

(*e*) *The Comparison of Mono-, Di-, and Tri-calcium Phosphates as Sources of Phosphorus Supply for Sheep.*—The results of the first phases of this experiment have been discussed in previous reports, and the investigations have now been completed. No differences were observed in general health, increase in weight, wool production, or inorganic blood phosphate level, during the three years of the experiment. The control group, which received only 0.6 gm. of phosphorus daily showed a smaller increase in weight, and the mean concentration of blood phosphate in this group has been for the last year in the vicinity of 2.5 mg./100ml., while that of the groups receiving added phosphate has remained above 6mg./100 ml. Examination and analyses of the skeletons of the experimental animals have yet to be carried out. When these are completed, the results and significance of the experiment will be discussed in a Bulletin.

(ii) *The Effects of Ingestion of Fluorine by Sheep.*—(*a*) *The Effects of Continual Ingestion of Fluorine.*—The results of these experiments, which have been discussed in previous reports, will be published in the near future as a Bulletin.

(*b*) *The Effects of Intermittent Ingestion of Fluorine.*—This experiment was discussed in the last report. It has now been in progress for 18 months, and so far no difference in general condition or weight has been observed between the three groups of sheep under investigation.

(iii) *Coast Disease.*—(*a*) *General.*—The results of the coast disease investigations have been published as a scientific monograph in Bulletin 113, which contains a description of the aetiology and the means of control of this malady. Since that publication went to press, evidence has accumulated which indicates that the available fodder on the affected littoral at Robe is more grossly copper deficient than was first suspected, and that the amount of copper used in conjunction with cobalt in the treatment of sheep grazed in these areas may be materially increased with still further benefit to the animals. Further experimental work has been undertaken to determine the optimal level of copper intake of the sheep and to investigate the factors involved in copper assimilation.

Experiments aimed more directly at the practical control of the malady have been continued. Soluble cobalt and copper diluted with common salt have proved effective in preventing the appearance of untoward symptoms in areas where the flocks take salt licks. In such cases, if the intake of lick is watched and the concentration of the other elements admixed with it is controlled so that the average intake of cobalt is 1mg. per day and that of copper 4 mg. per day per sheep, sheep may be run for long periods on affected country without evidencing any untoward symptoms. Treatment for a year costs a fraction of a penny per head.

Experiments designed to determine whether cobalt and copper might be administered less frequently than three times weekly, which was the procedure employed during the original investigations, have made it clear that the conditions of grazing on the affected country are such as render it impossible for sheep to store adequate quantities of these elements, particularly cobalt, for their normal requirements. It was found that as frequency of dosing decreased so did the degree of protection against coast disease, and so it seems unlikely that relatively infrequent dosing with large quantities of cobalt and copper will prove a practical method for the control of the disease.

An attempt to induce coast disease in rabbits by confining them solely to fodder produced on the affected country has so far proved unsuccessful.

Healthy sheep watered with distilled water and pen fed with " coasty " hay supplemented with gluten, which contains a very small quantity of copper, become lethargic and develop a wasting malady which terminates fatally without any obvious changes in the formed elements or in the oxygen carrying capacity of the blood. One milligramme of cobalt administered each day dramatically restores such animals to normal health. These symptoms are, with little doubt, the result of uncomplicated cobalt deficiency. Under field conditions, also, the syndrome of coast disease is capable of resolution into its components by suitable treatment with cobalt or copper salts. The specific symptoms exhibited by sheep suffering from uncomplicated deficiency of cobalt or of copper may now be studied in conjunction with the field investigations at Robe, for it is not unlikely that a deficiency of either one of these elements limit the productivity of pastoral lands elsewhere in Australia.

The field investigations at " Hawk's Nest " were discontinued in January, 1938. The owners of this property report that their flock, which has been allowed access to the recommended salt mixture, has remained healthy continuously for four years without appearance either of ataxia or coast disease.

(*b*) *Ataxia.*—The results of the experiments designed further to study the incidence and aetiology of the ataxia of young lambs bred on the coastal littoral were complicated by the fact that all untreated lambs exhibited symptoms of coast disease and died before any signs of ataxia were apparent. In light of our more recent knowledge, these experiments will be repeated, and the behaviour of pregnant ewes and their lambs receiving cobalt only will be contrasted with ewes receiving both cobalt and copper.

(iv) *Drought Feeding.*—(*a*) *Digestion of Roughage.*—The application of energy balance methods to the study of the extent to which roughage is utilized by the sheep indicated that the ability of sheep to digest sufficient rough, highly lignified straw to fulfil their call for energy varied with their size, and that while large sheep were found to consume and digest sufficient of a given ration to maintain them, smaller ones could not deal with enough to meet their energy needs. The higher efficiency of larger animals is seemingly associated with the ratio of the rumen volume to surface area. Experiments have been planned and equipment assembled to extend this work to larger ruminants.

During the year, it was established that practically the whole of the cellulose digested by the sheep is split by the bacterial agencies in the rumen, and that comparatively small amounts disappear in the lower levels of the intestine. Investigations carried out by rumen fistulae have materially extended our knowledge of the nature and rate of these activities.

Further attention is being given to the factors which influence the activity of the symbiotic rumen flora, with a view to supplying the materials which limit digestion of the cellulose in the dry rough rations available during periods of nutritional stress imposed by drought. By means of an *in vitro* experimental approach where the *milieu* of the rumen is imitated, the study of these factors have been extended further, and the products of the bacterial digestion of cellulose have been isolated and proved to be carbon dioxide and methane, together with a series of fatty acids from which the sheep derives its energy requirements.

The ability of the sheep to utilize acetic and propionic acids when these are substituted for the equivalent amount of cellulose in the diet has been observed. Preliminary experiments, utilizing 60 g. of acetic acid and 74 gm. of propionic acid as calcium salts, indicated that there is little, if any, upset either of energy metabolism or of wool growth.

Up to 500 gm. per day of commercial cellulose—sulphite wood pulp—have been found to be readily and almost completely digested and utilized by the sheep. This observation has provided means for extending out experimental technique for the study of influences of nutritional factors on wool growth.

(*b*) *Yeast and Wheat Straw Diets.*—The possibility of utilization of yeast, which could be produced from by-products of the sugar industry, for a protein source in supplementary feeding has been further investigated, and it was found that the sheep is able to obtain more than its energy requirement from wheat straw of poor quality if it is supplemented with 150 gm. of yeast daily. The growth of wool under these conditions was found to be sub-optimal, and the results are thus in conformity with the more extensive field experiments which the Division conducted some years ago in Queensland. It would seem that small amounts of yeast may find an important role in compounding drought rations, as other work indicates that those factors necessary for the activity of cellulose-splitting organisms of the rumen are supplied in high concentration in yeast.

(*c*) *Comparative Quality of Protein Concentrates for Supplementary and Drought Feeding.*—Much of the fundamental information necessary to evaluate the comparative usefulness of protein concentrates, &c., available for supplementary and drought feeding has been gathered. The technique for this investigation has been perfected, and by means of generous financial help from the Australian Wool Board the equipment has been assembled for an investigation which will extend the findings directly to practical application.

Further grants from the Wool Board have made it possible to begin a programme which will continue for several years, and when completed the information should render it possible to assess, by simple computation, the costs and returns from any given hand-feeding procedure.

(v) *Bovine Haematuria.*—The investigations into the possible cause of this disease have been continued along the lines mentioned in the previous report.

In December, 1937, a visit was made to northern Tasmania and Gippsland, Victoria, for the purpose of extending the geochemical observations already made in the Mount Gambier region. All the important areas in which the disease is enzootic in these localities were visited, and a large series of samples of soils, pastures, and animal products, &c., was collected for laboratory examination.

As a result of the field observations, it was concluded that the Mount Gambier area offered exceptional opportunities for investigation of the problem, as the geochemical aspects at that locality were less complex than elsewhere.

The chemical analyses of soils, pastures, and animal products from affected areas has been continued, and this work has been assisted by the co-operation of Mr. A. C. Oertel, of the Division of Soils, who has undertaken spectrographic examinations of some of the materials. The analytical and spectrographic results have indicated certain peculiarities in the samples collected in the Mount Gambier region, and these may possibly have some bearing on the problem. The investigations are, at present, directed towards ascertaining whether the observed peculiarities in chemical composition of pasture, &c., are a feature common to all districts in which the disease is enzootic.

(vi) *Agrostological Investigations.*—(*a*) *Pasture Investigations at Clare.*—Three cuts were made on the species trial at " Anama " during 1937, and yields and botanical composition were determined. The trial was completed in this year, and the results obtained over the three years in which the experiment was in progress are being prepared for publication.

(*b*) *Pasture Experiments at Robe.*—The application of copper sulphate to the highly calcareous soil at Robe in 1937 resulted in a marked improvement in the health and yield of wheat, oats, and barley. The untreated cereals suffered from a disease identified with that known in Europe as " reclamation disease ", " yellow tip ", or " Urbarmachungskrankheit ". The application of a mixture of manganese and ferrous sulphates was not successful in preventing the condition.

Although the numerous pasture and other species sown (42) in 1937 showed some slight improvement in growth by the application or copper sulphate, they failed to make normal development with the dressings employed. Results of these preliminary investigations have been published as a Pamphlet. Further field and pot culture experiments are in progress.

(*c*) *Pastures at " Wambanumba ".*—Intensive agrostological investigations were undertaken to finally test the hypothesis which arose from the observation of the response of sheep grazed on adjacent areas which had received a series of manurial treatments at " Wambanumba " (New South Wales). The suggestion that small amounts of sulphur in the soils may provide a first limiting factor in growth has now been fully substantiated. The productivity of soils of this particular region is evidently limited by both phosphate and sulphur.

The experiment started in the autumn of 1937 on previously unfertilized natural pasture at "Wambanumba", New South Wales, showed that the application of elemental sulphur together with soluble (100 per cent.) phosphate gave an eleven-fold increase in the yield of legumes during the first year's growing period. The application of either fertilizer alone gave no significant increase in the yield. Grazing was not permitted, in order to avoid complicating factors. The experiment is being continued in 1938, and two further trials, including sulphur treatments, are in progress.

VI. SOILS INVESTIGATIONS.

1. *General.*—The Division of Soils has its head-quarters at the Waite Agricultural Research Institute about four miles from Adelaide, and is housed there in the Darling Laboratory and part of the Melrose Laboratory. The recently completed Ranson Mortlock Laboratory provides further accommodation for the Division. A considerable part of the Division's work is, of course, conducted in the field. As the production of wealth in Australia's pastoral, agricultural and horticultural industries is dependent ultimately on the soil, the investigations of the Division of Soils, aiming at accurate knowledge which will permit of intelligent and economic methods of soil management, treatment, and improvement, are obviously matters which, in the interests of those great industries, cannot be neglected without serious consequences.

The main objects of the Council's soils investigations, are, therefore, twofold, viz. :—

(*a*) To provide a centre for the systematic investigation of Australian soils and soil problems in order to provide a fundamental basis for the advisory and administrative work of the State Departments of Lands, Irrigation, and Forestry.

(*b*) To make soil surveys of virgin areas for future settlement and development, and of such recently settled areas as present problems of immediate importance, and which may provide a groundwork of information for further settlements of a similar character.

While losses in certain land settlement schemes may be due to a variety of factors, in many instances, as in the irrigation areas, a major contributing factor has been the lack of information regarding soils or a lack of appreciation of the nature of the soil problems involved. The work of the Division in the irrigation areas, correlated with that of the Research Stations at Griffith and Merbein, indicates not only that much loss of money and of individual effort could have been avoided had the necessary soil investigations been made, but also that future developments can be undertaken with a reasonable degree of confidence due to our enhanced knowledge of the soil conditions essential for successful production. One prominent instance lies in the appropriate selection, after survey, of sites for irrigation and manuring experiments and the ready application of results to similar soils mapped on the settlement.

The most recent development in some of the irrigated settlements along the River Murray has been the provision of extensive drainage schemes to which every farm will have access. The soil surveys are likely to prove of service in the planning of the drainage systems required for the individual farms.

In view of the steadily increasing demand for soil surveys, it has been the policy of the Division to strengthen its staff each year by the addition of two field officers. Co-ordination with the work in other States has been secured by seconding an officer to the Victorian Department of Agriculture and by having with the Division, officers seconded from the Department of Agriculture of Western Australia and from the Departments of Forestry of Tasmania and of South Australia.

An increasing interest is being taken by the Division in problems of soil fertility, notably those associated with the large scale development of heath and scrub country. While the work so far has been restricted to easily accessible areas in South Australia, the principles involved will be capable of a wider application throughout the Commonwealth.

2. *Soil Surveys.*—During the year, field work has been continued in Victoria, South Australia, and Tasmania, and reconnaissance trips made in the Kimberley region of Western Australia and in North and Central Australia. As a result of these and previous visits to tropical Australia, the position with regard to the nature of the soils in these areas is becoming clarified, and a considerable body of information is being collected. As an immediate result of these investigations, it has been possible for the first time to report on some of the soils used for agricultural purposes in the Northern Territory.

Field surveys in the Mildura district continue to occupy the attention of the division, and the whole of the Mildura Trust District involving about 11,000 acres has been covered. The work will shortly go forward to the adjoining settlement at Red Cliffs. The survey at Red Cliffs will complete a ten-year programme of soil surveys in the irrigation settlements supplied by water from the Murray and Murrumbidgee.

In the Kerang Irrigation District, the survey begun in the previous year was completed by the mapping of 40,000 acres of additional territory. A detailed map has been prepared covering 54,000 acres of the country lying in the triangle enclosed by the Loddon River, the Pyramid Creek, and the Macorna Irrigation Channel. The district is acutely affected by high soil salinity and by a saline water table close to the surface. The investigations related to the present state of the soil, the existing vegetation, and the practicability of improvement.

Both these surveys at Mildura and Kerang are of a co-operative character, the Division having been responsible for the field work and the Victorian Department of Agriculture, through the State Chemical Laboratories, for the laboratory work.

At the request of the Irrigation Branch of the Lands Department an horticultural area at Mypolonga, South Australia, was surveyed and a possible extension of this area reported upon. In the south-east of South Australia a survey of the forest plantations of softwood (*Pinus radiata*) was completed at Mount Burr and at Mount Gambier. The aggregate area was 45,000 acres including 7,000 acres of virgin forest. These surveys have been made at the request of the Department of Woods and Forests of South Australia, one of whose officers was seconded to assist in the work. The aerial photographs of these areas prepared by the Royal Australian Air Force have proved of considerable value in the course of the field work.

It is expected that further surveys will be undertaken during the coming year into both forest and agricultural areas in this portion of South Australia.

In Tasmania, field and laboratory investigations related to the survey of the recently acquired Government Experimental Farm at Cressy and to the examination of soils from tobacco plots in various localities in the northern portion of the State. On behalf of the Department of Agriculture, a survey was conducted of an area of 7,000 acres at Currie's River representative of a large area in the north-east of the State. Traverses of a reconnaissance character were made extensively across the whole belt of coastal plains in this district. These surveys will form the basis for experimental work on the agricultural development of these areas.

A reconnaissance of areas proposed for irrigation in Tasmania was also made on behalf of the Hydro-electric Commission. Further and more detailed investigations are proposed in selected portions of these areas.

In Northern and Central Australia, three long traverses were made by officers of the Division. The most comprehensive was from Broome in Western Australia to Darwin in the Northern Territory. Use was made both of aeroplane and motor transport, with the co-operation of the Northern Territory Administration and of local pastoralists. Centres for observation and the collection of soil samples were Noonkanbah, Argyle Downs, Victoria River Downs, Katherine, Daly River and Darwin.

Officers took part in scientific expeditions to the centre, the journeys permitting of observations being made on soils and vegetation and on the nature and effects of erosion in these areas.

3. *Laboratory Investigations.*—The analytical work conducted in the laboratories in Adelaide and in Hobart related to the samples collected during the surveys above-mentioned, except where carried out by the State Chemical Laboratories in Melbourne. Seventy samples of soil were received from the Director of Agriculture of the Mandated Territory of New Guinea representing areas in New Guinea, New Britain, and New Ireland. These have been examined and reported upon. Samples were also received and examined of the volcanic ash, as mud and dust deposits, from the eruption at Rabaul in May, 1937. These form an interesting series for comparison with the soils developed from similar deposits elsewhere in New Britain.

During the past few years, a range of soil samples has been collected by various expeditions into the more arid and less accessible regions of Australia. These samples have now been examined in the laboratory, and a report is being prepared summarizing their main characteristics.

A report has been prepared on the soils used for the cultivation of the peanut at Katherine and Daly River in the Northern Territory. The industry is a relatively new and possibly precarious one, and the settlers are deserving of every scientific help possible in their effort to achieve settlement of a permanent character.

As part of the research programme of the University of Adelaide in association with the Division, a comprehensive report has been prepared on the red brown earths of South Australia. This group of soils is the most important group in the wheat belt of Australia and the South Australian members of the group have now been adequately described.

Two new methods of investigation have occupied the attention of the Division during the year ; these are the use of the spectrograph and of the polarograph, both of which are used for the estimation and determination of traces of metals in soils and in plant and animal tissues. The interest being taken in problems of animal and plant diseases associated with deficiencies of such elements as copper, boron, cobalt, and zinc, has made it necessary to make use of laboratory techniques more suited to the determination of such traces. Considerable progress has been made with the use and standardization of both instruments and a substantial amount of work

has been undertaken for other Divisions of the Council and for other Departments of the Waite Institute. On behalf of the Division of Plant Industry, examinations were made of pine-needles suffering from "needle fusion" and of diseased apples and pears. Although no conclusive result was reached, it has proved possible to make suggestions for further investigations. On behalf of the Division of Animal Health and Nutrition, tissues from animals suffering from "coast" disease and "red water" have been examined.

4. *Soil Microbiology.*—The investigations in microbiology have been limited to the study of the root-nodule organism (*Rhizobium*) associated with leguminous plants and responsible for the fixation of atmospheric nitrogen. The importance of efficient Rhizobial strains suited to any particular species of legume was emphasized in the last report, and strains suited to lucerne, subterranean clover, and field peas have been maintained and distributed.

Close contact has been maintained during the year with two groups of South Australian farmers interested in the development on a large scale of poor sands normally carrying a heath or scrub vegetation. The permanent establishment of subterranean clover on certain soils has been found to present special problems in Tasmania, South Australia, and Western Australia, and the maintenance of *Rhizobia* in the soil from crop to crop appears to be one of the factors involved.

The standard method of supplying cultures in test tubes has proved to be quite inadequate for the large scale operations involved in Austrialia, and investigations have been carried out with liquid cultures and on methods of dry inoculation. These investigations are still in progress and show considerable promise. The field work is being carried out on Kangaroo Island.

The soil factors necessary to secure successful inoculation on the poorer soils are also being made the subject of special study.

VII. IRRIGATION SETTLEMENT INVESTIGATIONS.

A. Commonwealth Research Station (Murray Irrigation Areas) Merbein, Victoria.

1. *General.*—The Commonwealth Research Station, Merbein, is concerned primarily with problems associated with the producing and processing of dried fruits, and the irrigation and drainage of the lanes on which the fruit is grown. The establishment of the Research Station at Merbein has provided special facilities for this work, and investigations common to all Murray River areas producing dried fruit are carried out in the Merbein district. An up-to-date laboratory, to provide accommodation and facilities for the work of the various officers, was officially opened on 21st September, 1937.

For other districts, where soils, climate, and the general producing environments differ, it has been found necessary to extend investigations so as to cover major problems of these areas.

Investigations relating to the preservation and reclamation of the irrigated areas on the Murray constitute at present the chief problems on which the staff of the Station is engaged. Until recent years, loss of productivity was accepted as inevitable on portions at least of all the irrigated settlements, with declining capital value accompanied by loss in revenue. As investigations gradually clarified the position, and ameliorative measures for prevention of salting and the general misuse of irrigation water became known, reclamation work has become prominent. This changed viewpoint has resulted in the steps now in progress for soil preservation in the various irrigated settlements.

In particular, there is now a general recognition that surplus waters arising either from storm waters or excess irrigation, must be removed; for this purpose comprehensive drainage schemes are in the course of construction or contemplated in most of the important irrigation areas producing dried fruits.

The part played by the Station in these works is to investigate the drainage potentialities of the various soil types, to assist in the examination and location of unproductive areas, and to suggest remedial measures. In addition, the Station is closely associated, through various State and local committees, in the planning of the drainage schemes suitable for each particular environment. The work covers a wide area, embracing the settlements along the Murray between Waikerie in South Australia and Kerang in Victoria, a distance of approximately 400 miles.

Soil investigations relating to soil preservation under irrigation conditions include the measurement of concentration and the location, in the soil horizons, of injurious salts in various irrigation and drainage environments, and also irrigation methods in reference to reclamation. A determination of the most economical depth and spacing of drains in relation to the soil profile is an important feature of this work. Other intensive investigations include a study of the rate of moisture losses at different seasons of the year, and relation to the periodicity of irrigation. Fertilizer experiments, more particularly the nitrogen supply in relation to the regular growth of cover crops, and the resultant reactions to vine growth and fruiting studies, are being carried out.

Viticultural studies have now advanced to the extent that reports have been issued covering the reactions of common routine practices such as pruning and shoot removal on the productive capacity of the vine. The latter study has necessarily proceeded for several years, so as to include possible residual effects, such as alternate cropping, which may result from the method of pruning. Yield results have shown that, apart from losses due to extraneous agencies such as disease, hail or frost, it is possible to secure a fairly uniform annual crop on sultana and Zante currant vines. This is obtained by controlling fruiting to the extent that the vine is not overloaded in respect to the fruit that it can carry, and also in respect to the fruiting wood that it can develop satisfactorily.

The work on fruit processing is being continued, and the standard of the product in comparison with that of competitive countries on the overseas markets is being well maintained in respect to sultanas and lexias. The quality of the Zante currants is still unsatisfactory, as the industry is experiencing a cycle of unfavorable seasons, characterized by excessive January rainfall which damages the fruit.

The results of the investigations of the Station, particularly in irrigation and drainage problems, are largely utilized by the States in administrative and constructive work. A close co-operation with State officials, particularly those dealing with horticulture, irrigation, and drainage, has therefore been maintained in recent years. The general procedure, before commencing investigations in additional districts, is to constitute a committee, consisting of the representatives of the Council, the State Departments concerned, and district settlers, to define the problems and to initiate necessary investigations.

The Advisory Committee of the Station, which functions as a link between the work of the Station and the practical requirements of the producers whom the Station serves, has recently been extended to include all major settlements producing dried fruits in the States of New South Wales, Victoria, and South Australia. The Committee meets twice annually, and takes a very active interest in the work of the Station.

2. *Irrigation and Drainage.*—The present dominance of investigations of drainage problems at the Merbein Station is due to the extent of reclamation and drainage works constructed or projected in the various irrigation districts. The value of Agricultural drainage in maintaining and restoring soil productivity has long been recognized. The present problem is to define the drainage responses and requirements of the various soil types, and to design a drainage system suitable to the general environment of the irrigated lands requiring drainage. A close study of the soil type, and particularly the soil profiles is essential. In this connexion, the soil surveys carried out in the irrigation districts by the Division of Soils have been utilized very fully in planning drainage works and in selecting sites on which the investigation will have the widest possible application. The soil surveys have limited the geographical range of the investigations, as the drainage reactions obtained on a major soil type in one district are applicable to a similar soil type occurring elsewhere.

The investigations prior to the construction of a district drainage scheme, preferably include the following :—

(i) A soil survey.
(ii) An examination of the extent and cause of soil wastage.
(iii) A study of the responses of the major soil types to agricultural drainage, including the depth and spacing of drains.
(iv) A study of the possibilities of natural drainage in relatively deep-seated pervious subsoil horizons.
(v) A determination of the nature and the cost of constructional work to provide an outfall for drainage waters.

The planning of drains for the disposal of drainage waters is essentially an engineering problem and is undertaken by the irrigation authorities concerned. The design of the drainage system is, however, dependent on a knowledge of the soil responses to drainage, the areas requiring drainage, and the type of drainage which will most economically and efficiently serve the district concerned. The staff of the Station has been working in this field, and the information obtained is used by the constructive authorities in planning and carrying out drainage works.

Investigations dealing with internal drainage of individual blocks include intensive studies on drained and undrained soils, on a limited number of major soil types. The layout on the drained sites includes variations in the depth and spacing of drains, in conformity with the soil type, and with special regard to the soil profile. Laboratory determinations, for specification of soil characteristics, the measurement of salt translocation, and soil moisture, are considered in relation to the free water levels as affected by the drains. The rate of clearance of sub-soil water to the drains, in relation to the spacing and depth of the latter, the periodicity of irrigation, and the soil type is proving the most important basis for the study of the effects of drainage in general.

Mildura District (*Includes Mildura, Merbein, and Red Cliffs*).—The external drainage system is now complete. It consists of deep mains, through which drainage waters are discharged by gravitation to the Murray River or to natural depressions in the surrounding Mallee. The internal drainage waters of the individual holdings are discharged into these mains; the establishment of this internal drainage system is a matter for the individual landholders and will probably take them several years to complete. Investigations by the Station in this district are now practically limited to problems associated with the internal drainage of the principal soil types occurring in the district.

Woorinen District.—Investigation of the community drainage requirements of this district and the responses of the various soil types to agricultural drainage were completed, and an agreement reached in reference to the allocation of the cost between the Victorian Government and the settlers. The drainage plans are finalized, and the constructional work is being commenced. The soil type over large areas does not respond to agricultural drainage, and on such portion the system is limited to surface drainage.

Nyah District.—Investigation of the responses of the principal soil types to drainage was completed and a report submitted to the State Rivers and Water Supply Commission and the settlers. A drainage plan, with estimated costs, is being prepared for joint consideration of the drainage authorities and the settlers. The soils of the major portion of the Nyah area respond to agricultural drainage.

Renmark District.—Investigations carried out to date, considered in conjunction with the soil survey and the surface survey, indicated that it would be necessary in a large part of the settlement to pump the drainage waters for return to the Murray River. It is considered that the sands underlying the settlement are sufficiently pervious to provide drainage to a series of wells from which the water could be pumped out. No other solution appears feasible, and it is necessary to determine the range over which subsoil waters discharge to a well before an estimate of the cost of drainage can be made.

Berri District.—The soil types have been defined, and it has been found that the soils of the major portion of the settlement respond to agricultural drainage. Portion of the settlement has been drained. The question of a more comprehensive scheme is now being considered by the authorities concerned.

Barmera District.—Portion of this settlement has been served by a deep community drain traversing badly affected areas. In parts at least, the nature of the subsoil (limestone and sand) is such that natural drainage, over a considerable range to a deep main is quite possible. Effective drainage to the present main over distances up to 14 chains has been confirmed at one point by borings and water table records. Further investigations over wider areas are necessary before it is possible to define the system of drainage best suited to this district.

Waikerie (*South Australia*).—The shaft system, comprising discharge of the drainage waters by boring into a deep-seated limestone layer (80 feet to 100 feet), has now been extended to about 50 additional units. The subsoil is sufficiently pervious to provide natural drainage for distances ranging up to 6 chains to the central wells from which the water is discharged through a 4-in. mining bore to deep-seated pervious layers.

Coomealla District (*New South Wales*).—A community drainage scheme has been designed, and the constructional work is now in progress. The drainage plan is on similar lines to the Mildura system, the outfall waters being discharged by gravitation in deep mains, the internal drainage waters being collected by tile drains. The soils belong to the mallee group, and most of them have been defined for other districts. The responses of the principal soil types to drainage have been determined in the Mildura district, but observations are being continued on three sites in the Coomealla district.

Goodnight District (*New South Wales*).—The settlers in this district have applied for preliminary investigations to determine a suitable drainage system. The soil survey discloses that the soil types are again of the mallee group.

3. *Irrigation Methods.*—Further investigations of the results of irrigation have proceeded, principally in the direction of ascertaining the results of differential applications along an irrigation furrow and the percentage run-off in agricultural drains. It has been found that the excess water commonly applied is unduly high, as in practice over 50 per cent. in excess of the required amount of water is used on average holdings. In cases, the amount of run-off to agricultural drains on relatively large areas is 30 per cent. of the total amount applied. Apart from the special case of leaching out injurious salts, these excesses serve no useful purpose. The methods of application, by which a closer approach to the minimum efficient quantity of water can be obtained, have been worked out; as yet, however, there is little indication of the adoption of more economical methods on a community basis.

4. *Salt Investigations.*—The mapping of the re-distribution of injurious salts resultant on irrigation of mallee lands has been continued. The results of these studies show that the movements of injurious salts in the soil can be largely controlled and that the degree of soil fertility bears a close relation to the method of irrigation, the quantity of water applied, and to agricultural drainage. The general finding is that, where virgin soil does not contain excessive amounts of injurious salts within the root zone, productivity may be maintained or increased if agricultural drainage is carried out at the commencement of irrigation. Conversely, potentially salty land deteriorates with the advent of irrigation without agricultural drainage. Reclamation studies, on soils where the productivity has been lost by salting, have also been carried out. In permeable soils, heavy applications of irrigation water readily wash out the salts to agricultural drains in cases where drains are installed at spacings and depths consistent with the soil type. In heavy soils with a feeble response to agricultural drainage, reclamation is more difficult and may be uneconomical. In all cases of salted land, the first essential is a reduction in the level of free subsoil water. In cases where agricultural drainage is poor or uneconomical, the control of the application of irrigation waters, and the surface drainage of excess storm waters, are necessary for soil preservation and to aid reclamation.

5. *Viticultural Studies.*—The viticultural studies have mainly consisted of field experiments designed to produce a maximum yield without impairing the yield of the subsequent year. Various yield reactions to differential pruning have been determined and the results utilized in trials in which a designed relation of fruit production to the leaf surface has been secured by pruning and the removal of bunches and shoots.

The methods by which yield can be stabilized at a high level are rather involved. Determination of the producing capacity is necessary; and following this, it is possible, by leaving excess fruiting wood, to so regulate the leaffruit ratio that differences in annual yield can be considerably reduced while still maintaining the vineyard at its full carrying capacity. Owing to the increased leaf fruit ratio, the actual mean carrying capacity can be increased. The position is simplified by the fact that the removal of shoots and leaves has been shown to be detrimental, and that an excess crop adversely affects the yield in the subsequent year. Routine practices in the past have included the removal of shoots, whereas all investigations show that early removal of excess inflorescences is much more useful in maintaining and increasing yields. In effect, light pruning followed by disbunching is shown to be much more advantageous than control of yield by pruning alone. A fairly rigid control of yield is necessary, as otherwise a heavy crop in one year is frequently associated with poor quality and reduced yields subsequently.

Fertilizer experiments have been continued and the results of the applications measured by yield and by quality. Over a series of years, increases in yield have been mainly due to applications of nitrogenous fertilizer, though cases have been noted where the soil nitrogen obtained from heavy leguminous cover crops has been ample.

A close study of the dried fruit from the fertilizer trials clearly shows that the crop increases associated with applications of a nitrogenous fertilizer are also associated with reduced quality.

6. *Fruit Processing.*—The special investigations in fruit processing are being continued. Steady progress has been made in the stabilization and the study of reactions of the dipping solution. New avenues for investigations are apparent, chiefly in the direction of further studies of wetting substances, and of the resultant texture of the dried fruit. Further investigation of keeping qualities of dried fruit, as affected by changes in processing methods, is necessary.

An additional number of fumigants have been examined, in reference to their possible application to the control of dried fruit pests. Improvements in pest control now include general fumigation at the packing point with ethyl formate, and the utilization of toxic grease bands containing pyrethrum or organic thiocyanate to prevent the migration of larvae from unprocessed fruit. Pest control in dried fruits is now comparatively satisfactory. Improvements and preservation of the colour of sultanas has been shown possible by the absorption of comparatively small amounts of sulphur dioxide. This is conveniently applied by immersion in a 2 per cent. solution of the gas.

7. *Pasture Plots.*—The pasture plots at the Station have demonstrated no new principles, but have tended to show that good strains of perennial rye grass associated with white clover produce a cover of high carrying capacity. The pastures have now reached the stage at which on some plots the proportion of rye grass is decreasing, probably due to nitrogen shortage, with a corresponding increase in the growth of clover.

The advantages of irrigated pastures, as supplementary feeding for stock in districts of low and uncertain rainfall, are now more generally recognized, and irrigated pastures are now extending to additional districts.

8. *Financial Assistance.*—Contributions to the revenue of the Station are still on a high level. The principal annual contributors are the Australian Dried Fruits Control Board (£1,800), the Packers' Association of Mildura (£1,000), the Nyah-Woorinen Research Committee (£60), the Red Cliffs Branch of the A.D.F.A. (£50), and the Curlwaa and Coomealla Horticultural Advisory Committee (£50); the State Rivers and Water Supply Commission (Victoria) also supplies irrigation water to the Station.

B. Commonwealth Research Station (Murrumbidgee Irrigation Areas), Griffith, New South Wales.

The Griffith Research Station was established in 1924 in the horticultural district of the Murrumbidgee Irrigation Areas. The station has an area of 90 acres. Thirty-four acres have been planted with oranges, a few acres have been sown to irrigated pastures, and an area has been laid down for permanent irrigation investigations. Investigations are carried out on green manuring, fertilizers, bud selection, frost incidence and damage, the cool storage of oranges, irrigation methods, &c.

The New South Wales Water Conservation and Irrigation Commission contributes £1,500 per annum towards the working expenses of the station. Very helpful contact is also maintained with the Griffith Producers' Co-operative Co. Ltd., especially in the provision of special cool storage facilities for citrus preservation work.

1. *Soil Fertility.*—It is found that for the continued healthy growth of citrus trees, abundant applications of some suitable organic matter to the soil are necessary. For several years, this is most effectively carried out by the use of leguminous green crops, of which winter growing crops have been found to be the most suitable, as summer growing crops offer too much competition for soil moisture during the hot summer months.

The response to winter growing leguminous green crops is almost immediate from the first year. Several varieties of winter legumes have been tried over a period of some years, but for this district tick beans (*Vicia faba*) are the best.

Tick beans can be grown satisfactorily for about ten to twelve years and in some cases, even longer. After that period, however, the trees grow to a size which precludes the growth of satisfactory green crops, besides which the land may tend to become " bean sick ". Recourse must then be made to farmyard or sheep manure.

During the first six or seven years, the green manure and nitrification are sufficient to supply the nitrogen requirements of the trees; but after that, heavy dressings of artificial nitrogenous fertilizers must be made.

The stimulating effect of leguminous green manure or farmyard manure in this district is of great interest. It causes vigorous dark green vegetative growth, not only of trees but also of herbaceous plants, and this effect is obtained even on fallow land under conditions where applications of inorganic nitrogen are without effect. Interesting results are obtained in this connexion both with regard to field experiments and observations, and pot cultures. Lack of applications of suitable organic manure leads to an unhealthy condition of citrus trees. The roots become susceptible to fungal attacks which rapidly lead to the death of the tree.

The growth of tick beans leads to a rapid accumulation of nitrates near the surface in the summer but a depression of nitrates during the winter. However, over the whole root zone, it has been found that clean cultivated plots contain more nitrates than tick bean plots.

Following on the results of these green manure experiments, the use of tick beans for green manure is now a recognized practice amongst horticulturists, both on the Murrumbidgee Irrigation Areas and the Murray River Settlements, and so rapid has been the increase in the use of the beans that during the last few years seed supplies have been far from sufficient, despite increased seed production.

Citrus trees do not make any direct response in increased growth to superphosphate; the latter leads, however, to the growth of volunteer leguminous herbage which may act as a green manure crop, thus leading to an indirect response to superphosphate. Superphosphate will induce zinc deficiency (mottle leaf); it has also been used to modify the acid content and colour of the oranges.

2. *Irrigation Investigations.*—The amount of water used in irrigation often departs widely from the optimal range possible under practical conditions, with resultant injury to the plant, and, in the case of excess water, possible severe damage to the soil. Resultant reduced growth and yields are particularly serious where establishment costs are heavy, as in vineyards and orchards. The rational application of irrigation water, however, is a much more complex problem than appears at first sight. Controlling factors, such as soil, slope, and layout, vary greatly both between farms and within individual farms; irrigation practice must, therefore, be varied accordingly.

Fundamental studies of the furrow method of irrigation are being made. Important relationships have been established between the amount of water absorbed after any given time at any distance down the furrow, and the slope, head of water, and soil type. From the data obtained, it has been possible to indicate on the soil type concerned, the head of water to be used to apply a given irrigation norm, say three of four inches, under any condition of slope or length of run. Provided the correct head is selected, and under conditions of uniform flow from the ditch, the evenness of distribution is improved as the slope decreases and does not depend on the length of furrow. Two practical limitations, however, are the capacity of the furrow on smaller slopes, and the scouring which occurs above a critical velocity on steeper slopes. The limits set by these factors have been defined.

To permit the continuation of these investigations under standard conditions, permanent irrigation furrow sites have been laid out on grades varying from 0.1 per cent. to 2.2 per cent. Each grade is divided into strips seven feet wide bordered by strips of lucerne. The purpose of the lucerne is to dry out the soil again between irrigation tests. Permanent gauging tanks and distributing conduits permit the discharge of the desired flow of water into the head of the furrows within a one per cent. error.

With the co-operation of the Council's Division of Soils, preliminary results of the Division's soil survey of the Murrumbidgee Irrigation Areas are being utilized for determinations of the field permeability of various soil types. A comprehensive study is also being made of the various factors affecting soil permeability, a property which is of importance in drainage and soil erosion investigations as well as in irrigation. Soil texture is generally the chief factor involved, but in many of the soils in this district, soil structure is important. With some of the heavier types, it is the predominant factor. A detailed study is, therefore, being made of the morphology and structure of the various soil types. This has involved the comparison of methods for soil monoliths—a difficult procedure under local soil conditions—and certain quantitative measures of structure, including pore space determination of undisturbed soil blocks. Methods of aggregate analysis are also to be used. The structural morphology of the soils is also being studied by micro-physical and chemical methods.

Many citrus growers on the more permeable soils are paying attention to spray irrigation, and the systems being installed have been evolved largely at the Station from the work concerning the hydraulics of such irrigation.

3. *Alternate Cropping of Valencias.*—The investigation of the objectionable habit of Valencia oranges in bearing alternate light and heavy crops is being carried out in co-operation with the Division of Plant Industry. Not only does this biennial bearing lead to marketing difficulties, but the fruit of the light year crop tends to be over-large and coarse, while the fruit of the heavy year is often unduly small. It has been found that, by removing some of the fruit of the heavy year crop while still small, the crop of the following year is increased. It has also been found, however, that by removing some of the fruit early, has very little effect on the ultimate size obtained by the remaining fruit. Allowing fruit of the heavy crop to remain on very late (until February) slightly decreases the size of the fruit of the next crop and slightly decreases the number of fruit set at the next heavy crop. These are important findings in view of the custom of allowing some fruit to hang late to supply a good market in late summer. Carrying out the practice on the heavy crop year tends to reduce the unevenness of the crops and the excessive size of the fruit the following light crop year. The effect of the time of application of nitrogenous manures on the alternate bearing habit is also being studied.

4. *Cold Storage of Citrus Fruit.*—The citrus preservation work being carried out at Griffith, forms part of the extensive investigations conducted at different centres by the Council in co-operation with the State authorities. Besides mould wastage, storage spot—a cold store breakdown—sometimes enormously depreciates the value of oranges that are shipped overseas. Storage spot occurs more frequently in the early picked or immature fruit, and susceptibility to the trouble seems to vary from farm to farm and tree to tree. Factors conducive to its development and methods of control are being investigated.

5. *Soil Salt Studies.*—The movement of soil salt due to soil moisture relationship is being studied by means of specially constructed columns of soil in its undisturbed state. It has been found that, where a water table is maintained near the surface by means of supply of water from below, salts quickly accumulate at the surface, but that, where the water table is maintained by addition of water to the surface, the rise of salt is very slow.

6. *Soil Temperatures.*—Extensive and complete records of the soil temperature at varying depths from the surface down to eight feet are kept. The data are being compiled and tabulated for publication in a form that will permit an accurate picture to be obtained of the soil temperature under a variety of conditions. Such information is of value to investigators in many fields of soil and plant research.

7. *Pasture Plots.*—The pasture plots to form a local trial and demonstration of various mixtures of clovers and grasses and of fertilizer dressings have proved valuable in assisting the growing livestock industries of the areas.

VIII.—FOREST PRODUCTS INVESTIGATIONS.

1. *General.*—The year 1937–38 has been characterized by steady expansion in every branch of the Division's activities. This is shown by the fact that there is hardly a corner of the new building which is not now occupied and continuously in use.

The outstanding need of the Division is a considerable expansion of the Section of Utilization which is taking over, as fast as its staff can be increased, an increasing proportion of the essential liaison with the industry.

In the early years, each Section made its own contacts and maintained these until the rapidly increasing demands for advice or practical assistance absorbed too much of the valuable time needed for investigations. Certain of this work has been gradually transferred to the Utilization Section as far as possible ; but the extent to which this could be done has been limited by the need of more staff.

During the year, more than 1,700 separate inquiries have been dealt with by the various Sections, in personal contacts, apart from the numerous requests that reach the Division by mail. In addition, 230 visits to factories and mills have been made in every State of the Commonwealth. It is obvious that the four officers of the Utilization Section are unable to carry this load in addition to other duties, and other Sections have necessarily to assist in this work.

The Utilization Section has gradually built up a fund of information, collected by various members of the staff during visits to large numbers of mills and factories and by correspondence, on the various uses to which specific timbers are successfully applied, the timbers suitable for specific purposes, and the source of supply, quantities available, prices, and other information of value in regard to various species of local and imported timbers. In addition, it has accumulated information on innumerable problems of utilization from the records of the Division's work and from publications from all parts of the world. Amongst other things, the Section has carried on the work of the Sectional Committee on Timber of the Standards Association of Australia, and has given a good deal of time to the planning of laboratories erected for the Council.

A problem which has been facing the Division for some years has been the difficulty of keeping wet timber free from fungus attack while awaiting test. The time between receipt of a shipment of timber and the completion of tests on the wet material is often several months, and from time to time valuable material has been ruined in spite of every precaution having been taken, especially in such material as cannot be kept under water. This difficulty has been overcome by the erection of a cold store in the basement. This was made possible by the generous donation of a 7-ton freezing plant by the Postmaster-General's Department and by funds supplied by various donors for the general purposes of the Division, including £250 from the Queensland Forest Service. The plant has been working satisfactorily for some time.

In addition, a constant temperature and humidity room has been installed, particularly for work on paper testing. Another addition to the Division has been the erection and equipment of a laboratory for experimental pulping of wood and the necessary plant for the production of sheets for testing.

There is an increasing demand for lectures of a more or less popular type on different aspects of the work of the Division, and these are arranged whenever possible. During the year, nineteen such lectures were given to various interested bodies, and three wireless broadcasts were delivered. In addition, the following courses of lectures were given :—Seasoning course, one week in Melbourne—attendance, 53 ; seasoning course, one week in Sydney—attendance, 20 ; course on preservation to officers of State Electricity Commission of Victoria, three days—attendance, 15 ; course of three half-days to engineers of Melbourne and Metropolitan Tramways Board—attendance, 5 ; course of six lectures to architectural students of the University of Sydney ; course of ten lectures to technical school instructors in woodworking and senior students, Melbourne—average attendance, 50.

The lectures to architectural students were of particular interest. It has been felt that many difficulties experienced by architects will be greatly reduced by some proper training in their student years on the properties of timber. This is the first course to be held, and others are now being arranged. Thanks are due to Professors Wilkinson and Hook for their ready co-operation in arranging the course.

A feature of importance in the year's work is the increasing interest shown by officers of the Postmaster-General's Department, Railways Department, Electricity Commission, Harbour Boards, and similar large timber-using bodies in the preservation work of the Division.

Arrangements are made whenever field inspections of test plots are to be made to invite engineers from these co-operating bodies to attend. Commonly, from 20 to 30 engineers are present and spend two or three days in the field with officers of the Division. It is co-operation of this sort which has led to great improvement in practice within the last few years. Only five or six years ago, creosote consumption was about 50,000 gallons per year. It is now about ten times this and rapidly growing.

Standards work has progressed favorably, the main feature being the increased readiness of interested parties to get together and smooth out differences by compromise. At a special conference held in Sydney between delegates from Queensland, New South Wales, and Victoria, many of the difficulties which existed were discussed and a programme of work to overcome them laid down. This programme is being implemented and is showing results already.

It is useless spending time and effort in drawing up standard specifications which are not applied in practice, either because they are not so drawn as to prove agreeable to producer or consumer, or because there is no real understanding of the value of such standards. A great deal of work has been done by individual visits to large timber users, such as Government and semi-Government Departments and architects, and there is a marked improvement in this direction. This work is carried out under the auspices of, and with the co-operation of, the Standards Association of Australia.

Another feature of interest is the growth of the Timber Development Association. During the year, a very live branch was established in New South Wales, and in its very early months it has done a great deal of valuable work. The Division continues to give all the assistance it can to both the existing branches of the Association, and among other assistance it provides a good deal of matter for the two journals.

Contact with States.—All States were visited during the year by officers of the Division, and contacts thus maintained with the local forest services as well as timber associations and individual producers or users of timber.

The New South Wales Forestry Commission established its recently created Division of Wood Technology in well equipped laboratories and show rooms. The Division welcomes this move and feels sure of still more effective co-operation than was possible beforehand. The State body will call upon the Division where it has special experience or where further experimental work is required.

The Utilization Branches in Western Australia and Queensland also help in the same way and the visit of Mr. Gregson, Utilization Officer of the Western Australian Forests Department, who spent some weeks in the Division, was much appreciated.

Flax Investigations.—During the year, at the request of a company which is developing the flax fibre industry, it was decided to undertake work into methods of retting. The Division was asked to undertake this work, and a specially equipped laboratory was set up. The company provided £500 towards the cost and two chemists and an assistant were employed.

Much of the time available in the year was taken up in equipping the laboratory and in a study of available literature. Sufficient experimental work was done, however, to enable advice to be given on the first commercial tank retting to be carried out in Australia, and it is gratifying that the results have proved to be sufficiently satisfactory for the company to project an immediate increase in the quantity of flax straw so treated. Hitherto dew retting has been the only method used in Australia and this has given very irregular and, in many cases, unsatisfactory results.

An extensive programme has been laid down for the coming year which should yield results of great value and assist in the development of this most important industry. It has already been shown that fine quality straw can be grown, and what remains to be done is to ensure uniform retting to a good quality flax.

Grants.—It is desired to thank those bodies who have assisted in the Division's work with grants of money and material. The following money grants were received :—

	£
Flax Fibres Ltd.	500
Australian Paper Manufacturers Ltd.	500
Associated Pulp and Paper Mills Ltd.	500
Australian Newsprint Mills Pty. Ltd.	500
Victorian Railways	25
State Electricity Commission of Victoria	100
Messrs. Hardys Ltd.	20
Messrs. Gunnersen Nosworthy Pty. Ltd.	21
Brisbane Timber Merchants' Association	25
Queensland Timber Export Association	25
Queensland Forest Service	250
Annual Grants from four Forest Services and Commonwealth Forestry Bureau	125

In addition, numerous firms, associations, and Forestry Departments of various States and the Commonwealth Forestry Bureau have supplied a large amount of valuable material for test, and it is gratifying to record a constantly increasing readiness on the part of these people and bodies to co-operate in a very practical way in the work of the Division.

2. *Utilization.*—Utilization studies were advanced by personal visits of officers to Queensland, New South Wales, and South Australia, through visitors from other States, by correspondence, and by personal service in Victoria. The calls for service increased markedly, over 630 enquiries of a varied nature being dealt with.

(i) *Trade Contacts.*—Visits were paid to saw-millers, timber merchants and secondary industries using wood for a wide variety of purposes. Enquiries received concerned timbers suitable for between 70 and 80 different uses such as agricultural implements, battery separators, blind rollers, boats, bobbins, vats, and veneers.

The converse problem was met of suggesting uses for certain species, and describing their technical properties, 29 different timbers native to Australian States being dealt with. Contact was established with firms interested in New Guinea timbers, and preliminary information on the characteristics and probable uses of the principal species was published.

(ii) *Utilization Index.*—The index of utilization data was systematically expanded, and it was frequently used for the benefit of inquirers wishing to find suppliers of various timbers, possible users of certain woods or manufacturers of specific products.

(iii) *Case-making Timbers.*—The Section co-operated with the Forests Commission of Victoria in testing mountain ash for butter boxes in the local trade and in preparing a specification that could be used in assembling a shipment for trial under export conditions. Minor investigations were made into the incidence of moulds on kauri boxes. Assistance was also rendered in trade trials or testing of orange, grape, and pineapple cases constructed from the lighter Australian hardwoods or plantation grown softwoods. Among the objects of these trials was an investigation of the suitability of thinnings and immature trees for case-making.

(iv) *Fibre Boards.*—Public interest in these products was maintained, and technical and economic phases of manufacture were dealt with. Various inquirers requested advice on the possibility of using sawdust and shavings, wheat straw, and wood for board manufacture. Information on the production of wood wool was given to an enquirer using this product in the manufacture of a mineralized fireproof wall board. Data were recorded concerning the uses, prices, and distributors of fibre boards on the Australian market. A major industrial development took place early in the year when a large public company was formed and proceeded with its plans for establishment of a factory in Australia.

(v) *Grading Studies.*—The secretarial work for the Timber Sectional Committee of the Standards Association of Australia was continued. A meeting of the Committee and a conference of State Sub-committee Secretaries were held in Sydney, plans for publicising standards work and for encouraging the adoption of grading rules already issued being discussed, and a programme for the preparation of further specifications being laid down. The Association this year issued Technical Standard No. O.1—" Australian Standard Terms and Definitions used in Timber Grading Rules ", and circulated the proof of Technical Standard No. O.51—" Australian Standard Specification for Doors " for public critical review. Progress was made in the revision of Technical Standard No. O.2—" Trade Nomenclature of Timbers " and No. O.6—" Australian Standard Specification for Plywood ".

The policy of bringing timber standardization directly to the notice of practical graders made an important advance during the year when the Senior Timber Inspector of the New South Wales Railways Department spent six weeks with the Division discussing the preparation and application of standard specifications.

A pamphlet on " Grading Studies in Ash Eucalypts " based on previous work carried out in New South Wales, Tasmania, and Victoria was published and distributed. A trade circular, " The Selection of Timber—Part 1., Grading of Timber " was issued, the manuscript of " Part 2 : Structural Timber " was prepared and finally revised, and the first draft of another circular on " Timber Terms " was completed.

A field study was made of the characteristic quality of plantation grown *Pinus radiata*, particularly as regards the size of knots, the frequency of occurrence of their various sizes, and the percentage of clear cuttings of various lengths. Corresponding investigations were made on imported baltic timbers. Data gathered last year in New South Wales on the grading of structural timbers were analyzed, and three reports were issued. In addition, specifications were submitted on poles and building scantling. Arrangements were made with the mill-study staff of the New South Wales Forestry Commission to record mill tallies in certain quality groups so that the influence of grading rules on mill outputs could be judged. An investigation was

carried out in Brisbane and Maryborough timber yards, Queensland, to gauge the merits of certain amendments proposed to the draft standard grading rules for milled hardwood floorings. The results of the study led to the adoption of a standard acceptable to both New South Wales and Queensland and amply demonstrated the need for such studies to hasten decisions in Committee.

(vi) *Timber in Building Construction.*—An officer of this Section acted on the Standards Committee of the Building Industry Congress and contributed to the preparation of the carpentry and joinery sections of a model specification for brick residences.

(vii) *Problems in Manufacturing Industries.*—Visits were paid to industrial plants using timber for many purposes and in some instances specific problems were studied. In window blind manufacture, assistance was given in the selection and preparation of a suitable timber, causes of rejection were diagnosed and avenues of use explored for rejected stock. A suitable coating for textile bobbins used under warm humid conditions was procured for a manufacturer. Advice was tendered for overcoming the " dryness " of wooden ice cream spoons. Methods of avoiding faults in corestock, laminated panels, and flush doors, were suggested. Match manufacturers were aided in their problems. Equipment for pulp and paper manufacture and economic factors relating to the successful operation of a proposed industry were discussed at length with interested parties. Requirements for the manufacture of wood wool and wood flour were indicated. A costing system was drawn up for a manufacturer of veneers and plywood.

(viii) *Design of Plants.*—Plans for a new saw-mill were discussed with saw-mill engineers, data on the cost and performance of modern equipment for converting small diameter logs were submitted, and the performance of equipment of various types compared. In response to inquiries, machinery suitable for log loading, log turning, log sawing or slicing, end-matching of flooring, and manufacture of overlay flooring was indicated. Sketches of sawdust incinerators were distributed, and the design of various refuse-burning furnaces was discussed with a firm intending to generate steam and power for industrial purposes.

(ix) *Electrical Moisture Meters.*—The publication of the technical description of a new capacity-type moisture meter aroused considerable interest in the timber trade and also in industries concerned in the measurement of moisture content of substances other than timber. Numerous demonstrations of the instrument were given. Negotiations opened by the Timber Physics Section for the construction of a commercial instrument were carried forward by the Utilization Section and co-operation maintained with a manufacturer in the design and testing of a commercial model. After various trials it was decided to concentrate on the production of an instrument which would function simply as an alarm and which could be set to indicate boards above or below a chosen moisture content. This instrument is now practically ready for public sale.

Another capacity-type instrument was built for use in testing boards of *Pinus radiata* intended for corestock manufacture, and some progress was made in calibrating it.

A modification to the " blinker " type instrument was designed to enable the special batteries formerly used, to be replaced by a unit including standard cells of longer service life. Arrangements were made for the replacement unit to be manufactured commercially.

Interest beyond the timber trade was made evident by inquiries received concerning the practicability of designing instruments to measure the moisture content of casein, cheese, honey, living plants, sawdust, seeds, soils, and wood wool.

3. *Wood Chemistry and Pulp and Paper Investigations.*—The Section of Wood Chemistry has devoted most of its time to problems related to the fundamentals of paper-making which are being investigated with the assistance and co-operation of the industry. Three companies, viz., Australian Paper Manufacturers Ltd., Associated Pulp and Paper Mills Ltd., and Australian Newsprint Mills Ltd., are now contributing towards the cost of this co-operative work. In view of their varied interests, it has become necessary to compromise on the programme of work in order to concentrate on problems in which all three companies have a common interest. Accordingly, the work of the Section and list of projects have been re-organized, and the new programme has received the general approval of the companies concerned. It consists essentially of problems which are concerned with the chemical composition and physical properties of woods and pulps in relation to their paper-making properties.

These studies naturally require standard methods of analysis for woods and pulps and, in view of this, a considerable amount of time has been devoted to analytical procedure and particularly to the causes or irregularities, the degree of replication, and the significance of

results. The causes of irregular results in the determination of Cross and Bevan cellulose have been investigated, and adjustments to the method in order to eliminate these have been made. Of fundamental importance to all wood and pulp analysis is the method of preparation of a sample for analysis. While it is agreed that no particle size fraction should be eliminated from a milled sample, it is also essential that extremes in particle size should be avoided and that the method of disintegration should not, in any way, cause chemical degradation. At the present time, in the Division's laboratory, wood samples are milled until all of the sample will pass a 100-mesh sieve. This procedure is accompanied by a certain amount of heat development, and the possibility of degradation by this heat has been investigated. To date, there has been no significant difference between the analysis data of woods which have been milled in the usual manner and of woods which have been milled while cooled with carbon dioxide. The 100-mesh sample, as prepared, contains a large percentage of material which will pass a 240-mesh sieve. This extremely fine material is undesirable for many reasons, and efforts to avoid its formation are being made. It is hoped that, by using a mill with a cutting action, the resulting product will be more uniform in size and relatively free from extremely fine material. This investigation is proceeding.

The determination of pentosans (mainly xylan) is of vital importance for correlating chemical composition of pulps with their strength properties. Since furfural is the intermediate product involved in this determination, a reliable method for its estimation is desirable. The investigation of the use of thio-barbituric acid as the precipitant for furfural has been proceeding and is, in fact, nearing completion. The objection to the use of this reagent, put forward by Campbell and Smith, has been discounted, and a satisfactory explanation of the peptization effect reported in the case of softwoods has been obtained. The reagent gives recoveries of furfural of the order of 103 per cent. of the theoretical recovery and the cause of this, as well as means for correcting it, have been investigated.

Consideration has been given to the effect on the composition of wood of hot extractions with dilute sodium hydroxide and sodium sulphite solutions. Some reagent for removing substances which interfere in the lignin determination of eucalypt wood is desirable. At the same time it should have little or no effect on the major constituents. This is the problem confronting the Section at the present time. The studies using the above mentioned reagents are only preliminary to a survey of reagents which might serve the purpose.

Pulp and paper investigations have been continued with the co-operation of the Australian Paper Manufacturers Ltd., but the installation of pulping, sheet-making, and testing equipment at the Division's laboratories will facilitate future work as well as remove a burden from the staff of the company. The study of three trees of *E. sieberiana* has been completed and reported, and the results are to be published shortly. This investigation served to indicate the problems which lie ahead and revealed some interesting relationships which might well be investigated further. One of these, concerning a relationship between water soluble content of wood and lignin content of the resulting pulp has been investigated further using other species of eucalypts. It seems that the relationship may have wide application. One tree of *E. regnans* has been studied but the results have not been reported, pending revision of some testing methods. Further pulping studies will be undertaken as soon as the new equipment is available.

The Section has handled more than the usual number of general inquiries relating to wood chemistry and chemical treatment of wood. A large percentage of the inquiries were concerned with bleaching, a problem which is becoming more important every year.

Preliminary experiments on the isolation of the total carbohydrate fraction from eucalypt woods have been carried out. The method of Ritter and Van Beckum has been applied to eucalypt woods, but difficulty has been experienced in determining the delignification end point. Furthermore, losses of pentosans have been experienced and modification of the method may be necessary.

4. *Timber Seasoning.*—Two interstate visits, each of approximately two months' duration were made to fix a definite basis for co-operation with officers doing similar work in the Queensland Sub-Department of Forestry, and in the New South Wales Division of Wood Technology. A visit was also made to Tasmania.

The trend towards increase and improvement of kiln drying practice is still noticeable, the actual increase being somewhat greater than is indicated in the table below. This shows the net change in number of kilns for the year, but in several cases more or less obsolete kilns were converted to, or replaced by, more efficient ones. Apart from those issued for general information only, plans were issued to 49 contacts.

RECORD OF KILNS AT 30TH JUNE, 1938.*

State.	Number of Plants at which Kilns are operating.		Number of Kilns operating.	
	At 30th June, 1938.	Increase since 30th June, 1937.	At 30th June, 1938.	Increase since 30th June, 1937.
Victoria	40	4	160	17
New South Wales	43	9	112	12
Queensland	28	3	96	10
Tasmania	19	3	57	8
South Australia	7	..	36	4
Western Australia	8	..	18	..
Total	145	19	479	51

* Including veneer driers and re-drying rooms.

In addition to special tests with four miscellaneous species, regular work towards the development of kiln-drying schedules was done with the following species : *Eucalyptus rostrata* (red gum), supplementary work with timber from other localities—two reports issued ; *Eucalyptus pilularis* (blackbutt)—two reports issued ; *Eucalyptus redunca* var. *elata* (Wandoo) ; *Eugenia gustavioides* (grey satin ash) ; *Xanthostemon* spp. (brown penda) ; *Eucalyptus jacksonii* (tingle) ; and *Eucalyptus maculata* (spotted gum), immature trees—four reports issued.

An investigation of the application of chemical seasoning to thick stock was commenced with three species. Similar work done previously with windmill bearings made of *Eucalyptus tereticornis* has led to the installation of a commercial plant in Sydney for the treatment of such stock. The project is rapidly becoming one of major importance. The seasoning of veneer was investigated in several commercial plants and a big field of work has opened up in this regard, also. A new design of kiln was built and studied in operation and shows considerable promise. Further work is necessary in comparing its efficiency with existing designs. Thirty enrolments in the correspondence courses were received during the year, bringing the total to date to 216.

5. *Timber Mechanics.*—The volume of testing was maintained throughout the year, approximately 7,000 individual tests (excluding moisture content determinations) having been made.

The formation of the Divisional Computing Section has enabled the computation to be kept up to date, but the detailed analyses of the results are still considerably behind the testing work. The policy has been adopted of publishing the species averages as soon as they are obtained, leaving the detailed analysis to be published at a later date. In this way, the principal results of the tests are made available to the industry as soon as possible.

Standard Mechanical Tests.—Because of pressure of other work, routine testing under this project had to be curtailed, but it is hoped that the volume of testing will be increased during the coming year. The results of the tests on *P. radiata* have been prepared for publication, and a Pamphlet dealing with the mechanical properties of this species has gone to the printer. Routine tests were carried out on hoop pine ; the results will be published shortly. Logs from eighteen trees of jarrah (*E. marginata*) were received and have been cut up into test specimens, half of which have been stacked for drying. The remainder are being kept green until testing can commence.

Steam Bending.—A considerable amount of work on steam bending was carried out during the year. A reconnaissance of the bending properties of Australian timbers is being made and material from a number of species has been obtained, principally from the State Forest Services. To permit tests to be carried out on a limited quantity of material, hand bending equipment has been developed. This permits of the use of specimens as small as 1 inch x $\frac{1}{2}$ inch x 21 inch long. Two forms, one 3-in. radius and one 6-in. radius, are being used, together with suitable straps, which permit of the adjustment of end pressure as bending proceeds (an important point in most species). The bend is prevented from leaving the form by a radial arm fitted with a roller. The severity of the bend can be altered by varying the thickness of the piece being bent.

Preliminary hand bending tests have been made on 44 species, and the most promising have been noted and will be thoroughly investigated at a later date. More extensive tests have been made on blackbutt which appears to be a poor bending timber ; brown mallet which bends excellently provided that proper precautions are taken ; silver wattle and silky oak both of which bend very well, Cairns hickory which gave very poor results because of irregularities of grain, Queensland maple which gave fair results, grey satin-ash which was unsatisfactory, and blush cudgerie which gave promising results but requires care because of its softness.

Comprehensive tests were made on karri (*E. diversicolor*), but the results have not been analysed. Work was also done on several miscellaneous problems such as the bending of walking sticks and the manufacture of snowshoe frames.

Tests on Split-ring Connectors.—The testing of split-ring connectors when used with Australian timbers was continued, and tests on green specimens of karri, jarrah, and Victorian "hardwood" (obliqua and stringybark) have been completed.

A study is being made of the effectiveness of various treatments for protecting the connectors against corrosion caused by wood acids and moisture. Each treatment is being applied to twelve $2\frac{1}{2}$-in diameter split-rings which, with untreated controls, will be assembled into specimens using green karri as the timber. Karri has been chosen for the tests as it is known to be one of the most corrosive of Australian timbers.

Tests on Coach Screws.—In co-operation with the Standards Association of Australia, systematic tests on the relative efficiency of three types of coach screw are being made. Tests have been completed on screws driven into green Victorian "hardwood" (obliqua and stringybark) and pulled immediately, both the force required to withdraw the screws and the torque required to drive them being measured.

The Sagging of Timber Beams.—Experimental work on the increase in deflection of timber beams under long-continued loads has been commenced. The first experiments were made with 4 inch x 2 inch green mountain ash joists, with spans varying from 6 feet to 20 feet, the loads being applied at the quarter points by cast iron weights. It was found that the majority of the beams failed by lateral buckling. Attempts were made to overcome this by constructing a roller bearing carriage clamped to the specimen at mid-span and sliding freely in a rigid angle-iron frame. This apparatus effectively prevented lateral buckling at mid-span, but the majority of the beams finally failed by lateral buckling between the ends and the centre support. The cause of the buckling was undoubtedly the very large increase in deflection which took place under long-continued load.

The amount of sagging obtained was much greater than anticipated, after a few weeks being three to four times the initial deflection. However, this series of tests was abandoned because of lateral buckling, and a second series of tests started. The specimens in the second series are $3\frac{1}{4}$ in. square and have no tendency to buckle laterally. The tests on green specimens, out of doors, have been set up, but the indoor tests have not yet been commenced. Tests will also eventually be made on dry material. It is too early to say how far the beams in the second series will eventually sag, but it has been noticed that the degree of sag appears to depend among other things on (*a*) the stress in the extreme fibres, and (*b*) the modulus of elasticity under short time loading.

Since the sagging of timber beams under load is one of the most serious objections to timber as a structural material, a considerable amount of work on this problem is justified.

Relation Between Silviculture and Properties—Alpine Ash (*E. gigantea*).—In conjunction with the Commonwealth Forestry Bureau, a series of tests on the relation between rate of growth and mechanical properties of alpine ash has been made. Three hundred specimens from 100 trees in the Australian Capital Territory, selected by the Bureau, were tested. In addition to the rate of growth, the ring age and distance from the pith of each specimen were recorded. The necessary computations have not yet been made.

Queensland Species.—In co-operation with the Queensland Forest Service, a scheme for comprehensive tests on the properties of the wood of young trees subject to silvicultural treatment has been drawn up. The objects of the investigation are :—(i) to determine the effect of rapid rate of growth induced by silvicultural treatment on the properties of the wood, (ii) to determine the properties of thinnings of merchantable size, and (iii) to investigate the variation with time in the properties of wood laid down in the early life of the tree. The following species will be studied :—*Araucaria cunninghamii, Pinus caribaea, Pinus taeda, Euc. maculata, Euc. paniculata, Euc. pilularis, Callitris glauca.* Representative samples will be taken at every thinning until the stands reach maturity, thus enabling the variation in properties with time to be examined.

General.—The need for readily accessible information on the load-carrying capacity of timber beams and columns has been felt for many years. Engineers and architects are considerably assisted in the design of steel and concrete structures by the valuable information given in handbooks issued by the producers of such materials, and it has been felt that timber design has been unduly handicapped by the lack of such information. The stage has now been reached when tables of load-carrying capacity can be prepared. The principal structural species used in this country have been divided into four groups, the timbers in each group being of approximately the same strength. Each group has been divided into two grades :—(i) select grade in which the permissible defects are such that no piece will have a strength less than 75 per cent. of clear timber, and (ii) standard grade, in which no piece will have a strength less than 60 per cent. of that of clear timber. The necessary computations are almost completed.

Finally, short series of tests were made on the construction of boxes, the strength of flush doors, the cause of brittleness in hickory insulators, the strength of bridge decking, and the impact cleavage strength of hoop pine and karri.

6. *Wood Structure.*—One important feature of the year has been the development of the co-operative scheme between this Section, the Forest Services of New South Wales, Queensland, Victoria, and Western Australia, and the Commonwealth Forestry Bureau, whereby, in return for a yearly subsidy, there will be supplied to each co-operating body (*a*) mounted cross, tangential, and radial sections of all timbers cut and examined, (*b*) copies of photomicrographs of Australian timbers, (*c*) services relating to the card sorting scheme of identification, and (*d*) copies of reports and general information on matters of wood anatomy. In the furtherance of this project, there have been despatched to each co-operating body 113 slides of Australian timbers, 148 photomicrographs, 213 species identification cards duly typed, notched, and ready for use in the card sorting scheme of identification, and a report on the method of using the identification scheme. This project will be continued over a period of years.

Wood Anatomy.—The work of the detailed investigation of Australian timbers according to family groupings has been continued. The results of the investigation of the Australian *Rutaceae* have been published as Bulletin 114, and the results of the examination of the Australian Cunoniaceae will be issued as Bulletin 119. Australian timbers of the Meliaceae and *Lauraceae* have also been investigated fully, and a paper on the Meliaceae will be ready for publication within a short time. In the case of each of these studies, it was shown that a knowledge of the wood anatomy was of considerable assistance in obtaining a better picture of the classification within the family.

Considerable attention has been paid to the various species of the genus *Eucalyptus*. It was considered that the examination of more recently acquired material and the re-examination of older material might assist methods of identification and also afford some check on the botanical grouping of the species. For this purpose, slides have been prepared from some 400 samples of 70 species. In the preparation of these slides the method of softening the harder blocks by treatment under pressure was investigated, and it was found that a pressure of 50 lb./square inch in 90 per cent. alcohol for 0 to 15 minutes softened the hardest timbers satisfactorily. The time was varied according to the hardness of the sample, and only the ironbarks required the maximum period.

Basic Density.—All basic density results for Australian species have been assembled together with air-dry density results for the same species, for a comprehensive publication on the density of Australian timbers. This work is being carried out in co-operation with the Section of Timber Physics.

Causes of Brittleness.—The investigation of the relation of minute compression failures and broken fibres to "brittle heart" and brittleness in general was continued with samples of *E. marginata* and *E. regnans*. The extent of "brittle heart" as revealed by the broken fibre test was found to be relatively small in the samples of *E. marginata* examined. One large butt log of *E. regnans* was examined in detail for the presence of minute compression failures; this log showed no "brittle heart" but contained many small areas both near the pith and out towards the sap from which broken fibres were isolated. The indication was that very localized minute compression failures were present, a finding which agreed with the variations in toughness which were observed. Another interesting result was the discovery of minute compression failures and broken fibres in numerous sapwood samples of hickory which were apparently normal in all other respects. These specimens were decidedly brittle and of low toughness for the species, and no explanation for the presence of the minute failures could be advanced. In a comparison between fast grown and suppressed samples of *E. regnans* of the same age and from the one locality, it was found that broken fibres were few to absent in the suppressed samples, but definitely present near the pith and of somewhat irregular occurrence out to the sapwood in the case of the faster grown samples.

Compression Wood and Tension Wood.—In the examination of hoop pine logs with eccentric pith and a wide area of pronounced compression wood, it was found that the wood from the narrow tension side was very brittle and full of macroscopic and microscopic compression failures. In another experiment with an eccentric log of *Acacia dealbata* which showed distinct "tension wood", it was found that in this wide "tension wood area" there were numerous minute compression failures. Just what the connexion between these observations may be has not been determined. Experimental work on the presence of gelatinous fibres (tension wood fibres) in Australian timbers and on the properties of tension wood is being carried out by Miss Gretna Parkin, a research student in the Botany Department of the University of Melbourne.

Identification.—A total of 470 samples were received for identification during the year. This number may be compared with 300 for 1936–37, 230 for 1935–36, and 224 for 1934–35.

General.—The Section continues to control the photographic work of the Division. Arrangements have been made whereby photographic work is carried out for other activities of the Council. The photographic copying of published articles using the miniature camera has been further standardized and a routine procedure adopted; the latter is simple and rapid

and the clear reproduction of journal articles up to whole plate size is easily accomplished. During the year 4,513 prints, 6,118 enlargements, 299 lantern slides, 2,049 Leica copy negatives, 346 plates, and 60 roll films were prepared.

7. *Preservation.—Field Investigations.*—The results being obtained from the various pole-testing sites are already proving of material value, and they have had a considerable bearing on the practices adopted by some of the larger pole-using authorities.

In South Australia the *Pinus radiata* poles have created very favorable comment, their general appearance in the line being excellent. All the creosote-impregnated poles are sound, while more than half of the untreated control poles have been destroyed by decay or termites in about two years. Successful results from this test will be of definite advantage in the utilization of *P. radiata* in South Australia.

In Victoria, inspections of the test poles at Belgrave and Benalla indicated little change from the previous year. The creosote oil impregnated poles are still in good condition. Poles previously de-sapped and seasoned and then treated by the oxy-acetylene process are also in good condition, while all other treatments show a greater or lesser degree of attack by decay or termites. The value of brush treatment with creosote oil and puddling, particularly in the case of poles set green, has been demonstrated.

At Ballarat (Victoria), after only one year's service, there has been a slight breakdown in round unsapped poles impregnated with Ascu and zinc chloride plus arsenic solution. This breakdown is only of the nature of a slight softening and may be a treatment effect. The untreated controls have all been affected by decay and indicate the satisfactory nature of the test site.

A first inspection of the test poles at Wyong and Clarencetown, New South Wales, also revealed decay or termite attack in the untreated poles. At these sites, the only treated poles not sound are those which were treated with zinc chloride and arsenic, a number of these showing definite evidence of slight decay.

A detailed inspection which was made of the 2,250 fluarized karri sleepers in Western Australia showed than an average of about 15 per cent. have been destroyed by decay or by decay and termites after about $7\frac{1}{2}$ years' service. Splitting and checking of the treated karri sleepers appears to be a large factor in their deterioration, the splits and checks extending through the treated area. It is possible that the average life of fluarized karri sleepers in the test sections will be about 11 years as compared with 6 years for untreated karri.

In South Australia a number of untreated *P. radiata* sleepers have been renewed because of decay or termite attack after less than two years' service. All treated sleepers are sound. Generally, the mechanical condition of the sleepers is excellent.

The possible utilization of some at least of the less durable Victorian timbers as sleepers is considered to be of coming importance, and at the request of, and in co-operation with, the Victorian Railways Department and the Victorian Forests Commission, preliminary investigations have been made. A large scale test involving over 4,000 sleepers has now been planned in order to determine the natural durability of eight of the less durable species, the value of creosote spray treatment of both sleepers and road bed, and the value of maintenance re-treatments.

With the exception of the test lines in Western Australia, which have been in service for about seven years, all the treated fence posts in the various test lines are sound, untreated controls only being affected. In Western Australia, the 70 creosote plus 30 crude oil treated posts are in the best condition, although slight decay has commenced in a small percentage of these. White arsenic, alone or in conjunction with sodium fluoride and zinc chloride, has been very effective in preventing termite attack. All the water-soluble preservatives are commencing to fail due possibly to leaching, the greatest percentage of decay being in the highest rainfall site.

Treatability of Timbers.—Tests of a modified incising method, consisting of saw cuts across the grain of the wood, gave a marked increase in the absorption and penetration of creosote oil in both *E. australiana* and *E. viminalis*. The method appears, however, to be of restricted value.

A preliminary investigation of the pressure treatment of round poles of *E. paniculata*, *E. microcorys*, and *E. punctata* was made, and it was found that complete sapwood penetration and absorption to refusal was obtained using very mild treating schedules and at a treating temperature of 90°F. With water solutions complete sapwood penetration can be obtained using solutions at room temperature and pressure application only. For various reasons, the use of pressure treatments in Australia appears at the present to be very restricted.

On behalf of a State Government Department, an investigation was made to determine the possibility of butt treating poles by the use of a hot and cold spray treatment. For comparison, treatments were made at the same time using the standard hot and cold bath (open tank) process. In all cases the latter process gave much better results. Incomplete penetration of the sapwood

was obtained with the spray process, although the penetration was fairly even to a depth of about half an inch. The absorption per cubic foot of sapwood penetrated was markedly lower than that obtained by the hot or cold bath process and the work generally indicated that the process, so far as poles were concerned, was not effective or commercially practicable.

Some preliminary tests were made to determine the possibility of treating Douglas fir mining timbers, in large sections, with zinc chloride solution by the hot and cold bath process. The penetrations and absorptions obtained were too small to afford any marked protection to the timber. Similar treatment of reject blind rollers of hoop pine gave very satisfactory results and indicated the possibility of utilizing some sizes for garden stakes.

Preservation Processes.—The oxy-acetylene charring process for the treatment of new poles is fairly extensively used by a number of pole using authorities. The general practice in Australia is to instal poles in the green condition. When first introduced, the treatment was often applied to green poles and checking subsequently occurred. The desirability of preliminary seasoning is obvious, and about two years ago, tests were made on poles, the sapwood of which had been seasoned to a moisture content of about 17 to 20 per cent. The final results indicated that in storage very little new checking or extension of existing checks occurred, provided that the sapwood moisture content was below 20 per cent. at the time of treatment. Considerably less change occurred in similar poles placed in service, some being unaffected. The results apply only to the species tested which were representative of the Class I. durability hardwood poles.

Preservatives.—Tests of a large number of preservatives impregnated into *P. radiata* and *E. regnans* truewood and *E. regnans* sapling billets are still in progress, although definite results will not be available on some of these for a few years. To date, creosote oil and creosote plus oil are markedly superior to all other preservatives which have been tested.

Field tests of timber samples impregnated with the oil of *Eremophila mitchelli* indicated that the quantity of oil impregnated into the samples did not materially increase the durability of the specimens to decay. The test against termites, although less satisfactory because of the method of testing used, indicated that little or no termite resistance will be obtained from the use of the oil.

After a period of about one year, it has been found that a brownish resin-like deposit forms on the surface of open-tank or pressure-creosoted poles. This brownish deposit, in the case of poles for city streets, appears to be objectionable, and investigations have been commenced into its cause. A chemical examination indicated that the deposit consisted of about 50 per cent. dust and 50 per cent. changed creosote oil. Comparative analyses have been made of Australian vertical, horizontal, and coke-oven creosotes, and supplies of European and American creosote obtained for comparison. Further field and laboratory tests are planned. It has also been noted that sapwood impregnated with vertical retort creosote becomes brittle with age, the cause of the brittleness apparently being chemical in nature, possibly a lignin-tar acid reaction as the tar acid content of the oils used is about 15 to 20 per cent.

Timber Pathology.—Further work on the problem of " heart " in *E. regnans* using mainly material freshly collected from young trees showed a fairly constant association of " heart " with a non-basidiomycete fungus which has been identified as *Gonytrichum caesium.* The actual significance of the presence of this fungus is not known and further investigations are proposed. Considerable work has also been done on the rots of jarrah.

Lyctus Investigations.—Further experiments have shown that sodium fluosilicate in relatively low concentrations in susceptible sapwood effectively prevents Lyctus attack. Unfortunately, however, the use of sodium fluosilicate, especially in the veneer and plywood industry, is attended with a serious industrial hazard, due to the toxicity and cumulative effect of small doses of fluosilicates or fluorides from wood dust. The use of the material, therefore, is not advocated under the above conditions. In the field, swabbing of freshly peeled poles of *E. obliqua* with sodium fluosilicate has prevented Lyctus and Bostrychid attack for a period of two years, the untreated poles being badly attacked. Laboratory work with other chemicals has indicated that boric acid or mixtures of boric acid and borax are also effective in low concentrations, and the commercial use of these chemicals is now being investigated.

Log seasoning experiments with *E. obliqua* in the forest show that incomplete starch resorption occurred after a period of eighteen months, and during this time considerable stain and decay occurred. For this species, it appears that log storage in the forest is of little value as a means of commercially de-starching the timber, except under carefully controlled conditions. The starch survey of living trees has been continued in co-operation with the Victorian Forests Commission and the New South Wales Forestry Commission.

Veneer and Plywood.—The greater part of this work has been confined to an investigation of present trade practices and to advisory work. In this connexion several visits were made to woodworking plants where studies were made of the existing conditions and of any difficulties encountered. Experimental work was carried out and advice given.

Tests were made of the water resistance of various types of glues, and preliminary tests made to determine the value of brush-treating plywood with fire-proofing chemicals. The results showed that there was a considerable increase in resistance to flame penetration and also that glowing after removal of the test flame was greatly reduced.

The chemical investigation of Australian caseins for glue-making, has been completed and shows that with the exception of the clause relating to fat content, the caseins conform to the American specification. This specification, with the modification that the fat content shall not exceed 5 per cent. has been suggested for Australian caseins for glue-making.

Miscellaneous.—A reconnaissance survey of termite damage in north-eastern and northern Victoria was made in conjunction with an officer of the Division of Economic Entomology.

Numerous inquiries regarding various aspects of wood preservation, gluing and painting of wood have been received, the number, 687, being markedly higher than in previous years.

8. *Timber Physics.*—The Officer-in-Charge of this Section was absent on " study leave " for the last four months of the year, the only work done during that time consisting of a few routine observations made by a junior assistant. In spite of this curtailment, some valuable lines of investigation were followed up.

During the eight months to which work was limited, the subject to receive most attention was that of collapse and its removal—a subject of particular practical significance in Australia. A Pamphlet was prepared and published giving a general discussion of collapse and its removal, and a detailed account of recent investigations on the subject by the Section. Work done subsequent to this publication included a survey of the variation of the incidence of collapse from bark to pith in a number of trees of the " ash " group of eucalypts. In co-operation with the Section of Wood Structure, preliminary work was carried out in an attempt to correlate collapse with structure, while work in co-operation with the Section of Timber Mechanics showed a high correlation between toughness and ability to recover from collapse. These and other results were of direct practical significance, while a number of miscellaneous tests led to valuable results regarding the mechanism of re-conditioning collapsed timber.

Routine work in establishing green and air-dry density figures for 4 inch x 1 inch x 1 inch shrinkage samples was continued. Five new species were covered, bringing the number dealt with to date up to 203, represented by 2,339 samples. In co-operation with the Section of Wood Structure, supplementary air-dry density determinations were made on 723 samples from the Division's authenticated collection and these results, together with previous ones have been collected and analysed for publication.

Basic shrinkage determinations, using the special method of thin sections, were made on samples of practically all green material received at the laboratory during the eight months. Shrinkages obtained in this way are strictly comparable, and results are now available for 198 Australian species. In the course of these investigations it has now been found that, generally, shrinkage increases from the bark in. Attempts to correlate rate of growth with shrinkage in *E. gigantea* did not lead to any definite findings.

Routine determinations of tangential, radial, and longitudinal shrinkage of Australian timbers, using A.S.T.M. Standard procedure, except that the samples were re-conditioned after air-drying and before oven drying, were continued. Supplementary shrinkage measurements were made in co-operation with the Section of Timber Seasoning, using sample boards prepared for kiln schedule work, and fundamental investigations concerned with the longitudinal shrinkage of wood were continued.

Species correction figures for use with the blinker electrical moisture meter were determined for a further six species, bringing the total number of species covered to 144.

A new project, dealing with the equilibrium moisture content of 24 species under both increasing and decreasing humidities at 80° F., yielded some interesting results. A difference of from 2 per cent. to 2½ per cent. between moisture contents at any one set of conditions was found for the desorption and absorption curves respectively.

Statistical Analysis.—Experiments were designed to determine the holding power of three types of coach screws, to test the normality of data from certain timber bending tests, to determine the efficiencies of different types of casein glue, and to investigate the uniformity of pore counts and the personal bias of different observers in the Wood Structure Section.

In addition, the data from numerous experiments were analysed to determine definite points such as the relation between modulus of rupture and specific gravity, rings per inch and percentage of summerwood in *Pinus radiata*, the significance of the differences in durability between poles treated in various ways, &c.

A steady inflow of routine computation for the various Sections has been dealt with, and it has been necessary to engage an extra computor for some months. As an indication of the amount of such work to be done, one publication now in preparation necessitated over 100,000 calculations. Six special investigations have been made for outside research workers.

IX. FOOD PRESERVATION INVESTIGATIONS.

1. *General.*—In March, 1938, effective occupation of the Council's new laboratory at the State Abattoir, Homebush Bay, Sydney, took place; various new investigations on the storage and handling of fruit, meat, and fish are accordingly being commenced. The ground floor, with six cold rooms, is equipped for meat and fish work, and the first floor, with nine cold rooms, is devoted to fruit storage and engineering investigations. Wherever possible, all mechanical equipment has been made fully automatic, and considerable time has, initially, been devoted to its adjustment in order to secure complete reliability. In this respect, the automatic equipment, which was constructed to the designs of the Section's staff, has proved most satisfactory. The new laboratory is giving great satisfaction, and the thanks of the Council are especially due to the designer, Mr. William McDonald, who acted in an honorary capacity.

While most of the Council's food preservation investigations will be concentrated in the Homebush Bay laboratory, it has been decided to continue certain investigations on chilled beef at the Council's Brisbane Abattoir laboratory, and to maintain a small staff, for the time being, at the Government Cool Stores, Melbourne, where fruit storage investigations are being carried out in co-operation with the Department of Agriculture, Victoria. The continuation of the chilled beef investigations in Brisbane has been greatly aided by the provision of facilities and a large annual grant of money by the Queensland Meat Industry Board.

With the erection of the central laboratory in Sydney, it has been possible to establish a sub-section devoted particularly to the study of physical and engineering problems arising out of the storage and handling of foodstuffs. Attention is initially being given to the problems of the cooling of a wet body and of the transfer of moisture from stored fruit and meat.

2. *Chilled Beef Investigations.*—(i) *General.*—With the exception of the studies on the factors influencing the loss of bloom during storage, the programme of chilled beef investigations has now been completed, and a considerable amount of time has been devoted to the analysis of the results and to their preparation for publication. In respect of the hygienic precautions to be adopted in the meatworks, a general, non-technical article has been published as the Council's Circular 2–P. A detailed analysis of the results on which this circular was based has been prepared for publication.

(ii) *The Cooling of Beef in Sides.*—This experimental work has been completed: the main conclusions, which should, however, be regarded as tentative in view of the fact that the analyses of results are incomplete, are as follows:—

(*a*) In the first 20 to 24 hours of cooling (the cooling phase), the bacterial population in the surface tissues may increase, remain stationary, or decrease, depending on the rate of temperature reduction and the rate and extent of surface desiccation.

(*b*) The rate and extent of surface desiccation are dependent on the rate of cooling of the meat surface, and for equal rates of cooling they are dependent on the rate of air movement over the beef, the relative humidity of the air in the cooling phase having only a minor effect.

(*c*) To obtain the desirable decrease in the microbial population during the first 20 to 24 hours, a rapid rate of cooling must be maintained together with a fairly rapid air movement over the beef surfaces, generally in excess of $1\frac{3}{4}$ feet per second. It is difficult to define this minimum cooling rate in simple terms. A rate of reduction of the "bone" temperature of the hindquarter such that it reaches 52° to 53°F. in 325 to 335 lb. sides within 24 hours may, however, be regarded as a criterion of a minimum rate of cooling when the mean air speed over the beef is about $1\frac{3}{4}$ feet per second.

(*d*) In the second (storage) phase of cooling, when the surface tissues remain approximately at the temperature of the surrounding air, while the deeper tissues gradually fall in temperature, the extent of the changes in the microbial population depends solely on the drying power of the air. The ideal is to maintain the microbial population virtually stationary without excessive loss of weight from the beef taking place. In terms of evaporation from a free water surface, the desirable drying power of the air is approximately 60 milligrammes per square centimetre of surface per 48 hours. To maintain this drying rate during the second phase, the relative humidity of the air must be maintained at 84 to 90 per cent. according to the air speed over the beef, the lower value being necessary for the air speeds of about 9 inches per second and the higher value for speeds of about $2\frac{1}{2}$ feet per second.

(iii) *Growth of Micro-organisms on Ox Muscle.*—The results of the investigations on the growth of certain bacterial and yeast genera on ox muscle of various water contents in air at temperatures in the range of − 1° to + 25°C. have been published in the Council's Journal (10: 338, 1937).

A paper dealing with the influence of 10 per cent. carbon dioxide on the rates of growth at −1° C. has been submitted for publication. On muscle of normal water content, the growth of *Achromobacter* was usually reduced to between 0.4 and 0.5 of the rates in air, for *Pseudomonas* to approximately 0.25, and to 0.46, 0.55, and 0.83 for three species of Asporogenous yeasts belonging to the genera *Candida*, *Geotrichoides*, and *Mycotorula*, respectively. The critical muscle water contents for growth were always slightly higher than in air at the same temperature, while for bacteria the efficiency of 10 per cent. carbon dioxide as a growth inhibitor increased with decreasing muscle water contents. The results may be applied to the storage of beef in 10 per cent. carbon dioxide on shipboard, and they indicate the marked advantages which would accrue if the drying power of the air during such storage could be such as to maintain the water contents of the surface of the exposed muscle at values in the range 100 to 150 per cent. (normal water content is 300 per cent. approximately).

(iv) *Studies on Loss of Bloom.*—Mention was made in the last report of the invitation by the Queensland Meat Industry Board to co-operate in a series of experimental shipments made by the Board in connexion with the visit of Mr. F. M. Bell—a member of the Board—to England. Most of the cattle used in the experimental shipments were bought by the Board before Mr. Bell's departure in July, 1937. Seven shipments of experimental chilled beef were made with the objective of gaining information chiefly as to the effects upon bloom of (*a*) shrouding, and (*b*) feeding and resting of cattle for approximately one week before slaughter. Further studies within both of these divisions were made, comparing firstly beef quality, and secondly beef from steers and maiden speyed heifers. Left hinds and crops were used as controls, corresponding right hinds and crops being used for the experimental treatment. Great care was devoted to stowage of the experimental material on board ship, with the objective of eliminating any factors liable to vitiate valid comparisons between control and treated material.

The following summarizes the main points mentioned in the landing reports :—shrouding, while giving, what is to many people, an improved appearance of the fats, in cases where the fat covering is good, apparently makes little difference in market value, and it is questionable whether the expense of shrouding is justified. Shrouding poor quality beef is definitely of no value. Results from animals fed and rested before slaughter, as compared with those not so fed and rested, gave further confirmation to previously existing belief that "quick kill" beef is definitely more fiery than "fed and rested" beef. This condition of fieriness is not liked by the trade.

Perhaps the outstanding indication from these experimental shipments was in regard to the importance of initial quality of the beef in respect to the reduction of good bloom. The experiment was very definitely valuable in that if afforded much information upon which future experimentation can be based.

The laboratory at Cannon Hill, which is being continued for the express purpose of carrying out investigations relating to loss of bloom, is being considerably modified for this work. The Queensland Meat Industry Board is generously undertaking this modification, most of which is connected with radical alteration in the method of refrigeration employed in the experimental cold rooms. When completed, these chambers will have continuous top to bottom air circulation and provisions enabling storage experiments to be carried out at definite relative humidities as well as at accurately controlled temperatures and rates of air circulation.

3. *Citrus Fruit Preservation Investigations.*—(i) *General.*—Investigations under the direction of the Council's Citrus Preservation Technical Committee are continuing in four centres. Although no striking advances have been made in the past twelve months, there has been a steady accumulation of fundamental data, more particularly on the storage of Washington Navel and Valencia oranges. One striking feature has been the failure of extensive chemical data to provide a basis for the prediction of the storage life of the fruit. In consequence, the chemical work has now been restricted to pre-storage and post-storage determinations of the acidity and palatability of the juice.

(ii) *Report of Citrus Research Officer.*—Intensive investigations into the pathology of storage spot lesions of Washington Navel and Valencia oranges show the possibility of fungal as well as physiological causation of spots situated at the button or stem end of the fruit. Several organisms have been consistently isolated, and these when re-inoculated into fruits have apparently been responsible for the production of button spots which are macroscopically indistinguishable from those naturally occurring in cool store at temperatures of 40° F. and 45° F. This work, which was carried out in co-operation with the New South Wales Department of Agriculture, is to be continued on a larger scale during 1938–39.

An experimental plant for the extraction and canning of citrus juices has been set up at the Homebush Laboratory, and will be used for a series of investigations covering the many factors associated with orange juice preservation.

Field work connected with the handling of citrus fruits has largely been held over in anticipation of the establishment of an experimental packing house in the Gosford area. In Victoria, results with Valencia oranges indicated a definite increase in mould wastage when fruit was passed over a commercial sizer as compared with sizing by hand. Commercial handling and processing also greatly increased *Penicillium* wastage in New South Wales Washington Navels in contrast with fruit carefully packed in the orchard. The investigators stress the need for improvement in packing shed methods.

The value of sweating in reducing wastage is still being investigated. In South Australia, the commercial process appears to permit some degree of culling by development of a rind blemish similar in appearance to storage spot. In New South Wales and Victoria, sweating under controlled conditions has given results which, while variable, are in the direction of reduced wastage by the reduction of a proportion of the rind disorders.

Further confirmation was obtained of a number of general conclusions previously reached, viz.—(*a*) storage spot is more severe in early than in late picks, (*b*) storage rots become increasingly important with advance of season, (*c*) processing in borax solutions exerts an outstanding effect in the control of green mould, and (*d*) Washington Navel and Valencia oranges from the Gosford district are much more subject to physiological and fungal storage diseases than fruit from the inland areas.

(iii) *Citrus Investigations, Melbourne (in Co-operation with the Department of Agriculture of Victoria).—(a) Washington Navel Oranges.*—Storage of Washington Navel oranges has been carried out at 40°F., 45°F., and 50°F. together with preliminary " sweating " at high temperatures, and ethylene treatment. It appears that storage spot and other low temperature disorders cannot always be controlled by immediate storage at 45°F., but sweating and ethylene treatments have given promising results in the subsequent control of these disorders. The oranges appear to be much less liable to storage spot when they have passed the climacteric and have reached the phase of constant respiration. There has been no appreciable difference in the loss of palatability or the rate of acid loss in the range of temperature from 40°F. to 50°F. Similar work is being carried out in the 1938 season, and the effect of manurial and handling factors on the subsequent wastage in storage is also being investigated. An experiment in " gas " storage during the last season did not result in any extension of the storage life, and the flavour was definitely affected by some of the artificial atmospheres used. This work has confirmed earlier conclusions.

(*b*) *Valencia Oranges.*—The effect of commercial picking and grading of Valencia oranges on the subsequent wastage in storage has been investigated. Machine grading was found to increase attack by mould in subsequent storage as compared with hand grading.

(*c*) *Grapefruit.*—Further experiments with grapefruit have confirmed the results of previous work in that 50°F. seems to be a satisfactory storage temperature for this fruit. Wastage in the early picked fruit was due to storage spot and in the later picked fruit to mould development.

4. *Non-tropical Fruit Investigations (Melbourne) in Conjunction with the Department of Agriculture of Victoria.*—(i) *Peaches and Plums.*—During the current season, further experiments have been carried out on the storage of fairly mature peaches and plums at 32°F., with weekly removals to a series of higher temperatures ranging from 37°F. to 65°F. It has been found that the maximum period the fruit may remain at 32°F. without subsequent deterioration depends on the ripening temperature ; fruit which is to be ripened at the lower temperatures has to be removed earlier from storage at 32°F. Most of the varieties tested could only be kept for four weeks at 32°F. if they were to be subsequently ripened at 45°F. (the approximate average temperature in London during March). The later varieties of peaches ripened and remained in good condition for about three weeks at this temperature, while the plums kept for six weeks.

No further increase in the life of peaches was obtained by means of " gas storage " in the present season. This finding is at variance with the reasonably consistent results obtained in the three previous seasons, and is probably due to the peaches being more mature than those used previously. The control of brown rot in peaches stored in trays, by using various types of wrappers, is also under investigation.

(ii) *Pears.*—Experiments conducted in 1937 on the " gas " storage of four varieties of pears at 32° F. resulted in an increase of 50 per cent. in the storage life when the concentration of carbon dioxide was maintained at 5 per cent. Injurious effects resulting in internal lesions have been obtained after storage in higher concentrations of carbon dioxide, particularly in concentrations above 10 per cent. In some cases, the injury produced by excessive concentrations of carbon dioxide was indistinguishable from that produced by prolonged storage. The effect of carbon dioxide on the storage of pears is being further investigated in the present season.

(iii) *Grapes.*—Storage experiments with grapes in 1937 demonstrated the value of the cork-filler pack in controlling mould as compared with the paper and woodwool pack. Further work is being conducted at present to confirm this result, to test the value of precooling, and to investigate the effect of " gas " storage, ozone, and impregnating the cork with various chemicals.

(iv) *Apples.*—Work is being continued with Jonathan apples on the effects of storage temperature, "gas" storage, and the effect of delay at 45° F., 55° F., and 65° F. before storage at 32° F., on the development of soft scald and breakdown. It has been shown that the less mature Jonathan apples pass through a phase of maximum liability to scald and minimum liability to Jonathan spot when they have passed the climacteric and are approaching the period of constant respiration. Preliminary holding at 65° F. has been found to result in greater liability to scald than preliminary holding at lower temperatures. With regard to "gas" storage, it has been found that atmospheres containing 5 per cent. of carbon dioxide and 10 per cent. to 16 per cent. of oxygen increase the storage life, particularly by controlling Jonathan spot. Higher concentrations of carbon and lower concentrations of oxygen have been found to be injurious.

A preliminary experiment was carried out with Granny Smith apples in the last season, and a more comprehensive experiment is now in progress on the effect of oiled wraps and preliminary holding at 45° F., 55° F., and 65° F. on wastage during subsequent storage at 34° F., particularly the development of superficial scald. Preliminary work along these lines is also being conducted with the Delicious and Stewart varieties, and samples of every variety are being held at 36° F. in "gas" storage.

(v) *Experimental Shipments of Pears.*—Further experimental shipments of pears were sent from Sydney and Melbourne this year in order to determine the nature and extent of wastage under various commercial conditions. The work is again being conducted in conjunction with officers of the British Food Investigation Board.

5. *Egg Storage Investigations.*—In the last report, reference was made to the scientific survey into the nature and extent of wastage being conducted in England by the Council's liaison officer, in co-operation with officers of the Commonwealth Department of Commerce and of the Food Investigation Board. This survey has been continued for a further season, and twelve experimental shipments of eggs of known history were forwarded to London for detailed examination and classification; a large number of selected cases of eggs from certain commercial shipments were also carefully examined.

In conjunction with the Queensland Investigation Group of the Egg Producers' Council, a series of experiments was carried out on the effects on wastage of a variety of cleaning methods. This work is to be continued on a larger scale during the 1938–39 season, and it forms part of an extensive investigation scheme which is being directed by the Council at the request of the Egg Producers' Council. The five mainland States are participating in this work, and the Investigation Committee of the Egg Producers' Council, on which the Council is represented, is co-ordinating the widespread investigations.

6. *Physics.*—(i) *The Cooling of a Wet Body.*—A study of the cooling of a wet body under various sets of conditions has been commenced. This work arose out of studies on the chilling of beef, and the conditions existing in certain beef chillers are the only ones which have yet been studied. Assuming certain published evaporation and heat transfer data and making assumptions as to the nature of the air flow, approximate solutions of the partial differential equation expressing the temperature history of the wet body have been obtained for a number of cases by the Schmidt method. These solutions have been shown to be in accord with the results of direct measurements. It is difficult to modify the cooling conditions so that a direct study of the effects of various changes can be made. Consequently, the effects of these changes are being investigated arithmetically, and the results of this work will be checked by direct measurements for certain selected cases.

(ii) *Overseas Transport Investigations.*—A programme of experimental shipments of beef eggs, and fruit, similar to that arranged last year, has been carried out in co-operation with the British Food Investigation Board. One special experiment, supplementary to the Board's survey which was referred to last year, has been carried out in a lower hold of special design carrying frozen meat to England.

(iii) "*Freezer*" *Burn in Frozen Offals.*—Several kinds of "edible offal" are exported in the frozen state from Australia. These are sometimes affected by "freezer burn", i.e., a discolouration and change in texture of the surface due to desiccation. In order to reduce this injury, a number of the products are usually wrapped in waxed paper. Moisture penetration tests were carried out on a number of samples of waxed paper and other wrapping materials in use or obtainable in Australia. A number of these were then selected for use in a test of their effectiveness in restricting desiccation of frozen offals in storage. An experiment has been completed in which calf livers, and ox sweet-breads were wrapped in various ways and stored for five months. It was found that (*a*) there was an exact parallel between the weight loss and the extent of "freezer burn", (*b*) the various materials used differ very greatly in their effectiveness, (*c*) the most effective material tested was a special paper consisting of a sheet of aluminium foil between two sheets of waxed parchment, and (*d*) slight "burning" may occur at sharp edges in the material in storage even when the total weight loss is extremely small.

X.—FISHERIES INVESTIGATIONS.

1. *General.*—During the year under review, progress was made in the provision of the necessary staff and facilities for the carrying out of fishery investigations. A bacteriologist was appointed and carried out an intensive study of existing commercial conditions and methods in Victoria and South Australia. Four biologists were also appointed, and two of these were sent abroad, one to study especially the tuna fisheries in Europe and the United States, the other to obtain general experience in the fisheries laboratories of the Pacific coast of North America and in field work. Appointments were also made of two experienced technical officers, one to assist in operations in the marine biological laboratory and the other to take charge of routine scientific work at sea. Consideration is being given to the appointment of two officers to conduct hydrographic and plankton researches, respectively. A preliminary series of chemical analyses of common Australian fish was concluded. The results of this work, which was carried out in the Chemical Department of the University of Melbourne, are being prepared for publication.

By arrangement with the New South Wales Government, a lease of the Fisheries Reservation at Port Hacking, 18 miles south of Sydney, was obtained for the purpose of erecting a marine biological laboratory. Some existing works consisting of the hatchery buildings and tanks used by H. C. Dannevig during his investigations rather more than twenty years ago, are being taken over and adapted on the site. The head-quarters of the Section were removed from Melbourne to these buildings in April, 1938. The additional laboratory building is expected to be completed early in 1939, when suitable facilities for biological, hydrographic, bacteriological, chemical, and aquarium work will be available.

Early in May, 1938, delivery was taken of the motor ship *Warreen*, the diesel-powered research vessel which was built to carry out investigations of a comprehensive nature, including the nature and distribution of the common pelagic fishes. A photograph and description of this vessel appeared in the May, 1938, number of the Council's Journal. A preliminary cruise was commenced on 11th May, and early in June, the ship returned to Melbourne for necessary adjustments. In addition to the Master (Captain A. Flett) the complement of the vessel consists of a first mate, second mate, engineer, wireless operator, cook, and four deckhands.

2. *Marine Investigations.*—Between December, 1937, and May, 1938, it was found possible to conduct active investigations at sea. It was thought to be particularly desirable to obtain more precise evidence on the distribution of the tuna group of fishes in south-eastern waters, aerial reconnaissance during the corresponding seasons in the previous year having indicated that large shoals should be encountered. Prior to the delivery of M.S. *Warreen*, two exploratory cruises were carried out, the first by means of the motor patrol vessel of the Tasmanian Sea Fisheries Board, and the second on the *Peter R.*, a 50-ft. auxiliary ketch which was chartered for approximately six weeks. From 11th May to 9th June, 1938, the *Warreen* carried out a cruise of investigation covering the coastal waters of Victoria from Port Phillip Bay to Wilson's Promontory, eastern Bass Strait, the east coast of the Furneaux Group of islands, Banks Strait, and the east and south coasts of Tasmania as far as Southwest Cape. Three of the four commercially important species of tuna were, as a result, shown conclusively to be present in large quantities within 300 miles of Hobart.

Bluefin Tuna.—The occurrence of this species was established during a six months' period, and the total extent of the season of occurrence may prove to be even more extensive. The largest schools were encountered by the *Warreen* off the east coast of Flinders Island and of north-east Tasmania to as far south as St. Helens. The assembly of blue-fin tuna and of striped tuna observed off Babel Island on 14th May was of vast proportions. Lesser numbers of bluefin were observed at points over the whole area from Wilson's Promontory (Victoria) to Southwest Cape, although in southern Tasmanian waters the occurrence was restricted to certain inshore areas. It is noteworthy that, whereas in December and January the run appeared to be composed mostly of fish of from 8 to 10 lb. in weight, in February and March, and in May the range was between 13 and 38 lb. (mostly 24 to 29 lb.). The stomach contents included small pink crustaceans (the distribution of which, as shown in plankton collections, appeared to coincide closely with that of the tuna), small squid, barracouta, mackerel, anchovies, and other sardine-like fish. Numerous samples of the tuna were obtained on bone jigs and feathered jigs, but the latter were liable to damage, especially by barracouta. The purse-seine net was not effectively tested owing to a defect in the pursing gear.

Skipjack (striped tuna) were not encountered until during the May cruise. They were then especially numerous east of Flinders Island, and weighed from 9 to 16 lb. (mostly 11 to 13 lb.) each.

Albacore—the most valuable of the tuna species—were found, on the contrary, mostly in February and March, when they appeared to outnumber bluefin. The main bodies of this species may possibly have left the area under investigation by May, when only an occasional specimen was secured.

It should be mentioned that large, and what appear to be related, occurrences of blue-fin were noted during the year under review in South Australian waters, while the species is also known to occur off Western Australia, Victoria, New South Wales and Queensland. A fourth tuna species—*Yellowfin Tuna*—has also been recorded from Western Australia and Queensland.

During the marine investigations referred to above, few occurrences of large shoals of other pelagic fish species were noted. *Horse mackerel* and *barracouta* were, however, rather plentiful, in Storm Bay and off St. Helens, respectively.

No specific shellfish investigations were made during this preliminary cruise of the *Warreen*, but it was shown that the vessel could successfully operate the scallop dredge. A certain amount of hydrographic and plankton work was accomplished, the results of which will not be available until the records and material have been studied in relation to more extensive work done over a considerable period.

3. *Aerial Reconnaissance.*—Continuing the aerial observations carried out during the previous year, a further series of flights was made during the period, 7th July, 1937, to 8th August, 1937. As before, the flights were conducted with the co-operation of the Air Board, and the observations were again carried out by Mr. S. Fowler, Fisheries Officer of the Section. On this occasion, however, the Air Board required that all out-of-pocket expenses (fuel, oil, travelling allowance for flying personnel, transport expenses, &c.) be borne by the Council. The area covered in this instance embraced the eastern sea-board of Australia, comprising the southern and eastern waters of Tasmania, the eastern waters of Victoria and Bass Strait, and the coasts of New South Wales and Queensland as far north as Cairns. Valuable assistance and co-operation were again rendered by the Air Board, the Fishery Departments of Victoria, Tasmania, New South Wales, and Queensland, the Cinema and Photographic Branch of the Department of Commerce, Red Funnel Trawlers Ltd. of Sydney, and fishery officials and fishermen at various ports.

During the first series of flights undertaken in the previous year (21st October, 1936, to 1st December, 1936) the great concentration of pelagic fish was observed in the vicinity of Montague Island off the coast of New South Wales, whilst the southern and eastern waters of Tasmania, at that time, appeared to be void of such pelagic fish as lend themselves to aerial observation. During a later series of flights (25th February, 1937, to 28th March, 1937), the position was reversed, a great concentration of fish being found off the eastern coast of Tasmania and relatively few shoals on the southern coast of New South Wales. During each of the two first series of flights, little evidence of the existence of pelagic fish in large quantities was found in eastern Victorian waters.

On the series of flights conducted during the year under review (extending from 7th July, 1937, to 8th August, 1937), the waters of Tasmania proved again to be poorly supplied with pelagic fish life, except for a few shoals of Australian salmon observed about 10 miles north-west of Flinders Island on 14th July, 1937. A notable and spectacular occurrence of pelagic fish was, however, observed in eastern Victorian waters on 15th July, 1937. A great number of shoals were observed in an area extending over 50 sea miles from about 8 miles west of Lakes Entrance to a point south of Sydenham Inlet. The shoals generally were in an area from about 2 to 8 miles from the shore but, at one point, shoals were observed about 15 miles out from land. A choppy sea was encountered just beyond Sydenham Inlet, and no further shoals were observed. The fish comprising the shoals were of a small size and may have been identical with a sardine-like fish named "smig" by fishermen in the locality. At the request of the Section, efforts to capture specimens were made by the local fishermen but, owing to the lack of suitable nets, they were unsuccessful. No shoals of fish were observed offshore in the southern waters of New South Wales but, at Wombyn River and Wagonga Inlet (Narooma), large shoals of Australian salmon were seen. The body of fish seen at Wagonga Inlet was enormous, and a portion of a shoal which was photographed has since been estimated to contain about 12,000 tons of fish. Smaller, but commercially important, shoals of salmon were observed lying in the beach shallows of the southern coast north of Narooma and south of Sydney.

Apart from a few shoals of salmon in the southern portion of the New South Wales coast, no shoals of large pelagic fish were seen but, in the vicinity of Port Stephens, large concentrations of sardine-like fish were observed over an area of 20 sea miles. The detection of these shoals in the day-time is particularly interesting, as it was considered somewhat doubtful whether such fish could be detected except during hours of darkness. Adverse weather hampered operations on the journey north along the Queensland coast as far as Townsville, but somewhat better conditions prevailed during the return flights to Brisbane. Apart from small shoals of Spanish

mackerel amongst the reefs, and a few shoals of sea mullet at Hervey Bay, no evidence of pelagic fish was observed in Queensland waters. The absence of pelagic fish at this period cannot, however, be taken as evidence that such fish do not at some other season occur in these waters. As has already been stated, the waters of Tasmania, which appeared to be virtually devoid of fish life during the first flights were, during the second series of flights, found to be abounding in shoals of fish.

Repeated surveys, during which specimens are secured, must be made at regular intervals, if a true record of the extent and the times of the occurrences of the various species is to be obtained. The value of aerial observations for the rapid location of shoals of pelagic fish, for determining the area containing the greatest concentration, and swiftly surveying a large expanse of water has, however, been demonstrated. At a later date, further flights in co-operation with the investigation vessel are contemplated.

4. *Murray Cod Investigations.*—In conjunction with the State Fisheries Department of Victoria, investigations into the life history of the Murray cod, before and during the spawning season, were carried out from September to December, 1937, at Barmah Lakes, near Echuca, Victoria. These lakes cover a 50,000 acre area which is normally inundated to a shallow depth by the Murray River and forms a natural spawning ground for the cod. The object of the investigations was to attempt to gauge the possibilities of re-stocking the depleted fishery by artificial propagation. Over 200 cod, together with other species, were examined, and material for assessing age and growth rate was obtained ; this remains to be worked up.

Owing to the fairly severe drought conditions obtaining, it was found that the river level had, in September, sunk to approximately half that of the previous year and that most of the swamps had dried out. It is possible that these conditions may have restricted the success and extent of the 1937 spawning season. Only four out of a total of 72 female cod examined showed ripe ova, whereas 118 out of 130 male fish had ripe milt. The maturation of the ova may have been retarded by the restricted area of relatively warm shoal water available, or it may be that female fish mature on the whole at a greater size and age than do male fish. The number of ripe female fish available for stripping for artificial fertilization of the eggs would not be great, except perhaps in selected portions of the river, but, since over 20,000 eggs are available from each fish, it would probably suffice for operations on a reasonable scale. Experiment showed that certain precautions would require to be taken to keep the young fry alive after their development from the eggs. Under the conditions of these experiments, fry were kept alive for up to six weeks from time of hatching. To avoid the development of fungus, it would probably be necessary to use deep ponds where variation in temperature would be avoided.

5. *Analyses of Common Australian Fish and Fish Oils.*—During the last sixteen months, a preliminary series of analyses has been carried out in the Chemical Department of the University of Melbourne. This work was sponsored by the Council and assistance was rendered on the biological side by its officers. A report detailing methods and results will shortly be published.

It has been found possible to make a classification of the commoner fish into—

(i) Oily or " fat " species (containing more than 2 per cent. oil). Examples, in order of oil content, are sea mullet, albacore, barracouta, bluefin tuna, salmon.

(ii) Borderline species between oily and white fish. Examples—schnapper, Murray perch.

(iii) White fish (containing usually much less than 2 per cent. oil). Examples—schnapper and " gummy " sharks (" flake "), whiting, flathead, garfish, anchovies, small pilchards.

From the point of view of palatability as human food, white fish rank high in importance, and it will be of future interest to determine the relative quantities of garfish available, as this fish is not at present marketed to anything like the degree which its quality merits. It is noteworthy that two of the sharks which have already found considerable favour in certain of the home markets have a low oil content. This fact, combined with their relatively high protein content, justifies increased efforts to popularize their sale, especially since white fish are apparently by no means as abundant as oily fish in Australian waters. In addition, these sharks have large livers yielding good percentages of oil with high vitamin content.

It is probably from the oily group of fishes, however, that greatest commercial development is to be expected. Particularly in canned or smoked form, some of these fish are highly palatable, expecially if excess oil is removed by processing. In addition, the group also provide valuable sources of material for fish meal and oil production. Analyses throughout the year show that, especially from mullet, there is great variation in the yield of oil from season to season, and attention to this feature would be required in deciding upon the optimum season for commercial operations. The food value of mullet varies, according to season, from 522 to 976 calories per pound.

In general, the oily species have proved to be capable of yielding, weight for weight, quantities of oil comparable with those obtained from species normally used abroad for oil and meal production. The vitamin A contents of the body oils from Australian species are also normal, while those of the liver oils are much higher than average. In many cases, however, the small sizes of the livers would tend to limit their exploitation. Fish meals produced from the various species showed on analysis normal protein and mineral contents.

6. *Bacteriological Investigations—Determination of Sources and Degrees of Fish Spoilage.*—Quantitative and qualitative examinations have been made on fish from Victoria and South Australia at various stages between the point of catch and the retail store.

(i) *Qualitative Investigations.*—Some 314 cultures have been isolated, purified, and examined for cultural characters. These were obtained from the following sources:—air and drip at the fish market, Melbourne; fish muscle; fish slime; air at various fishing ports; air in streets, Melbourne; sea water at various ports and in Port Phillip, and in the Melbourne water supply. The same species was often repeatedly isolated from the same source, whilst individual species were often isolated from different sources. In fish muscle, *Cocci* predominate, with fluorescing *Pseudomonas* and *Achromobacter* next in importance in that order. The genus *Flavobacterium* occurs but rarely. No sporing aerobes were isolated from fish muscle.

(ii) *Quantitative Investigations.*—Whilst it is not possible to establish a strict correlation between degree of spoilage and bacterial content of fish samples, there is no doubt that, in general, fish in fresh condition are characterized by showing a low bacterial count, while fish in an advanced stage of deterioration exhibit a high count. Counts of total bacterial populations have been made on over 250 samples of fish—mainly whiting and barracouta—in Victoria and South Australia. From the results, the conclusions given in the paragraphs that follow and which are supported by other evidence of a more general nature, appear to be justified.

Fish in the Municipal fish market gave, in a large proportion of cases, relatively high bacterial counts, indicating unsatisfactory conditions. One potent source of spoilage is the fish box in common use. This is used and re-used without sterilization. Drip taken from these boxes after washing or after packing with fresh fish contains up to 3,000 million organisms per cubic centimetre, thus showing gross contamination, which is readily communicated to fresh fish introduced to the boxes. Disinfection of these boxes, or the more general use of non-returnable boxes (as used, for example, at Port Pirie) would effect a greater improvement, which would be further aided by periodical disinfection of holds of fishing vessels and by increased care in handling, packing, and icing fish. That it is possible, if every precaution is taken, to transfer fish over large distances in good condition is shown by the fact that consignments from Thevenard (South Australia) reached Melbourne in excellent condition after a journey of 1,200 miles.

Bacterial examination indicated that, with rare exceptions, fish in the Adelaide fish market are in superior condition to those in the Melbourne market. In the latter, bacterial counts from various surfaces and from drip from display benches, wash trough, cleaning benches, &c. during sales and after the "washing down", gave figures of the same very high order as those obtained from fish boxes.

It is strongly recommended, therefore, that provision be made during market reconstruction for the handling of fish in a thoroughly hygienic manner, and for disinfection of premises, appliances, and containers at frequent intervals. In many cases, the conditions under which fish were being carried in retail stores was also found to be unsatisfactory, contributing to a still further deterioration in quality. On the other hand, fish in inferior condition were often found in shops where the utmost attention is given to hygienic handling and storage. Such fish, at the time of receipt in these shops, have obviously suffered from poor treatment in the earlier stages of transport and handling.

(iii) *Trimethylamine Determination.*—Within the last few years, it has been shown by Canadian investigators that, as a fish deteriorates in quality, the amount of trimethylamine—a product of the disintegration of proteins—increases, in common with the increase of the bacterial population. Preliminary trials on Australian fish indicate that this method of detecting the various stages of spoilage will prove of considerable use.

(iv) *Lysis.*—A method of detecting bacterial lysis of water-soluble fish protein has been developed, and it is proposed to correlate this with actual spoilage in fish muscle. This method is capable of qualitative and quantitative application.

7. *Ichthyological Investigations.*—(i) *The Australian Pilchard* (*Sardinops neopilchardus*).—Various samples typical of local runs of this species, chiefly in Port Phillip Bay, were shown to be apparently three years of age (size 5 to 7 inches) and quite immature, or at most in the early stages of maturation. The locations of the corresponding adult and larger pilchards remain to be determined.

(ii) *The Tunas* (*Thunnidae*).—Critical examination was made of the undermentioned species in respect to length, weight, sex, degree of maturity, food, and somatic characters. Material for age determination was also secured but has not yet been examined.

(*a*) *The Australian Bluefin Tuna* (*Thunnus maccovii*) was found to differ only slightly from European tunny and Californian bluefin tuna. Specimens secured from Tasmanian waters between December, 1937, and June, 1938, at individual weights from 8 to 50 lb.

(*b*) *The Albacore* (*Germo germo*).—This fish is identical with the albacore of California, Hawaii, and Japan. Specimens secured from Tasmanian waters between February and May, 1938, at weights from 5 to 17 lb.

(*c*) *The Skipjack* (*Euthynnus pelamis*).—This fish, called "bonito" in Australia, is identical with the skipjack of California and is found in most warm seas. Specimens of from 9 to 16 lb. in weight were secured from Tasmanian waters in May, 1938.

(*d*) *The Bonito* (*Sarda chiliensis*).—This species, called horse mackerel in New South Wales, is virtually identical with the bonito of California and is also known from New Zealand, India, Hawaii, Chile, and Japan. Specimens of about 3 lb. gutted weight were noted from Port Fairy, Victoria, in May, 1938.

(*e*) *Other Species.*—In addition to the above species, it appears from the examination of photographs that there exists in Australian waters, two species of yellowfin tuna (*Neothunnus*) not previously recorded. One obtained from tropical Queensland waters, closely resembles *Neothunnus macropterus*, the yellowfin tuna of Japan, Hawaii, and Mexico; the other, from Western Australia, has not yet been definitely identified.

XI. STANDARDS TESTING AND RESEARCH FOR THE SECONDARY INDUSTRIES.

1. *General.*—In the previous report it was stated that consideration was then being given by the Government to the report of the Secondary Industries Testing and Research Committee, a body which the Government had set up to advise it in connexion with its desire to extend the activities of the Council into the field of the secondary industries. The Committee's report was tabled in Parliament and subsequently printed as a Parliamentary Paper (No. 30.—F.2322, 1938, Commonwealth Government Printer, Canberra). The Committee recommended, briefly, that a National Standards Laboratory be established, that aircraft and engine-testing and research work be initiated, that a research service be established to carry out investigations of value to the secondary industries, and that the Council's existing information service be extended so that it would be better equipped to maintain and disseminate information regarding scientific and technological matters.

During the year, the recommendations of the Committee were approved by the Government, and as one step towards putting them in effect a Bill—the Science and Industry Research Appropriation Bill, 1938—was introduced into Parliament late in the year under review. It received the general support of all political parties in the House and was finally passed by the Senate on the 28th June, 1938. This Act appropriated a sum of £250,000 to be paid into a Trust Fund for the purpose of financing the capital expenditure involved in the establishment of the Standards Laboratory, the Aeronautical and Engine Testing Research Laboratory, for the setting up of various subsidiary establishments, and for the extension of existing establishments of the Council.

2. *Standards Laboratory.*—In its consideration of the details of the establishment of this Laboratory, the Council has been greatly helped by the Standards Sub-committee set up by the above-mentioned Secondary Industries Testing and Research Committee. Some ten years ago, too, a Committee set up by the Council itself reported on the matter, and its report and the information it collected at the time has proved most useful. Much of this information has come from the National Physical Laboratory of Great Britain, the authorities of which organization have at all times been most generous in the assistance they have afforded.

The University of Sydney has generously offered to provide a site for the Laboratory within its grounds, and arrangements have now practically been completed for the acceptance of that offer. The establishment of the Laboratory in Sydney would mean that it would be in close proximity to a large number of engineering industries of the Commonwealth in connexion with which its services would be particularly valuable.

It is proposed that the Laboratory will be organized into three sections, viz., those of Metrology, Electrotechnology, and Physics. Advertisements calling for applications for appointment to the positions of Officers-in-Charge of each of these three Sections have recently been issued.

3. *Aeronautical and Engine Testing Research.*—In order to advise on the whole question of aeronautical testing and research, Mr. H. E. Wimperis, C.B., C.B.E., M.A., late Director of Scientific Research, Air Ministry of Great Britain, visited Australia in August, 1937, and after spending a period of about six months making himself conversant with local conditions prepared a report containing recommendations for the organization of the proposed Australian work. His report, which was placed in the Government's hands in January, 1938, has been printed as a Parliamentary Paper (No. 29.—F.2321, 1938, Commonwealth Government Printer, Canberra).

Mr. Wimperis included the following in his recommendations :—

(*a*) That there should be provided at a suitable centre a research establishment for aeronautical (and engineering) investigations, and that the programme of research at this Laboratory should be supervised by an Aeronautical Research Committee.

(*b*) That at one of the Australian Universities there should be established a Chair or Department of Aeronautics, with a Reader in Meteorology at the same or another University, in order to supply aeronautical engineers who would be available for aviation as well as for aeronautical construction and other experimental and meteorological services.

Mr. Wimperis estimated the ultimate capital cost of this Laboratory as in the region of £140,000, and the annual maintenance cost, £12,000 per annum.

The Government has agreed that the Laboratory should be located in Melbourne, close to the centres of aeronautical and automobile construction in that city. The Victorian State Government has provided, at a low rental, an area of 10 acres at Fishermen's Bend, alongside the factories of the Australian Aircraft Corporation, and consideration is now being given to the design of the necessary building of this site. Mr. Wimperis has been retained as a consultant to assist the Council at the London end in designing and ordering of equipment and apparatus and in the selection of personnel for the Laboratory. Recently, Mr. L. P. Coombes, who has had extensive experience in aeronautical research in Air Ministry establishments in Great Britain, has been appointed as Officer-in-Charge and is expected to reach Australia early in 1939.

4. *Other Research.*—Consideration is being given to the planning of a programme of other research into problems concerned with secondary industries ; as a first step, inquiries are being made and information is being gathered together regarding several problems that might appropriately be undertaken. It had been hoped that it might have been possible to erect a central chemical laboratory and a physical laboratory to accommodate much of this work, but it seems likely that progress will be slow owing to lack of funds.

5. *Information Section.*—One of the recommendations of the Secondary Industries Testing and Research Committee concerned the enlargement of the information work that has been carried out by the Council for some time past. Technical literature has become so voluminous and its rate of increase during the last few decades so rapid that its efficient handling has become a definite problem. In Australia, with her distant location from more highly industrialized centres, and with the risk that some items of scientific information may not reach her, it can easily happen that much time and money may be spent on scientific research work aimed at the obtaining of information which already existed elsewhere before the work was commenced. Large chemical and engineering enterprises in Europe and America have recognized this need and thus many private information services are now in existence in those countries. There is a need, particularly in a country such as Australia, where large-scale secondary industries are not common, for an information service of a somewhat different type, for it will need to cover the secondary industries as a whole and without an elaborate staff appointed for that special purpose.

Following the acceptance of the above-mentioned recommendation, the Secretary of the Council (Mr. G. Lightfoot) left Australia in June, 1937, on a visit to Europe and America in order to obtain first-hand knowledge of the work and organization of information services in those countries, and to establish contacts with organizations from which useful information could be obtained. His visit was assisted very largely by the Carnegie Corporation of New York which made a grant towards the cost involved.

Mr. Lightfoot returned to Australia in January, 1938, and then furnished a report to the Council on his observations. Briefly, he recommended (*a*) the organization of an Information Service by the Council for the purposes visualized by the Secondary Industries Testing and Research Committee ; (*b*) the reinforcement of the Information Service by the initiation of research work by the Council in co-operation with industry ; and (*c*) the extension of the Imperial Agricultural Bureaux plan so as to include branches of science and industry other than those relating to agriculture.

The functions which he recommended for the new body to carry out were—

(i) The preparation of bibliographical references and abstracts of scientific papers, accompanied in appropriate cases by summaries of information for the use of (*a*) the Council, its Executive Committee, and its other Committees; and (*b*) of scientific workers whether members of the Council's staff or otherwise.

(ii) The supply of scientific and technical information, in response to inquiries received from persons engaged in industry or from members of the public, including advice and assistance to persons who experience difficulties in manufacturing processes or the establishment of new industries.

(iii) The preparation of information relating to recent advances in the application of science to industry, new processes, &c., and the dissemination of such information through appropriate channels, e.g., Chambers of Manufactures, industrial associations, individual industrial establishments, trade journals, &c.

(iv) The preparation and publication of articles, so far as practicable in non-scientific terms, explaining the objects and results of researches undertaken by the Council in a form likely to be understood by those who would derive benefits from the application of the results.

(v) The preparation and issue from time to time to members of the Council, its Committees, to senior members of its staff, and to bodies corresponding to it in other parts of the Empire, of confidential statements summarizing the contents of reports received on its work.

(vi) The preparation and issue to the press of statements concerning the work of the Council.

(vii) The exchange of bibliographics, summaries of information, &c., with such institutions in other countries as may be arranged, and particularly with bodies corresponding to the Council in other parts of the Empire.

(viii) The editing and publication of the Council's quarterly Journal, Bulletins, Pamphlets, Annual Reports, and all other publications.

(ix) The distribution of the Council's publications.

(x) The control and development of the Council's library.

(xi) The preparation and collection of exhibits demonstrating the work of the Council.

(xii) The maintenance of such indexes and other special records as are necessary for the above purposes.

(xiii) The provision in appropriate cases of secretarial services to Committees of the Council.

The above recommendations have now been approved and the Information Section formed to carry out the proposed functions. The Section has been located in the Head Office of the Council and has been placed in charge of the Assistant Secretary of the Council, Mr. G. A. Cook. Two officers with chemical training and experience have recently been added to the staff of the Section, and it is proposed to make another appointment at an early date. From now on, the Section will carry out the duties discussed in previous reports under the title of "Bureau of Information".

During the year the usual large number of enquiries seeking information on a diversity of subjects was dealt with. The following is a selection from a list of subjects not directly under investigation by the Council:—

(i) *Primary Industries.*—Saline waters for stock, the utilization of surplus apples, cheese mites, lime in agriculture, the conservation of water in dams, soil erosion, cocoa waste, dingoes, mushroom culture, sugar by-products, blackberry control, ramie, sheep branding fluids, candlenut tree, and synthetic manures.

(ii) *Manufactures.*—Colloidal sulphur, wool grease, coco-nut by-products, galvanized wire, limestone burning, brick manufacture, fibro cement pipes, banana confections, maize products, producer gas, unshrinkable wool, fly sprays, oaten flour preservatives, synthetic rubber, sodium perborate, rubber finish, power alcohol, potato starch, glace fruits, mildew-proofing canvas, casein manufacture, lubrication oil reclamation, soap making, ozone, and mothproofing.

(iii) *Industrial Minerals.*—Zircon, bauxite, talc, beryllium ores, rutile, diatomaceous earth, Fuller's earth, mica, gallium and germanium compounds, and vermiculite.

(iv) *Miscellaneous.*—Silverfish control, cochroach control, illumination of coal mines, abattoirs, research organizations, mistletoe control, bibliofilm developments, and film preservation.

In addition to supplying information on particular subjects the Council's library, containing as it does a valuable collection of scientific journals, serials, and Government publications is being extensively used by investigators both inside and outside the Council's organization. It is also fulfilling a useful function in tracing obscure titles and in locating references in other libraries.

XII.—OTHER INVESTIGATIONS.

1. *Commonwealth Prickly Pear Board**.—The feature of the year has been the very marked increase in prickly pear growth in many districts of southern Queensland, especially in the territory for 100 miles south of the main western railway between Chinchilla and Roma, and in the Upper Maranoa. The increase is, in part, regrowth springing from old pear butts, and the remainder seedling development. Apparently, the opening up by the destruction of the standing timber of former dense pear areas has contributed to the renewed growth of the pear, which is now heavier than for several years. *Cactoblastis* is generally distributed, but, as much of the growth is comparatively young, the population of the insect is rather light; where the pear is more advanced, good concentrations of larvae can be found.

In central Queensland, *Cactoblastis* has continued to exercise control of the scattered regrowth and seedling plants. In south-western Queensland, little alteration has occurred among the rather extensive areas of persistent regrowth in the St. George–Thallon sector, where, until the middle of 1938, prolonged dry conditions militated against the welfare of the insect. However, further east, in the Goondiwindi district, where a great deal of seedling pear has sprung up on improved pastures during recent years, *Cactoblastis* has been very active in eradicating or reducing these types of infestation.

Turning to New South Wales, considerable regrowth with a light *Cactoblastis* population persists in the Mungindi–Collarenebri district, which had, until very recently, experienced drought conditions. Patches of scattered pear are not infrequent in the general vicinity of the Mungle scrub; most of these areas support a very good insect population. The insect has performed excellent work during the year in the resistant pear country of the Bingara–Inverell section, mainly as a result of extensive timber destruction. In the Pilliga–Baradine district, although the dense pear has been destroyed, a good deal of seedling development is noticeable on newly reclaimed land. The pear infestation in the Hunter Valley has continued to be reduced progressively, but certain areas of resistant pear still show little evidence of destruction.

Concerning the lesser pest pears, the beetle, *Lagochirus funestus*, has furnished very definite evidence of its destructive powers among the tree pears of central Queensland, *Opuntia tomentosa* and *O. streptacantha*. An abnormally dry hot midsummer has been responsible for a temporary setback to the insect in the field. Large numbers were reared and were used for many new liberations during the year. In the case of tiger pear, *O. aurantiaca*, extensive destruction has been brought about by the Argentine cochineal, *Dactylopius confusus*, in the past twelve months among heavy infestations in the Roma–Surat, Nindigully, and Warwick districts, Queensland, while good work has been achieved in several smaller areas in New South Wales.

In collaboration with the Council's weeds investigators, experimental investigations and liberations have been continued with the Noogoora burr seed-fly, *Euaresta aequalis*. Large series of tests on economic plants have been carried out with two other *Xanthium* insects from America. Further information has been gathered concerning the insect enemies of *Bassia* and related plants.

Overseas investigations have dealt entirely with the biological control of *Xanthium*. The work in North America has embraced field surveys, life history and related studies, and the collecting and forwarding of large numbers of *Euaresta* and other insects to Australia. Recently, an officer has been despatched to India to search for insect enemies of *Xanthium*.

2. *Radio Research Board*.—The work of this Board has continued as in previous years with the co-operation of the Postmaster-General's Department and the Universities of Melbourne and Sydney.

At the Sydney end, the most important results during the year have been concerned with the connection between conditions in the ionosphere and the meteorological conditions at the ground. It has been established that the ionization in the F_2 region of the ionosphere is greater above an anticyclone than above a cyclone. It has also been found that the ionization in the F_2 region, which is normally the same above Sydney and Canberra, is markedly different when a "front" or meteorological discontinuity passes through New South Wales. These results seem likely to have an important influence on the development of meteorological theory. They have been achieved with the aid of the automatic multi-frequency equivalent height recorder developed by the Board.

* The Board is an independent body financed by the Commonwealth (through the Council for Scientific and Industrial Research) and the States of Queensland and New South Wales.

Further work has amply confirmed the association, discovered during the previous year, between solar eruptions and the ionization of the F_2 region. Every solar eruption is found to be accompanied simultaneously by a decrease in the ionization of the F_2 region. So good is the correspondence that consideration is being given to the desirability of supplementing visual observations with the spectrohelioscope by substituting radio observations on days of bad visibility.

In Melbourne, attention has been concentrated upon the investigation of the reflection of atmospherics at the ionosphere, but some attention has also been given to the problem of the exact synchronization between wave-form observations and observations made with the cathode-ray direction finder. The results lead to the conclusion that all atmospherics are reflected at the ionosphere. The height of the reflecting layer and the distance of the source of the atmospheric may be calculated from the recorded oscillograms. The balance of evidence favours the hypothesis that the atmospherics are radiated from a periodic electrical discharge and that this discharge is lightning. Until more practice is obtained in interpreting the oscillograms, it would be premature to anticipate the possible applications of the results, but it would appear that if the direction of the arrival of an atmospheric is observed by means of a cathode-ray direction finder at the same time as the atmospheric oscillogram is recorded, then both the distance and direction of the source of the atmospheric can be deduced, which is an advance in the methods available for locating thunderstorms, which should be capable of application in practical meteorology.

3. *Mineragraphic Investigations.*—During the past year, 30 investigations have been carried out by Dr. F. L. Stillwell, and his assistant, Dr. A. B. Edwards, into the mineral associations of the valuable minerals in ores, mill products, and rocks, submitted by mining companies and institutions. In many of these, the gold is present in particles of microscopic size, and special methods of preparation for microscopical examination in reflected light are employed to render possible direct observations of the way in which the gold occurs. Such observations are of considerable value to those engaged in developing the best methods of treatment or in investigating losses in milling.

Fourteen of these investigations have determined the mineral association of ores which have been subjected to the ore-dressing tests discussed in the section (4) that follows. These concerned auriferous ores from the Alexander Mine, Marble Bar, Western Australia, Etheridge and Grasstree in Queensland, Great Cobar Mine, New South Wales, New Deloraine, South Australia, and Coimadai, Victoria ; zinc-lead ore from Callington, South Australia, and Magnet, Tasmania ; tungsten ore from King Island ; nickeliferous copper ore from Cooper's Creek, Walhalla ; auriferous concentrates from Costerfield and Glen Wills, Victoria ; tailings from the Day Dawn South Mine, New Guinea, and the Deborah Mine at Bendigo.

A series of ore specimens from the Tennant Creek gold-field were studied for the Aerial, Geological, and Geophysical Survey of Northern Australia. They consisted mainly of hematite and partly of talc hematite schists. A large part of the hematite had developed from the oxidation of magnetite and possibly such hematite will pass into magnetite in depth. The Tennant Creek gold-field is not yet sufficiently developed to permit adequate discussion of the origin of the ores, but it is highly improbable that the hematite ore bodies will give place to sulphides in depth. It seems possible that the lenses of hematite may represent bodies of magnetite which formed during the regional metamorphism of the area, and that these lenses subsequently guided hydrothermal solutions, which deposited gold and bismuth in their present positions. In some cases, the solutions also circulated through fractures in the talc hematite schists.

Other examinations for the Aerial, Geological and Geophysical Survey of Northern Australia included a copper cobalt ore from the neighbourhood of Cloncurry, in which the copper is probably introduced after the cobalt, and a collection of rocks from the Croydon gold-field.

An interesting result of the examination of auriferous quartz from the Golden Plateau Mine, Gracow, was the discovery of particles of the silver telluride, hessite, and the lead telluride, altaite, in association with the free gold. The examination of ore from Mandurama, New South Wales, disclosed gold in the gangue and on the margins of pyrite and pyrrhotite, and also in arsenopyrite and lollingite. The small size of many of the particles was such as to indicate the probable reason of poor recoveries by cyanidation.

The acquisition of a Haultain super-panner has facilitated investigations on the association of gold in tailings or flotation concentrates. The heavy particles in tailings and concentrates which have been ground to pass through 200 mesh are panned off by this instrument, and concentrated at the head of the table. The efficiency of the instrument has been illustrated by the panning of gold particles from Mt. Lyell copper concentrates, containing 0.3 dwt. of

gold per ton. It was successfully applied to the examination of a tailing from the gold mines of Kalgoorlie mill, assaying 0.93 dwt. of gold per ton, where it was desired to explain why aqua regia was capable of dissolving all but 0.06 dwt. per ton of the gold in the tailing. The panning resulted in a small head of relatively pure pyrite, followed by a larger product consisting of iron oxides, some pyrite, and the heavier particles of gangue. When these products were mounted, polished, and microscopically examined, several particles of free gold and telluride were observed. It was determined that gold which could be extracted with aqua regia could be derived from gold attached to gangue particles, gold encased in particles of carbonate, rare particles of free gold, and partially decomposed gold telluride occurring both free and attached to gangue. The residual gold is due to enclosed particles of gold in quartz.

As a sequel to the examination of the iron ores of the Middleback Ranges by Dr. A. B. Edwards, an examination has been made of the rocks and iron ores of Yampi Sound. The results of this examination, together with the field work of F. Canavan, who collected the material indicate that the Yampi deposits are of the Lake Superior type. They occur as well-defined beds in an overfolded series of Pre-Cambrian quartzites and banded hematite-quartzites, and bear considerable resemblance both in composition and mode of occurrence to the iron ores of the Middleback Ranges.

Dr. Edwards has also completed an examination of ilmenite obtained from a number of Australian localities, and has been able to show that many apparently homogeneous specimens are in reality ex-solution intergrowths (intergrowths produced by the unmixing of solid solutions) of ilmenite with one or more of the oxide minerals, hematite, magnetite, and rutile.

All these mineragraphic investigations have been facilitated by contributions from a number of mining corporations through the Australasian Institute of Mining and Metallurgy. The University of Melbourne has also assisted by granting the investigations laboratory accommodation in its Geology School.

4. *Ore-dressing Investigations.*—As indicated in previous reports, these investigations are being carried out with the co-operation of the Kalgoorlie School of Mines, the South Australian School of Mines and Industries, and the Metallurgy School of the University of Melbourne.

There has been no diminution in the demand for ore treatment investigations at the Kalgoorlie laboratory, and samples for that purpose have been received from all parts of the State, as well as from New South Wales and the Northern Territory. Owners of treatment plants, small operators, and mine owners have now realized the advantage of having their treatment problems investigated in a properly equipped laboratory to assist them in overcoming difficulties met with in treatment and in designing new plants. Several treatment plants, designed in accordance with recommendations from the laboratory, are now successfully operating and others are in course of erection. The equipment available to the investigators has been increased by the purchase of ore-dressing machinery and an assay balance of the latest type.

In the Adelaide laboratory, the problems claiming most time during the year were the development of the best methods of treating various Australian ores of gold, silver, copper, lead, and zinc. A method which has been very successful on a laboratory scale was devised for the recovery of silver from a manganiferous-silver ore. Some use was made of the application of quantitative microscopical determination of minerals to ore-dressing problems. Further progress was made in the study of the alkalinity of pulps undergoing cyaniding, the results from which are of direct value to the gold-mining industry in Australia. The possibility of using sea-water in the cyanidation of a gold ore was also investigated, showing that such water is suitable for the treatment of some ores.

In connexion with the work at Melbourne, approximately 40 reports on miscellaneous materials comprising dumps and gold ores and various base metal ores were issued during the year. An investigation of scheelite ore from King Island showed that this mineral could be readily floated under laboratory conditions producing a finished product in one treatment stage as compared with the alternative practice of gravity concentration followed by magnetic separation. Investigations were also made on two silver-lead ores from Tasmania and on a copper-platinum ore from Cooper's Creek, Victoria. During the year, further information has been gained on the refractory sulphide ores of north-eastern Victoria. An extended examination of a sulphide concentrate from the Maude and Yellow Girl Mine has demonstrated the necessity for smelting as the only possible method of recovery of the gold and has proved of some academic value in regard to the gold association in the sulphide minerals. The gold particles which occur in some products, in amounts up to 6 oz. per ton, are sub-microscopic in size. A feature of the work during the period has been the closer co-operation between the laboratory staff and the industry with a view to solving treatment problems.

5. *Standards Association of Australia.**—The past year has been one of increasing activity and development, an indication of which is given in the appointment of a Publications Officer which has been found necessary for the co-ordination of editorial direction of the Association's publications. The filling of this office, which has been vacant during the years of financial stringency, considerably relieves the burden upon technical officers engaged upon committee activities and makes possible a much needed acceleration of some urgent undertakings. It has also facilitated the initiation of a universally approved proposal for the preparation of a standard minimum value for the interior illumination of buildings for various uses.

Also in the field of electrical industry are the codes for street lighting, preparation of which is well advanced, and for service rules, intended for application in those States in which confusing diversity exists. As part of the campaign for safeguarding the public against electrical hazards, many approval and test specifications have been prepared and proclaimed by statutory authorities as the basis of approval of appliance for sale to the public. Electrical wiring rules are undergoing periodical revision. A code for X-ray equipment and practice is nearing completion.

For the steel industry several new and revised specifications have been issued, and the Portland cement specification has been published in revised and extended form.

Interesting work is proceeding in the preparation of new codes for work in compressed air and for the use of explosives. A code for cranes and hoists is about to be published, and the codes for steam boilers and lifts are under revision.

Notwithstanding the difficulties to be faced, the preparation of standards for wearing parts of farm implements is proceeding satisfactorily. Of a very different character, and emphasizing the diversity of the work in hand, the preparation of specifications for hospital equipment, of all classes from gauze to laundry plant, continues to add to the Association's list of standards.

A full review of the Association's activities is made in the annual reports, and a quarterly Bulletin news service has been instituted. These are made available to interested enquirers.

The inadequacy of revenue continues to impose a limit on the extent of work undertaken, but it is hoped that, with early improvement in its financial position, the Association will be able to make substantial development.

6. *Biometrical Work.*—In all branches of the work of the Council, the aid of the biometrical staff is being sought continually, both for advice in planning experiments so that the results will admit of sound statistical treatment, and in subsequent analyses of the data.

In the Division of Plant Industry a variety of problems in connection with pathological experiments have received statistical attention. These include the effect of certain fungal diseases on the development of the wheat plant, germination counts of wheat smuts under different environmental conditions, tests of varietal susceptibilities of tobacco to yellow dwarf and the influence of fertilizers on the disease, and the effect of fertilizers on the development of potato tubers. Problems concerned with the control of weeds by cultivation and spraying methods, and investigations of the physiology of the wheat plant have also been dealt with statistically. Data from the manurial tests on different varieties of oranges and from experiments on the effect of fertilizers on the disease foliocellosis, and soil temperature studies, carried out at Griffith, have been examined, and plans have been made for an experiment to test the effect of different methods of handling and storing on the subsequent condition of oranges.

In the Division of Economic Entomology, biometric assistance has been given on questions concerned with counts of grasshopper populations, tests of different baits and types of trap for blowflies, and methods of control of peach moth.

In the Division of Forest Products, investigations on the sampling and testing of timbers have been treated statistically. Special statistical problems occur in this work owing to the difficulty in obtaining uniform numbers and types of samples.

The investigations in which the biometrician at the McMaster Animal Health Laboratory has assisted include experiments on the effect of the improvement of pasture and rotational grazing on parasitism and general condition of crossbred sheep in Tasmania, the effect on the superfine wool of grazing sheep on improved pasture in New South Wales, and studies of fertility in sheep. A series of papers has been written outlining the statistical methods required in veterinary experiments.

* This Association is an independent body which is financially supported by contributions from Governments and industries. The Council for Scientific and Industrial Research acts as the liaison body between the Association and its main contributor—the Commonwealth Government.

XIII. FINANCIAL MATTERS, STAFF, AND PUBLICATIONS.

1. *Finance.*—The statement of expenditure from 1st July, 1937, to 30th June, 1938, is as follows :—

	£	£	£
1. Salaries and contingencies	..	..	19,036*
2. Remuneration of Chairman and Members of Council ..	..	..	2,460†
3. Investigations—			
(i) Animal Problems—			
(*a*) Sheep diseases: foot-rot, black disease, preputial disease, caseous lymphadenitis, enterotoxaemia, pregnancy disease, and equine navel ill	7,087		
Less contribution from the Australian Pastoral Research Trust ..	200		
		6,887	
(*b*) Mastitis (Victoria)	4,847		
Less contribution from Australian Cattle Research Association and part Berwick Farm Revenue ..	4,847		
		..	
(*c*) Rabbit myxomatosis	..	651	
(*d*) Tick and tick fevers, pleuro-pneumonia, &c.	5,757		
Less contributions from Queensland Government, part proceeds from sale of vaccine, and C.P.P. Revenue Fund	1,235		
		4,522	
(*e*) Haematuria (Victoria and South Australia)	..	189	
(*f*) Toxaemic jaundice	34		
Less contributions from Australian Wool Board	34		
		..	
(*g*) Parasitology (at McMaster Laboratory, University of Sydney)	8,442		
Less contributions from the Australian Pastoral Research Trust, University of Sydney, and Australian Wool Board	2,024		
		6,418	
(*h*) Bacteriology	1,800		
Less contributions for University of Sydney	233		
		1,567	
(*i*) Biochemical problems	1,391		
Less contributions from Australian Wool Board	183		
		1,208	
(*j*) Parasitology and genetics (at F. D. McMaster Field Station, St. Mary's, New South Wales)	4,624		
Less contributions from the Australian Wool Board, University of Sydney, and Infertility Revenue Fund ..	1,576		
		3,048	

* 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; part salary of representative at Australia House; travelling expenses of Head Office staff, members of the Council, &c., and printing and general office expenditure.

† Provided from Consolidated Revenue Fund.

3. Investigations—*continued.*

	£	£	£
(i) Animal Problems—*continued.*			
(*k*) External parasites	249		
Less contributions from Australian Wool Board	249		
		..	
(*l*) Wool research	..	297	
(*m*) Pregnancy toxaemia in ewes	..	302	
(*n*) National Field Station "Gilruth Plains," Cunnamulla, Queensland	11,866		
Less contributions by Australian Wool Board, Commonwealth Bank, and Australian Pastoral Research Trust	11,184		
		682	
(*o*) Enterotoxaemia (braxy-like disease), Moora (Gingin) disease, ataxia in lambs, &c., (Western Australia)	..	368	
(*p*) Nutrition Laboratory	12,184		
Less contributions from Australian Wool Board, and Nutrition Laboratory Revenue Fund ..	2,756		
		9,428	
(*q*) Waite Institute	..	1,588	
(*r*) Coast disease	681		
Less contributions from the Australian Pastoral Research Trust	100		
		581	
(*s*) Drought feeding experiments at Waite Agricultural Research Institute, Glen Osmond, South Australia	663		
Less contributions from Australian Pastoral Research Trust ..	500		
		163	
(*t*) Field experiments on phosphorus deficiency (New South Wales and South Australia)	378		
Less contributions from the Australian Pastoral Research Trust ..	300		
		78	
(*u*) Agrostological investigations at Waite Agricultural Research Institute, Glen Osmond, South Australia	..	675	
(*v*) Central Office—			
Annual	4,096		
Capital	45		
		4,141	
		42,793	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)	..	7,000	
			35,793

3. Investigations—*continued.*	£	£	£
(ii) Plant Problems—Division of Plant Industry—			
(*a*) Central Laboratory—			
Annual	5,691		
Capital	815		
		6,506	
(*b*) Experimental plots		588	
(*c*) Plant pathology		2,586	
(*d*) Plant genetics		3,973	
(*e*) Agrostology		525	
(*f*) Herbarium		292	
(*g*) Weeds investigations		2,680	
(*h*) Fibre investigations		6	
(*i*) Experimental Farm, Duntroon		743	
(*j*) Potato virus studies		820	
(*k*) Pasture plant breeding, Gatton, Queensland ..		1,143	
(*l*) Plant introduction, Canberra		1,512	
(*m*) Plant Introduction Garden, Gatton, Queensland		809	
(*n*) Plant introduction (Fitzroy Vale, Middle Queensland)		836	
(*o*) Apple rootstocks, Stanthorpe, Queensland ..		792	
(*p*) Fruit problems	2,136		
Less contributions from Department of Commerce	30		
		2,106	
(*q*) Tobacco investigations	5,362		
Less contributions from Tobacco Trust Fund	5,362		
		..	
(*r*) Cunbumgi weed pest, Murrumbidgee Irrigation Area, New South Wales	406		
Less contributions from New South Wales Water Conservation and Irrigation Commission and Victorian State Rivers and Water Supply Commission	406		
		..	
			25,917
(iii) Entomological Problems—Division of Economic Entomology—			
(*a*) Central Laboratory—			
Annual	4,664		
Capital	321		
		4,985	
(*b*) Agricultural entomology and museum ..		1,900	
(*c*) Agricultural entomology (orchard and fruit pests)		53	
(*d*) Agricultural entomology (grasshopper investigations)		796	
(*e*) Noxious weeds		3,170	
(*f*) Veterinary entomology	5,066		
Less contributions from Australian Pastoral Research Trust, Australian Wool Board, and Economic Entomology Revenue Account ..	631		
		4,435	

3. Investigations—*continued.*	£	£	£
(iii) Entomological Problems, &c.—*continued.*			
(*g*) Forest entomology	2,821		
Less contributions from Economic Entomology Revenue Account ..	4		
		2,817	
(*h*) Oriental peach moth	850		
Less contributions from Department of Agriculture Victoria	850		
		..	
(*i*) Constant temperature chambers	7		
Less contributions from Sir MacPherson Robertson	7		
		..	
(*j*) Cotton investigations	20		
Less contributions from Ministry of Agriculture, Egypt	20		
		..	
			18,156
(iv) Horticultural Problems of the Irrigation Settlements—			
Citricultural—			
(*a*) Research Station, Griffith—			
Salaries and incidentals	6,123		
Capital	471		
	6,594		
Less funds provided from Station Revenue	144		
	6,450		
Less contributions by New South Wales Water Conservation and Irrigation Commission ..	1,500		
		4,950	
Viticultural—			
(*b*) Research Station, Merbein—			
Salaries and incidentals	6,421		
Capital	2,704		
	9,125		
Less funds provided from Station Revenue	2,595		
	6,530		
Less contributions by Dried Fruits Control Board and Nyah-Woorinen Dried Fruits Enquiry Committee	1,881		
		4,649	
(*c*) Ripening, processing, &c., of vine fruits Mildura District	843		
Less contributions by Irymple Packing Pty. Ltd., Mildura Co-op. Fruit Co., Red Cliffs Co-op. Fruit Co. Ltd., Aurora Packing Pty. Ltd., Swallow and Ariell Ltd., and Aden Packing Co.	836		
		7	
			9,606

3. Investigations—*continued.*	£	£	£
(v) Soil Problems—			
(*a*) Investigations at Waite Institute, and Tasmania—			
Salaries, &c.	8,030		
Capital	110		
		8,140	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)		2,500	
			5,640
(vi) Food Preservation and Transport—			
(*a*) Meat and fish investigations (Brisbane Abattoir)	2,874		
Less contributions by Queensland Meat Industry Board	400		
		2,474	
(*b*) Citrus preservation	..	2,287	
(*c*) Non-tropical fruits (Melbourne)	..	888	
(*d*) Engineering problems	..	676	
(*e*) Central Laboratory, Homebush, New South Wales—			
Annual	1,108		
Capital	19,395		
	20,503		
Less contributions by New South Wales Department of Agriculture, Australian Meat Board, and New South Wales Meat Industry Commission ..	3,500	17,003	
(*f*) Meat investigations (Homebush, New South Wales)	345		
Less contributions by Australian Meat Board	173	172	
(*g*) Fish investigations (Homebush, New South Wales)	..	2,036	
(*h*) Non-tropical fruits (Homebush, New South Wales)	780		
Less contributions from New South Wales Department of Agriculture	780	..	
(*i*) Adviser on Food Preservation	..	345	
		25,881	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)	..	2,000	23,881
(vii) Prickly Pear—			
(*a*) Grant for investigations	3,688		
Less contributions from Commonwealth Bank (Rural Credits Development Fund)	3,688	..	

3. Investigations—*continued.*	£	£	£
(viii) Forest Products—			
(*a*) Central Laboratory—			
Annual	9,106		
Capital	1,668		
	10,774		
Less contributions from Queensland Forestry Service	250		
		10,524	
(*b*) Seasoning	..	1,996	
(*c*) Preservation	..	2,008	
(*d*) Chemistry	..	1,524	
(*e*) Wood structure	1,858		
Less contributions from Bureau of Forestry, Canberra, and Queensland, New South Wales, Victorian and Western Australian Forests Services	93		
		1,765	
(*f*) Mechanics	..	2,168	
(*g*) Utilization	..	1,628	
(*h*) Physics	..	636	
(*i*) Fibre Section	1,048		
Less contributions from Flax Fibres Pty. Ltd.	500		
		548	
(*j*) Statistics and computing	..	230	
(*k*) Pole tests in New South Wales	22		
Less contributions from Sydney Municipal Council, Newcastle Municipal Council, and Department of Public Works, New South Wales ..	22		
		..	
(*l*) Preservation of rail sleepers	19		
Less contributions from South Australian Railways	19		
		..	
(*m*) Plant for new laboratory	414		
Less contribution by Russell Grimwade, Esq.	414		
		..	
(*n*) Paper pulp	1,563		
Less contributions from Australian Paper Manufacturers Limited, Associated Pulp and Paper Mills Ltd., Australian Newsprint Mills Pty. Ltd., and sundry cash donations	1,563		
		..	
		23,027	
Less sundry cash donations		257	
		22,770	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)		1,500	
			21,270

3. Investigations—*continued.*

	£	£	£
(ix) Mining and Metallurgy—			
(*a*) Mineragraphic investigations		814	
Less contribution by Australasian Institute of Mining and Metallurgy ..		368	
			446
(x) Radio Research—			
(*a*) Melbourne and Sydney Universities ..	5,315		
Less contributions by Postmaster-General's Department	3,900		
		1,415	
(*b*) Advisers on radio research		100	
			1,515
(xi) Library			1,168
(xii) Gold Mining—			
(*a*) Mineragraphic investigations (Melbourne University)		897	
(*b*) Ore-dressing (Melbourne University)		1,447	
(*c*) Ore-dressing (South Australian School of Mines)		1,024	
(*d*) Ore-dressing (Kalgoorlie School of Mines)		950	
(*e*) Advisory Committee		206	
			4,524
(xiii) Fisheries Investigations—			
(*a*) Administrative—			
Annual	4,292		
Capital	249		
		4,541	
(*b*) Marine biology		1,538	
(*c*) Marine bacteriology		910	
(*d*) Fish analyses		655	
(*e*) Investigations at sea		2,668	
			10,312
(xiv) Apple and Pear Investigations—			
(*a*) Grants to States		8,663	
(*b*) Thrips		170	
(*c*) Survey of " die-back " and sour sap		3	
(*d*) Codling moth		444	
(*e*) Experimental consignments of pears and apples overseas		68	
		9,348	
Less contributions from Department of Commerce		9,348	
			..
(xv) Secondary Industries Research			137
(xvi) Miscellaneous—			
(*a*) Dairy research		624	
(*b*) Ephemeral disease		148	
(*c*) Tomato wilt		172	
(*d*) Mineral deficiency in pastures		970	
(*e*) Statistical section		1,060	
(*f*) Evaporation from dams	50		
Less contribution from Australian Wool Board	50		
			..

3. Investigations—*continued.*	£	£	£
(xvi) Miscellaneous—*continued.*			
(*g*) Red-legged earth mite		756	
(*h*) Survey of potato problems		184	
(*i*) Bureau of Information		288	
(*j*) Secretarial, Waite Institute		260	
(*k*) Various		1,499	
			5,961
Total of Item 3—Investigations ..			164,326

2. *Contributions.*—The following statement shows the receipts and disbursements during the year 1937–38 of the funds provided by outside bodies and recorded in the special account established in 1931, entitled " The Specific Purposes Trust Account " :—

	Receipts including balances brought forward from 1936–37.	Expenditure 1937–38.
	£	£
Commonwealth Bank (Animal Health and Nutrition, Horticultural, Food Preservation and Transport, Prickly Pear, and Forest Products Investigations)	17,563 ..	17,563
Commonwealth Bank (Bee Investigations)	92 ..	..
Postmaster-General's Department (Radio Research) ..	3,900 ..	3,900
Australian Pastoral Research Trust (Animal Health and Animal Nutrition Investigations—Sheep Research)	2,080 ..	2,080
New South Wales Water Conservation and Irrigation Commission (Maintenance of Griffith Research Station)	1,500 ..	1,500
New South Wales Water Conservation and Irrigation Commission (Cumbungi Investigations)	265 ..	203
Victorian State Rivers and Water Supply Commission (Cumbungi Investigations)	290 ..	203
Department of Commerce (Fruit Problems, Tasmania)..	30 ..	30
Queensland Government (Animal Health Investigations—Cattle Research)	1,000 ..	1,000
Australian Wool Board (Animal Health and Nutrition Investigations—Sheep Research)	18,773 ..	16,227
Australasian Institute of Mining and Metallurgy (Minerographic Investigations)	368 ..	368
Dried Fruits Control Board (Dried Fruits Investigations)	2,098 ..	1,821
Nyah-Woorinen Dried Fruits Enquiry Committee (Dried Fruits Investigations)	60 ..	60
Australian Dairy Council (Wood Taint in Butter Investigations)	20 ..	..
Queensland Meat Industry Board (Food Preservation Investigation)	646 ..	400
Sir MacPherson Robertson (Entomological Investigations)	180 ..	7
Ministry of Agriculture, Egypt—Cotton Investigations (Entomological Investigations)	374 ..	20
N. Buffier—Buffier Memorial Building, F. D. McMaster Field Station (Animal Health and Nutrition Investigations)	500 ..	*500
University of Sydney (Animal Health and Nutrition Investigations)	688 ..	†688
Revenue Fund—Australian Wool Board (Animal Health and Nutrition Investigations)	43 ..	..
Revenue Fund—Contagious Pleuro-pneumonia Investigations (Animal Health and Nutrition Investigations)	499 ..	100

* This contribution was credited to Additions, New Works. † Includes £63 on account 1936–37 expenditure.

	Receipts including balances brought forward from 1936–37.	Expenditure 1937–38.
	£	£
Revenue Fund—Oonoonba Research Station—Sale of Vaccine (Animal Health and Nutrition Investigations)	1,599	135
Revenue Fund—Parkville Laboratory (Animal Health and Nutrition Investigations)	6	..
Revenue Fund—Berwick Farm (Mastitis Investigations)	1,462	1,097
Revenue Fund—National Field Station "Gilruth Plains", Cunnamulla, Queensland (Animal Health and Nutrition Investigations)	41	..
Revenue Fund—Bacteriological Investigations (Animal Health and Nutrition Investigations)	4	..
Revenue Fund—Parasitological Investigations (Animal Health and Nutrition Investigations)	111	..
Revenue Fund—F. D. McMaster Field Station (Animal Health and Nutrition Investigations)	368	76
Revenue Fund—Nutrition Laboratory (Animal Health and Nutrition Investigations)	175	14
Revenue Fund—Plant Industry Investigations	8	..
Revenue Fund—Entomological Investigations	270	130
Revenue Fund—Griffith Research Station (Citricultural Investigations)	4,982	144
Revenue Fund—Merbein Research Station (Viticultural Investigations)	4,085	2,596
Revenue Fund—Ore-dressing Investigations	236	..
Tobacco Trust Fund—Prime Minister's Department (Tobacco Investigations)	10,905	5,362
New South Wales Department of Agriculture (Food Investigations)	2,674	2,281
Australian Meat Board (Meat Investigations)	1,200	1,173
Metropolitan Meat Industry Commissioner of New South Wales (Food Investigations)	1,000	1,000
Department of Commerce (Apple and Pear Investigations)	10,159	9,348
Mildura Co-operative Fruit Company (Dried Vine Fruits Investigations, Merbein)	142	*142
Irymple Packing Company (Dried Vine Fruits Investigations, Merbein)	142	142
Red Cliffs Co-operative Fruit Company (Dried Vine Fruits Investigations, Merbein)	142	142
Aurora Packing Company (Dried Vine Fruits Investigations, Merbein)	141	141
Swallow & Ariell Limited (Dried Vine Fruits Investigations, Merbein)	141	141
Aden Packing Company (Dried Vine Fruits Investigations, Merbein)	141	141
Australian Dairy Cattle Research Association (Mastitis Investigations)	3,750	3,750
Department of Agriculture, Victoria (Oriental Peach Moth Investigations)	937	†937
Newcastle Municipal Council (Pole Tests in New South Wales) Sydney Municipal Council (Pole Tests in New South Wales) Department of Public Works, New South Wales (Pole Tests in New South Wales)	22	22
Australian Paper Manufacturers Limited (Paper Pulp Investigations)	522	522

* Includes £13 on account 1936–37 expenditure. † Includes £87 on account 1936–37 expenditure.

	Receipts including balances brought forward from 1936–37. £		Expenditure 1937–38. £
Associated Pulp and Paper Mills Limited (Paper Pulp Investigations)	500	..	500
Australian Newsprint Mills Pty. Ltd. (Paper Pulp Investigations)	250	..	250
Flax Fibres Pty. Ltd.—Flax Investigations (Forest Products Investigations)	500	..	500
Lands Administration Board, Queensland (Special Forest Products Investigations)	250	..	250
Russell Grimade, Esq. (Forest Products Investigations)	414	..	414
Bureau of Forestry, Canberra, and Forest Services of Queensland, Victoria, New South Wales, and Western Australia—Wood Structure (Forest Products Investigations)	125	..	93
Hardy's Pty. Ltd.—Plywoods (Forest Products Investigations)	20	..	..
South Australian Railways (Treatment of Railway Sleepers)	36	..	19
Sundry Contributors (Forest Products Investigations)	902	..	547
Egg Producers' Council (Watery Whites in Eggs)	2	..	..
Revenue Fund—Mining and Metallurgy	3	..	..
Sundry Contributors (Council for Scientific and Industrial Research Publications)	6	..	..
	99,302	..	78,679

3. *Staff.*—The following is a list of the staff of the Council as at the 30th June, 1938. The list does not include typists, laboratory assistants, and miscellaneous workers.

1. Head Office Staff.

Chief Executive Officer—Sir David Rivett, K.C.M.G., M.A., D.Sc., F.A.C.I.
Deputy Chief Executive Officer—A. E. V. Richardson, C.M.G., M.A., D.Sc.
Secretary—G. Lightfoot, M.A.
Assistant Secretary and Officer-in-Charge, Information Section—G. A. Cook, M.Sc., B.M.E., A.A.C.I.
Assistant Secretary (Finance and Supplies)—H. P. Breen, L.I.C.A.

Information Section—

E. J. Drake.
Miss N. Repin, B.Sc.

Library—

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

Accounts, Staff, Stores—

Accountant—M. G. Grace, L.I.C.A.
D. J. Bryant
R. Viney, L.I.C.A.
M. A. Elliott.
V. Leonard.
A. Patterson.
C. Munro.
J. Farey.
F. J. Whitty.
H. Smithwick.

Orders and Transport—

J. M. Derum.
J. J. Foley.

Records—
P. Domec-Carre.
W. J. Gillespie, A.F.I.A.
P. Knuckey.
F. Butler.
R. McVilly.
Head Typist—
Miss B. Thomas.
Clerical Assistant to Chief Executive Officer—Miss A. Slattery, B.A.
Clerical Assistant to Chairman—Mrs. N. E. Roberts.
Clerical Assistant to Deputy Chief Executive Officer—Miss J. L. Thomas.
Local Secretary, Canberra—R. F. Williams.
Clerk, Canberra—K. Prowse.
Clerk, Canberra—S. Young.
Clerk, Canberra—T. Lewis.
Clerk, Division of Animal Health and Nutrition Head-quarters, Melbourne—H. T. Chadwick.
Local Clerical Officer, Sydney—H. H. Wilson.

2. Secretaries of State Committees.

New South Wales—
Mrs. N. E. Roberts, 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. F. Todd, Commonwealth Offices, Anzac-square, Brisbane.
South Australia—
J. Ward Walters, Animal Nutrition Laboratory, University of Adelaide.
Western Australia—
L. W. Phillips, M.Sc., M.Ed., A.A.C.I., Technical College, St. George's-terrace, Perth.
Tasmania—
F. J. Carter, c/o Premier's Office, Hobart.

3. Australia House, London.

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

4. Division of Plant Industry.

At Canberra—
Administration—
Chief—B. T. Dickson, B.A., Ph. D.
Librarian (part-time)—Miss F. Stops, B.A.
Pathology—
Senior Research Officer—H. R. Angell, B.S.Agr., M.S., Ph.D.
Research Officer—J. G. Bald, M.Agr.Sc., Ph.D.
Research Officer—W. V. Ludbrook, B.Agr.Sc., Ph.D.
Technical Officer—N. H. White, B.Sc.
Genetics—
Senior Research Officer—J. R. A. McMillan, D.Sc.Agr., M.S.
Assistant Research Officer—J. Calvert, M.Sc., F.L.S.
Assistant Research Officer—F. W. Hely, B.Sc.Agr.
Technical Officer—S. G. Gray, B.Sc.Agr.
Plant Introduction—
Senior Research Officer—A. McTaggart, B.S.A., M.S.A., Ph.D.
Assistant Research Officer—R. M. Moore, B.Sc.Agr.
Horticulture and General Botany—
Research Officer—C. Barnard, D.Sc.
Weeds Investigations—
Assistant Research Officer—A. B. Cashmore, B.Agr.Sc.
Assistant Research Officer—D. G. Greenham, M.Sc.
Chemistry—
Technical Officer—E. H. Kipps, B.Sc.

Tobacco Investigations—
Officer-in-charge, curing and testing—G. E. Marks.
Technical Officer, curing and testing—G. H. Marks.
Research Officer (pathology)—A. V. Hill, M.Agr.Sc.
Technical Officer (pathology)—D. O. Norris, B.Sc.Agr.
Technical Officer (genetics)—E. T. Bailey, B.Sc.
At University of Sydney—
Adviser on Chemical Problems of Tobacco Investigation—Professor J. C. Earl, D.Sc., Ph.D., F.I.C.
Assistant Research Officer (chemistry and tobacco)—A. J. Tow, B.Sc.
Technical Officer (chemistry of tobacco)—Miss H. Moore, B.Sc.
At Waite Agricultural Research Institute—
Adviser on Physiological Investigations on Tobacco—A. H. K. Petrie, M.Sc. Ph.D.
Assistant in plant physiology (part-time)—Miss R. Watson, B.Sc.
Assistant in plant physiology (part-time)—Miss J. Brooke, B.Sc.
At Moss Vale, New South Wales—
Assistant Research Officer (genetics)—K. L. Hills, B.Agr.Sc. (on study leave).
At Griffith, New South Wales—
Assistant Research Officer (weeds investigations)—R. W. Prunster, B.Sc.Agr.
Assistant Research Officer (horticultural physiology)—Miss J. Hearman, B.Sc. Ph.D.
At Queensland Agricultural High School and College, Lawes—
Research Officer (genetics)—C. S. Christian, B.Sc.Agr., M.Sc.
Assistant Research Officer (plant introduction)—T. B. Paltridge, B.Sc.
Assistant Research Officer (weeds investigations)—R. Roe, B.Sc.Agr.
At Stanthorpe, Queensland—
Assistant Research Officer (horticultural investigations)—L. A. Thomas, M.Sc.
At Fitzroyvale, Central Queensland—
Assistant Research Officer (plant introduction)—J. F. Miles, B.Sc.Agr.
At University of Tasmania, Hobart—
Assistant Research Officer (fruit investigations)—D. Martin, B.Sc.

5. Division of Economic Entomology.

At Canberra—
Administration—
Chief—A. J. Nicholson, D.Sc.
Librarian (half-time)—Miss F. Stops, B.A.
Veterinary Entomology—
Principal Research Officer—I. M. Mackerras, B.Sc., M.B., Ch.M.
Assistant Research Officer (blowfly investigations)—Mrs. M. J. Mackerras, M.Sc., M.B.
Assistant Research Officer (blowfly investigations)—Miss M. Fuller, B.Sc.
Assistant Research Officer (blowfly investigations)—D. F. Waterhouse, B.Sc.
Assistant Research Officer (biochemist)—F. G. Lennox, M.Sc., A.I.C.
Technical Officer—D. L. Hall, Dip. Ag.
Forest Entomology—
Senior Research Officer—G. F. Hill.
Research Officer (termite investigations)—F. N. Ratcliffe, B.A.
Assistant Research Officer (termite investigations)—F. J. Gay, B.Sc. (on leave abroad).
Assistant Research Officer (termite investigations)—M. F. Day, B.Sc. (on leave abroad).
Technical Officer (termite investigations)—T. Greaves.
Agricultural Entomology and Museum—
Senior Research Officer—A. L. Tonnoir.
Assistant Research Officer—T. G. Campbell.
Assistant Research Officer (grasshopper investigations)—K. H. L. Key, M.Sc., Ph.D.
At Mooroopna (Victoria)—
Assistant Research Officer (peach moth investigations)—G. A. H. Helson, M.Sc.
In Western Australia—
Assistant Research Officer (earth mite investigations)—K. R. Norris, M.Sc.

Weeds Investigations—

At Canberra—

Principal Research Officer—G. A. Currie, B.Agr.Sc., D.Sc.
Assistant Research Officer—R. V. Fyfe, B.Sc.Agr.

At Farnham Royal, England—

Research Officer—S. Garthside, B.Sc.Agr., M.S.

At Le Lavandou, France—

Assistant Research Officer—F. Wilson.

At Uvalde, Texas, United States of America—

Assistant Research Officer—S. G. Kelly, M.S.(Agr.).

Insecticide Investigations—

At University of Sydney—

Assistant Research Officer—J. S. Fitzgerald, Ph.D.

6. Division of Animal Health and Nutrition.

At Animal Health Research Laboratory, Melbourne—

Chief—L. B. Bull, D.V.Sc.
Divisional Secretary—A. J. Vasey, B.Agr.Sc.
Chief Bacteriologist and Officer-in-charge—A. W. Turner, D.Sc., D.V.Sc.
Senior Research Officer (mastitis investigations)—D. Murnane, B.V.Sc.
Senior Research Officer (myxomatosis, bovine haematuria, caseous lymphadenitis)—C. G. Dickinson, B.V.Sc.
Senior Research Officer (pleuro-pneumonia, serological investigations)—A. D. Campbell, B.V.Sc.
Research Officer (immuno-chemistry)—A. T. Dann, M.Sc.
Assistant Research Officer (bacteriology, mastitis)—E. Munch-Petersen, M.Sc., Ph.B., M.I.F.
Assistant Research Officer (pleuro-pneumonia, toxaemic jaundice)—A. T. Dick, B.Sc.
Technical Officer—Miss C. E. Eales, B.Sc.
Technical Officer—Miss S. E. R. Clark, B.Agr.Sc.
Technical Officer—Miss K. A. Moore.
Technical Officer—E. Wold.
Librarian—Miss B. H. Anderson, B.Sc.
Biological Assistant—Miss J. Maclean, B.Sc. (part-time).

At F. D. McMaster Animal Health Laboratory, Sydney—

Officer-in-charge—D. A. Gill, M.R.C.V.S., D.V.S.M.
Principal Research Officer (bacteriology)—T. S. Gregory, B.V.Sc.
Senior Research Officer (parasitology)—H. McL. Gordon, B.V.Sc.
Research Officer (parasitology)—G. Kauzal, D.V.Sc.
Research Officer (bacteriology, foot-rot)—W. I. B. Beveridge, B.V.Sc. (on leave abroad).
Research Officer (field investigations, ectoparasites)—N. P. H. Graham, B.V.Sc.
Assistant Research Officer (parasitology, field studies)—I. W. Montgomery, B.V.Sc.
Assistant Research Officer (chemistry of wool)—M. R. Freney, B.Sc.
Assistant Research Officer (chemistry of dips)—A. R. M. Lipson, B.Sc.
Technical Officer—E. Parrish.
Assistant Technician—H. Munz.
Technical Officer (statistics)—Miss H. Newton Turner, B.Arch.

At Animal Nutrition Laboratory, Adelaide—

Chief Nutrition Officer and Officer-in-charge—H. R. Marston.
Secretary—J. Ward Walters.
Senior Research Officer (metabolism)—E. W. L. Lines, B.Sc.
Research Officer (chemistry)—R. G. Thomas, B.Sc.
Assistant Research Officer (ruminant physiology)—R. H. Watson, B.Sc.Agr.
Assistant Research Officer (biochemistry)—J. W. H. Lugg, D.Sc., A.I.C., A.A.C.I.
Assistant Research Officer (biochemistry)—S. T. Evans, B.Sc.
Assistant Research Officer (agrostology)—D. S. Riceman, B.Agr.Sc.
Assistant Research Officer (metabolism)—H. J. Lee, B.Sc.
Technical Officer—J. D. O. Wilson.
Technical Officer—F. C. Farr.
Statistical Recorder—G. W. Bussell.

At Waite Agricultural Research Institute, Adelaide—
Assistant Research Officer (mineral requirements and field investigations)—A. W. Peirce, B.Sc.

At F. D. McMaster Field Station, Badgery's Creek, New South Wales—
Principal Research Officer and Officer-in-charge (animal genetics)—R. B. Kelley, D.V.Sc.
Assistant Research Officer (field investigations)—H. E. B. Shaw, B.V.Sc.
Technical Officer—C. R. Graham.

At National Field Station, "Gilruth Plains", Cunnamulla, Queensland—
Research Officer-in-charge—J. H. Riches, B.Sc.Agr., Ph.D.
Station Manager—M. G. Murdoch.
Records Officer—S. J. Cossar.

At Dairy Research Institute, Palmerston North, New Zealand—
Dairy Research Officer—W. J. Wiley, D.Sc.

7. Mineral Deficiency of Pastures Investigation.

At Waite Agricultural Research Institute—
Assistant Research Officer (chemist)—R. E. Shapter, A.A.C.I.
Assistant Research Officer (agronomist)—C. M. Donald, B.Agr.Sc.

8. Division of Soils.

At Waite Agricultural Research Institute—
Chief—J. A. Prescott, D.Sc., A.A.C.I. (part-time).
Soil Survey Officer—J. K. Taylor, M.Sc., B.A.
Assistant Field Officer—T. J. Marshall, M.Agr.Sc. (abroad on studentship).
Assistant Field Officer—C. G. Stephens, M.Sc.
Chemist—J. S. Hosking, M.Sc., A.A.C.I.
Chemist—A. Walkley, B.Sc., B.A., Ph.D., A.A.C.I.
Chemist (spectroscopist)—A. C. Oertel, M.Sc.
Surveyor—P. D. Hooper.
Soil Microbiologist—T. H. Strong, B.Agr.Sc.
Assistant Field Officer—J. G. Baldwin, B.Agr.Sc.
Assistant Field Officer—G. D. Hubble, B.Agr.Sc.
Assistant Field Officer—R. L. Crocker, B.Sc.
Assistant Field Officer—B. E. Butler, B.Agr.Sc.
Assistant Field Officer—R. Smith, B.Agr.Sc.
Assistant Field Officer—R. I. Herriot, B.Agr.Sc.

9. Irrigation Settlement Problems.

At Commonwealth Research Station, Griffith—
Liaison Officer—F. K. Watson, M.A., B.Sc., A.M.Inst.C.E., A.M.I.E. (part-time).
Officer-in-charge—E. S. West, B.Sc., M.S.
Chemist—A. Howard, M.Sc.
Assistant Research Officer—R. R. Pennefather, B.Agr.Sc.
Orchard Superintendent—B. H. Martin, H.D.A.
Accountant—D. Chalmers (part-time).
Clerical Assistant—Miss A. Gralton.

At Commonwealth Research Station, Merbein—
Officer-in-charge—A. V. Lyon, M.Agr.Sc.
Senior Research Officer (chemist)—E. C. Orton, B.Sc., A.I.C.
Assistant Research Officer (irrigation and viticulture)—D. V. Walters, M.Agr.Sc.
Assistant Research Officer (drainage)—A. L. Tisdall, M.Agr.Sc.
Assistant Research Officer (chemist)—P. Dixon, M.Sc.
Technical Officer—J. E. Giles.
Research Officer—A. C. Ingerson (part-time).
Research Officer—R. C. Polkinghorne (part-time).

10. Division of Forest Products.

At South Melbourne—
Administration—
Chief—I. H. Boas, M.Sc., A.A.C.I.
Deputy Chief—S. A. Clarke, B.E., A.M.I.E.(Aust.).
Librarian and Records Clerk—Miss M. I. Hulme.

Chemistry Section—

Officer-in-charge—W. E. Cohen, D.Sc., A.A.C.I.
Assistant Research Officer (chemist)—A. W. Mackney, M.Sc, A.A.C.I.
Assistant Research Officer (chemist)—Miss T. M. Reynolds, M.Sc., D.Phil., A.A.C.I.
Technical Officer—A. G. Charles, A.A.C.I.

Flax Fibre Investigations—

Officer-in-charge—A. M. Munro, M.A.
Assistant Research Officer—Miss J. F. Couchman, B.Sc.

Seasoning Section—

Officer-in-charge—C. S. Elliot, B.Sc.
Assistant Research Officer—G. W. Wright, B.E.
Technical Officer—J. T. Currie.

Preservation Section—

Officer-in-charge—J. E. Cummins, B.Sc., M.S., A.A.C.I.
Assistant Research Officer—S. F. Rust, B.Sc., M.S.
Assistant Research Officer—H. B. Wilson, B.Sc., A.A.C.I.
Technical Officer—R. Deeble.

Wood Structure Section—

Officer-in-charge—H. E. Dadswell, M.Sc., A.A.C.I.
Assistant Research Officer—Miss A. M. Eckersley, M.Sc.
Assistant Research Officer—Miss J. Ellis, B.Sc.
Technical Assistant—Miss J. Galbraith.
Technical Officer—E. S. Smith.

Timber Mechanics Section—

Officer-in-charge—I. Langlands, B.E.E.
Assistant Research Officer—R. S. T. Kingston, B.Sc., B.E.
Technical Officer—B. Whitington.
Technical Officer—A. L. Gunn.

Timber Physics Section—

Officer-in-charge—W. L. Greenhill, M.E., Dip.Sc.

Timber Utilization Section—

Officer-in-charge—R. F. Turnbull, B.E.
Assistant Research Officer—A. J. Thomas, Dip.For.
Assistant Research Officer—W. R. Ferguson, B.E.
Technical Officer—A. Rosel.

Maintenance Section—

Technical Officer—S. G. McNeil.

11. Food Preservation Investigations.

At State Abattoir, Sydney—

Officer-in-charge—J. R. Vickery, M.Sc., Ph.D.
Research Officer (physicist)—E. W. Hicks, B.A., B.Sc.
Research Officer (biochemist)—S. A. Trout, M.Sc., Ph.D.
Research Officer (biochemist)—W. A. Empey, B.V.Sc.
Research Officer (citrus fruit)—L. J. Lynch, B.Sc.Agr.
Assistant Research Officer (biochemist)—C. C. Kuchel, M.Sc.
Assistant Research Officer (organic chemist)—J. F. Kefford, B.Sc.
Technical Officer (plant pathology)—P. R. Maguire.

At University of Melbourne.

Adviser and Investigator—Professor W. J. Young, D.Sc., F.A.C.I. (part-time).

At Government Cool Stores, Melbourne.—

Assistant Research Officer (biochemist)—F. E. Huelin, B.Sc., Ph.D., A.A.C.I.

At Brisbane Abattoir—

Assistant Research Officer (biophysicist)—A. R. Riddle, M.A., M.Sc.

At Australia House, London—

Assistant Research Officer—N. E. Holmes, B.E.E.

12. Fisheries Investigations.

At Port Hacking, Sydney—

Officer-in-charge—H. Thompson, M.A., D.Sc.
Biologist (co-opted, part-time, University of Sydney)—Professor W. J. Dakin, D.Sc., F.L.S., F.Z.S.
Fisheries Officer—S. Fowler.
Assistant Research Officer (biologist)—D. L. Serventy, B.Sc., Ph. D. (abroad on studentship).
Assistant Research Officer (biologist)—M. Blackburn, M.Sc.
Assistant Research Officer (biologist)—A. Tubb, M.Sc. (abroad on studentship).
Assistant Research Officer (librarian and biologist)—Miss F. V. Murray, M.Sc.
Bacteriologist—E. J. Ferguson Wood, M.Sc., B.A.
Clerk (Records, &c.)—R. D. Elder.
Technical Officer—A. Proctor (Laboratory).
Technical Officer—G. Clark (M.S. *Warreen*).
Master—M.S. *Warreen*—Captain A. Flett.

13. Radio Research.

At University of Melbourne—

Adviser—L. H. Martin, Ph.D. (part-time).
Investigator—A. F. B. Nickson, M.Sc.
Investigator—F. G. Nicholls, M.Sc.

At University of Sydney—

Research Physicist—D. F. Martyn, D.Sc., Ph.D., A.R.C.Sc.
Research Physicist—G. H. Munro, M.Sc.
Investigator—F. W. Wood, B.Sc.
Investigator—A. H. Mutton, B.E.
Investigator—W. K. Clothier, B.E., B.Sc.

14. Ore-Dressing Investigations.

At University of Melbourne—

Investigator—J. G. Hart.

At School of Mines, Adelaide, South Australia—

Investigator—L. M. Abell.

At School of Mines, Kalgoorlie, Western Australia—

Investigator—G. H. Payne, B.Sc.

15. Other Investigations.

Mineragraphic Investigations—

Investigator—F. L. Stillwell, D.Sc.
Assistant Research Officer—A. Edwards, B.Sc., Ph.D.

Biometrics—

At Canberra—

Research Officer (in charge of Section)—Miss F. E. Allan, M.A., Dip.Ed.

At Melbourne—

Assistant Research Officer—Miss M. Barnard, M. A., B.Sc., Ph.D.

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

(i) *Bulletins.*

No. 110.—Radio Research Board : Report No. 12—

(1) The Polarization of Radio Echoes, by D. F. Martyn, D.Sc., Ph.D., A.R.C.Sc., J. H. Piddington, M.Sc., B.E., and G. H. Munro, M.Sc.
(2) The design of an Automatic Variable-Frequency Radio Transmitter with Automatically Tuned Receiver, by H. B. Wood, B.E., B.Sc.

No. 111.—Radio Research Board : Report No. 13—

(1) The Control of Wireless Signal Variations, by A. L. Green, M.Sc., Ph.D., F.Inst.P., A.M.I.E.E., and Geoffrey Builder, Ph.D., F.Inst.P., A.M.I.E. (Aust.).
(2) Control of Phase Fading in Long Distance Radio Communication, by A. L. Green, M.Sc., Ph.D., F.Inst.P., A.M.I.E.E., and O. O. Pulley, B.E., Ph.D., A.M.I.E. (Aust.).
(3) Numerical Spacing of Adcock Aerials in Short-wave Direction-finding by A. L. Green, M.Sc., Ph.D., F.Inst.P., A.M.I.E.E., and Geoffrey Builder, Ph.D., F.Inst.P., A.M.I.E. (Aust.).

No. 112.—Studies in Fertility of Sheep, by R. B. Kelley, D.V.Sc.

No. 113.—Studies on Coast Disease of Sheep in South Australia (from the Nutrition Laboratory, Adelaide, Division of Animal Health and Nutrition), by H. R. Marston, R. G. Thomas, D. Murnane, E. W. L. Lines, I. W. McDonald, H. O. Moore, and L. B. Bull.

No. 114.—The Wood Structure of some Australian Rutaceae with Methods for their Identification: (Division of Forest Products—Technical Paper No. 25), by H. E. Dadswell, M.Sc., and Audrey M. Eckersley, M.Sc.

No. 115.—A Soil Survey of Part of the Denmark Estate, Western Australia, by J. S. Hosking, M.Sc., A.I.C., and G. H. Burvill, B.Sc. (Agric.).

No. 116.—The Relation of Phosphate to the Development of Seeded Pasture on a Podsolized Sand, by H. C. Trumble, M.Agr.Sc., D.Sc., and C. M. Donald, B.Sc.Agr.

No. 117.—The Regional and Seasonal Incidence of Grasshopper Plagues in Australia, by K. H. L. Key, M.Sc., Ph.D., D.I.C.

No. 118.—A Soil Survey of the Horticultural Soils in the Murrumbidgee Irrigation Areas, New South Wales, by J. K. Taylor, B.A., M.Sc., and P. D. Hooper.

No. 119.—The Wood Structure of some Australian Cunoniceae with Methods for their Identification: (Division of Forest Products—Technical Paper No 27), by H. E. Dadswell, M.Sc., and Audrey M. Eckersley, M.Sc.

(ii) *Pamphlets.*

No. 71.—The Grazing of Sheep on Improved Pastures: Its Effect on Superfine Wool, by I. Clunies Ross, D.V.Sc., N.P.H. Graham, B.V.Sc., Helen Newton Turner, H. B. Carter, B.V.Sc., and H. Munz.

No. 72.—Needle Fusion of Species of *Pinus* in Southern New South Wales, Progress Report 1933–36, by W. V. Ludbrook B.Agr.Sc., Ph.D.

No. 73.—Properties of Australian Timbers. Part 2.—Brown Mallet (*Eucalyptus astringens*); (Division of Forest Products—Technical Paper No. 23), by Ian Langlands, B.E.E.

No. 74.—Studies on the Chemotropic Behaviour of Sheep Blowflies, by Martin R. Freney, B.Sc.

No. 75.—Collapse and its Removal: Some Recent Investigations with *Eucalyptus regnans*: (Division of Forest Products—Technical Paper No. 24), by W. L. Greenhill, M.E., Dip.Sc.

No. 76.—Grading Studies in "Ash" Eucalypts: (Division of Forest Products—Technical Paper No. 26), by R. F. Turnbull, B.E., A. J. Thomas, Dip.For., I.F.A., and F. E. Hutchinson, B.Sc.F., B.For.Sc.

No. 77.—A Study of Persistency, Productivity, and Palatability in some Introduced Pasture Grasses, by A. McTaggart, Ph.D.

No. 78.—A Copper Deficiency in Plants at Robe, South Australia.

(1) Preliminary Investigations on the Effect of Copper and other Elements on the Growth of Plants in a "Coasty" Calcareous Sand at Robe, South Australia, by D. S. Riceman, B.Ag.Sc., and C. M. Donald, B.Sc.Agr.

(2) The Occurrence of "Reclamation Disease" in Cereals in South Australia, by C. S. Piper, M.Sc.

No. 79.—A Report on the Conditions of Animal Production in Australia, by John Hammond, M.A., D.Sc., F.R.S.

No. 80.—The Storage of Oranges with Special Reference to Locality, Maturity, Respiration, and Chemical Composition, by S. A. Trout, M.Sc., Ph.D., G. B. Tindale, B.Agr.Sc., and F. E. Huelin, B.Sc., Ph.D.

(iii) *Trade Circulars.*

No. 39.—The Selection of Timber. Part 1: Grading of Timber.

No. 40.—Testing a Timber-Seasoning Kiln.

(iv) *Quarterly Journal.*

Vol. 10, No. 3, August, 1937.

Vol. 10, No. 4, November, 1937.

Vol. 11, No. 1, February, 1938.

Vol. 11, No. 8, May, 1938.

(v) *Annual Report for the Year ending* 30*th June*, 1937.

XIV. ACKNOWLEDGMENT.

In various sections of this report reference has been made to the valuable assistance afforded by many organizations and individuals. The Council desires to express its gratitude for the help given by these bodies and persons in providing laboratory accommodation and other facilities and in many other ways. In particular, it desires to make special reference to the help given by the various State Departments, particularly those of Agriculture, and by the Universities, and to the contributions either in money or in kind provided by such bodies as the Australian Pastoral Research Trust, the Australian Wool Board, the Australian Dairy Cattle Research Association, the Australian Dried Fruits Control Board, and by other bodies, companies, and individuals. The Council also wishes to acknowledge the assistance it has received from its State Committees and other Committees, the members of which have placed their knowledge and experience so freely at its disposal.

G. A. JULIUS, Chairman
A. C. D. RIVETT
A. E. V. RICHARDSON
} Executive Committee.

G. LIGHTFOOT, Secretary.

13th October, 1938.

APPENDIX.

A.—PERSONNEL OF THE COUNCIL AND OF ITS VARIOUS COMMITTEES.

COUNCIL (AS AT 30TH JUNE, 1938).

EXECUTIVE.

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

CHAIRMEN OF STATE COMMITTEES.

Professor R. D. Watt, M.A., B.Sc. (New South Wales).
Russell Grimwade, C.B.E., B.Sc. (Victoria).
Professor H. C. Richards, D.Sc. (Queensland).
T. E. Field (South Australia).
E. H. B. Lefroy (Western Australia).
P. E. Keam (Tasmania).

CO-OPTED MEMBERS.

N. K. S. Brodribb, O.B.E., F.I.C.
G. S. Colman, C.B.E.
Professor E. J. Goddard, B.A., D.Sc.
Professor H. A. Woodruff, B.Sc., M.R.C.V.S., M.R.C.S., L.R.C.P.

STATE COMMITTEES (AS AT 30TH JUNE, 1938).

NEW SOUTH WALES.

Professor R. D. Watt, M.A., B.Sc. (*Chairman*).
E. C. Andrews, B.A., F.G.S.
Professor Sir Henry E. Barraclough, K.B.E., V.D., B.E., M.M.E., M.Inst.C.E., M.I.Mech.E.
Professor W. J. Dakin, D.Sc.
Professor J. C. Earl, D.Sc., Ph.D., F.I.C.
W. R. Hebblewhite, B.E.
C. H. Hoskins.
The Hon. Sir Norman W. Kater, Kt., M.L.C., M.B., Ch.M.
F. Leverrier, K.C., B.A., B.Sc.
Sir Frederick McMaster, Kt.
J. Nangle, O.B.E., F.R.A.S.
R. J. Noble, B.Sc.(Agr.), M.Sc., Ph.D.
E. D. Ogilvie, B.A.
Professor J. D. Stewart, M.R.C.V.S., B.V.Sc.
G. D. Ross.
F. J. Walker.
Lieut.-Col. H. F. White, C.M.G., D.S.O.

VICTORIA.

Russell Grimwade, C.B.E., B.Sc. (*Chairman*).
Professor W. E. Agar, M.A., D.Sc., F.R.S.
W. Baragwanath.
N. K. S. Brodribb, O.B.E., F.I.C.
G. S. Colman, C.B.E.
Sir Herbert W. Gepp, Kt., M.Aust.I.M.M., M.Am.I.M.M.
H. Herman, D.Sc., M.M.E., B.C.E.
Sir Dalziel Kelly, Kt., LL.B.
Professor W. N. Kernot, B.C.E., M.Mech.E., M.Inst.C.E.
Emeritus Professor Sir Thomas R. Lyle, M.A., D.Sc., F.R.S.
H. A. Mullett, B.Agr.Sc.
B. Perry.
F. J. Rae, B.A., B.Sc., B.Agr.Sc.
W. E. Wainwright, A.S.A.S.M., M.Aust.I.M.M., M.Am.I.M.M.
L. J. Weatherly, M.A.
Professor H. A. Woodruff, B.Sc., M.R.C.V.S., M.R.C.S., L.R.C.P.
Professor W. J. Young, D.Sc.

SOUTH AUSTRALIA.

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

QUEENSLAND.

Professor H. C. Richards, D.Sc. (*Chairman*).
Professor H. Alcock, M.A.
Professor L. S. Bagster, D.Sc.
J. D. Bell.
Professor E. J. Goddard, B.A., D.Sc.
J. B. Henderson, O.B.E., F.I.C.
T. L. Jones.
A. G. Melville.
J. F. Meynink.
Professor J. K. Murray, B.A., B.Sc.Agr.
Professor T. Parnell, M.A.
Professor H. R. Seddon, D.V.Sc.
R. Veitch, B.Sc.Agr., B.Sc.For., F.E.S.

WESTERN AUSTRALIA.

E. H. B. Lefroy (*Chairman*).
F. G. Brinsden, M.I.M.M., M.Aust.I.M.M.
W. G. Burges.
Professor E. de Courcy Clarke, M.A.
J. D. Hammond.
P. H. Harper, B.A.
L. St.J. Jones.
S. L. Kessell, M.Sc., Dip.For.
A. L. B. Lefroy.
Professor G. E. Nicholls, D.Sc., A.R.C.Sc., F.L.S.
Professor J. E. Nichols, M.Sc., Ph.D.
Professor A. D. Ross, M.A., D.Sc., F.R.S.E., F.Inst.P.
E. S. Simpson, D.Sc., B.E.
G. L. Sutton, D.Sc.Agr.
Professor H. E. Whitfeld, C.B.E., B.A., B.E., M.I.M.M., M.I.E.Aust.
N. T. M. Wilsmore, D.Sc., F.I.C., M.I.Chem.E.

TASMANIA.

P. E. Kcam (*Chairman*).
N. P. Booth, F.I.C.
Professor A. Burn, M.Sc., B.E.
F. H. Foster, M.H.A., B.M.E., A.M.I.E.Aust.
F. W. Hicks.
Professor A. L. McAulay, M.A., B.Sc., Ph.D., F.Inst.P.
D. O. Meredith, A.Inst.M.M., M.I.E.Aust., M.A.C.S.
A. K. McGaw, C.M.G.
W. E. Maclean, M.Inst.C.E., M.I.E.Aust.
F. H. Peacock.
The Hon. R. O. Shoobridge, M.L.C.
S. W. Steane, B.A., F.R.G.S.

COMMONWEALTH RESEARCH STATIONS, MERBEIN AND GRIFFITH—COMMITTEE OF CONTROL

Professor J. A. Prescott, D.Sc., Waite Agricultural Research Institute, University of Adelaide (*Chairman*).
B. T. Dickson, B.A., Ph.D., Chief, Division of Plant Industry, C.S.I.R.
F. K. Watson, M.A., B.Sc.(Agr.), B.Sc., A.M.I.C.E., Water Conservation and Irrigation Commission, Leeton, New South Wales.
A. L. Johnstone, Commonwealth Dried Fruits Control Board.
P. Malloch, Commonwealth Dried Fruits Control Board.

COMMONWEALTH RESEARCH STATION, MERBEIN—ADVISORY COMMITTEE.

D. C. Winterbottom, Mildura Packers' Association (*Chairman*).
A. R. McConchie, State Rivers and Water Supply Commission, Red Cliffs, Victoria.
A. Lever, Mildura Shire Council.
A. V. Lyon, M.Agr.Sc., Commonwealth Research Station, Merbein
F. K. Watson, M.A., B.Sc.(Agr.), B.Sc., A.M.I.C.E., Water Conservation and Irrigation Commission, Leeton, New South Wales.
J. A. Lockhead, Mildura Shire Council.
A. E. Cameron, Red Cliffs Settlement.
J. Gordon, Citrus Growers' Association, Merbein.
W. Heaysman, Cardross Horticultural Society.
L. W. Andrew, Waikerie, South Australia.
O. Weste, Renmark, South Australia.
S. Heaysman, Coomealla, New South Wales.
S. P. Taylor, Curlwaa, New South Wales.
P. T. Byrnes, Woorinen, Victoria.
W. Grundy, Nyah, Victoria.

COMMONWEALTH RESEARCH STATION, GRIFFITH—ADVISORY COMMITTEE.

F. K. Watson, M.A., B.Sc.(Agr.), B.Sc., A.M.I.C.E., Water Conservation and Irrigation Commission, Leeton, New South Wales (*Chairman*).
A. G. Kubank, Murrumbidgee Irrigation Rice Growers' Co-operative Society.
A. V. Lyon, M.Agr.Sc., Commonwealth Research Station, Merbein.
T. T. Morley, Griffith Producers' Co-operative Co. Ltd.
L. J. Rydon, Yenda Producers' Co-operative Society Ltd.
E. S. West, B.Sc., M.S., Commonwealth Research Station, Griffith.
V. C. Williams, Murrumbidgee Irrigation Areas Research Bureau, Griffith.

CITRUS PRESERVATION TECHNICAL ADVISORY COMMITTEE.

J. R. Vickery, M.Sc., Ph.D., Section of Food Preservation and Transport, C.S.I.R. (*Chairman*).
Professor W. J. Young, D.Sc., University of Melbourne.
E. S. West, B.Sc., M.S., Commonwealth Research Station, Griffith, New South Wales.
C. G. Savage, Director of Fruit Culture, Department of Agriculture, New South Wales.
R. J. Benton, Fruit Instructor, Department of Agriculture, New South Wales.
F. M. Read, M.Agr.Sc., Chief Inspector of Horticulture, Department of Agriculture, Victoria.
J. Hepburn, Manager, Government Cool Stores, Melbourne.
A. G. Strickland, M.Agr.Sc., Chief Horticultural Officer, Department of Agriculture, South Australia.

RADIO RESEARCH BOARD.

Professor J. P. Madsen, B.E., D.Sc., Department of Engineering, University of Sydney (*Chairman*).
Sir Harry Brown, C.M.G., M.B.E., M.I.E.E., Postmaster-General's Department.
Professor T. H. Laby, M.A., Sc.D., F.R.S., F.Inst.P., Department of Natural Philosophy, University of Melbourne.

MINERAGRAPHIC COMMITTEE.

Professor E. W. Skeats, D.Sc., A.R.C.Sc., F.G.S., Geology School, University of Melbourne.
W. E. Wainwright, A.S.A.S.M., M.Aust.I.M.M., M.Am.I.M.M., Australasian Institute of Mining and Metallurgy.

FRUIT PROCESSING COMMITTEE.

W. R. Jewell, M.Sc., Research Chemist, Department of Agriculture, Victoria (*Chairman*).
A. V. Lyon, M.Agr.Sc., Commonwealth Research Station, Merbein.
A. G. Strickland, Chief Horticultural Officer, Department of Agriculture, South Australia.
C. G. Savage, Director of Fruit Culture, Department of Agriculture, New South Wales.
E. S. West, B.Sc., M.S., Commonwealth Research Station, Griffith.
D. Quinn, Department of Agriculture, Victoria (*Secretary*).

SUPERVISORY COMMITTEE ON WEEDS INVESTIGATIONS.

B. T. Dickson, B.A., Ph.D., Chief, Division of Plant Industry, C.S.I.R.
A. J. Nicholson, D.Sc., Chief, Division of Economic Entomology, C.S.I.R.
G. A. Currie, B.Agr.Sc., D.Sc., Officer-in-Charge, Weeds Section, C.S.I.R.

ADVISORY COMMITTEE RED-LEGGED EARTH MITE INVESTIGATIONS, WESTERN AUSTRALIA.

E. H. B. Lefroy, Chairman, State Committee, C.S.I.R.
Professor J. E. Nichols, M.Sc., Ph.D., University of Western Australia.
L. J. Newman, F.E.S., Department of Agriculture, Western Australia.
I. Thomas, Department of Agriculture, Western Australia.
A. J. Nicholson, D.Sc., Chief, Division of Economic Entomology, C.S.I.R.
L. W. Phillips, M.Sc., M.Ed., A.A.C.I. (*Secretary*).

THE VETERINARY ENTOMOLOGICAL COMMITTEE.

(*Formerly the Inter-Divisional Blowfly Committee.*)

L. B. Bull, D.V.Sc., Chief, Division of Animal Health and Nutrition, C.S.I.R.
A. J. Nicholson, D.Sc., Chief, Division of Economic Entomology, C.S.I.R.
I. M. Mackerras, B.Sc., M.B., Ch.M., Division of Economic Entomology, C.S.I.R.

ADVISORY COMMITTEE ON NATIONAL FIELD STATION, "GILRUTH PLAINS".

N. Bourke, Queensland United Graziers' Association (*Chairman*).
Eric P. Beresford, Moonjaree, Cunnamulla, Queensland.
W. Kent, Jonbaryan, Darling Downs, Queensland.
E. Nantes, Queensland United Graziers' Association.

B.—COMMITTEES CONCERNING WORK IN WHICH THE COUNCIL IS CO-OPERATING.

SCIENTIFIC PUBLICATIONS COMMITTEE.

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Sir David Rivett, K.C.M.G., M.A., D.Sc., Council for Scientific and Industrial Research.
W. G. Woolnough, D.Sc., Geological Adviser to the Commonwealth.

CATTLE RESEARCH ADVISORY COMMITTEE.

(For Queensland Cattle Research.)

E. E. D. White, Queensland United Graziers' Association (*Chairman*).
J. L. Wilson, Queensland United Graziers' Association.
F. M. Bell, Queensland United Graziers' Association.
R. C. Philip, Queensland United Graziers' Association.
N. Bourke, Queensland United Graziers' Association.
E. W. Archer, Queensland United Graziers' Association.
P. A. Brown, Queensland United Graziers' Association.
Professor H. C. Richards, D.Sc., University of Queensland.
A. H. Cory, M.R.C.V.S., Department of Agriculture and Stock, Queensland.
Professor H. R. Seddon, D.V.Sc., University of Queensland.

ADVISORY COMMITTEE ON FRUIT COOL STORAGE INVESTIGATIONS.

Professor W. J. Young, D.Sc., Biochemistry School, University of Melbourne (*Chairman*).
S. Fish, M.Agr.Sc., Department of Agriculture, Victoria.
F. M. Read, M.Agr.Sc., Chief Inspector of Horticulture, Department of Agriculture, Victoria.
J. R. Vickery, M.Sc., Ph.D., Food Preservation and Transport Section, C.S.I.R.

ADVISORY COMMITTEE ON ORIENTAL PEACH MOTH INVESTIGATIONS.

A. J. Nicholson, D.Sc., Chief, Division of Economic Entomology, C.S.I.R. (*Chairman*).
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Printed and Published for the GOVERNMENT of the COMMONWEALTH of AUSTRALIA by
L. F. JOHNSTON, Commonwealth Government Printer, Canberra.