1941.

NEW ZEALAND.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(FIFTEENTH ANNUAL REPORT OF THE).

Presented to both Houses of the General Assembly by Leave.

CONTENTS.

MINISTER'S STATEMENT.

THE war has brought into prominence the necessity for applications of science and research to all our problems of warfare and supply in a more direct manner than hitherto. Moreover, the circumstances call for a shorter lag between the research worker and practical application of his results than is normally the case in peace-time. This has been exemplified not only in the application of research to weapons of defence and offence, as witness the developments of radio location and methods of countering the newer types of mines, but also in unexpected problems of agriculture and supply—for instance, in the application of soil research to the problem of securing increased effectiveness of fertilizers, the speeding-up of large-scale production of linen flax, and the production of many types of substitute materials through the necessities arising from the war.

Two tendencies have become marked in consequence—firstly there is an increased readiness of practical men to seek scientific work for their guidance, and secondly, the scientific research workers are finding in the practical problems presented an interest which appeals to their full scientific powers. In general, a more real co-operation has developed between science and practice which augurs well for the future and for the problems of reconstruction, since one of the chief problems of this scientific age is to bring to bear the best scientific knowledge into our consideration of practical affairs.

The work of the Department during the year has therefore been mainly on problems arising from the exigencies of the war, and its full resources have been placed at the disposal of the various Departments and organizations to which it could be of assistance. The work which has been done and the results achieved during the past year demonstrate most convincingly the necessity of maintaining in times of peace and war alike a national organization for the promotion of scientific research. We cannot develop our natural resources wisely and well under normal circumstances without the application of scientific knowledge of their extent and potentialities; nor could we adapt ourselves rapidly enough to emergency conditions requiring the maximum concentration of research effort if a research organization and trained personnel were not already in existence. Research is vital to social and industrial stability and progress at all times, and it is in this knowledge that we must foster it to national advantage.

D. G. SULLIVAN,
Minister in Charge of Scientific
and Industrial Research Department.

SECRETARY'S REPORT.

The Hon. D. G. SULLIVAN, Minister in Charge of the Scientific and Industrial Research Department.

I have the honour to submit herewith the annual report of the Department for the year 1940-41.

The Council of Scientific and Industrial Research held six meetings during the year.

The personnel of the Council is as follows:—

Professor H. G. Denham, M.A., D.Sc., Ph.D., F.I.C., F.R.S.N.Z., Professor of Chemistry, Canterbury University College, Christchurch (Chairman).
Dr. J. C. Andrews, Ph.D., M.Sc., Freezing-works Manager, Auckland.
Mr. A. H. Cockayne, I.S.O., Director-General of Agriculture, Wellington.
Professor E. R. Hudson, B.Sc., B.Agr., Dip. C.A.C., Director, Canterbury Agricultural College, Lincoln.
Dr. R. O. Page, D.Sc., Tannery-works Manager, Christchurch.
Mr. G. A. Pascoe, Factory Controller, Department of Industries and Commerce.
Mr. J. M. Ranstead, Matangi, Farmer.
Professor W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D., Massey Agricultural College.
Sir Theodore Rigg, M.A., M.Sc., F.I.C., F.R.S.N.Z., Director, Cawthron Institute, Nelson.
Dr. E. Marsden, M.C., C.B.E., D.Sc., F.R.S.N.Z. (Secretary).
Mr. F. R. Callaghan, M.A., F.R.E.S. (Acting-Secretary).

Professor E. R. Hudson, Director of Canterbury Agricultural College, Lincoln, was appointed to the Council on 1st June, 1940, to fill the vacancy created by the resignation of Dr. R. R. Milligan.

Mr. T. H. McCombs, M.P., M.Sc., continued to act on the Council as special representative of the Hon. the Minister.

Mr. F. R. Callaghan continued as Acting-Secretary of the Council and the Department, owing to my being almost wholly occupied with special scientific investigations for the defence services. Mr. F. J. A. Brogan, Assistant Secretary, has given excellent assistance.

I visited Egypt, Great Britain, and Canada during the year to study the latest scientific developments in relation to defence, and to discuss problems of common interest and importance.

The expenditure of the Department during the year was as follows:—

Permanent Services—

	£
Head Office: Comprising general expenses of administration, publications (including the *New Zealand Journal of Science and Technology* and departmental bulletins), research scholarships, and grants to the Royal Society of New Zealand, the Imperial Institute, and the Carter Observatory	14,708
Dominion Laboratory (with branches)	26,767
Dominion Observatory	2,063
Geological Survey	11,975
Magnetic Observatory	2,238
Grants to Imperial Agricultural Bureaux	5,588
Research Investigations	133,622
	196,961
Recoveries	32,887
	£164,074

Grants were made to the following research organizations in Great Britain:—

	£
Imperial Agricultural Bureaux Headquarters	1,438
Cambridge Low Temperature Research Station	2,000
Farnham House Laboratory	750
Wool Industries Research Association, Torridon	300
Imperial Mycological Institute	350
Imperial Institute of Entomology	450
Imperial Bureau of Dairy Science	113
Imperial Forestry Bureau	187
	£5,588

During the year the activities of the Department as a whole have been further concentrated on giving maximum possible help on problems arising from war conditions. Certain research and development problems are being investigated by a special section of the Department in collaboration with the University colleges and the Radio Section of the Post and Telegraph Department.

A special Defence Scientific Advisory Committee has been set up to collaborate with the defence Services, and consist of the following :—

Dr. E. Marsden, Director of Defence Scientific Developments (Chairman).
Mr. R. L. Andrew, Dominion Analyst.
Dr. J. C. Andrews, Works-manager, R. and W. Hellaby, Ltd.
Professor P. W. Burbidge, Professor of Physics, Auckland University College.
Professor H. G. Denham, Professor of Chemistry, Canterbury University College.
Professor T. D. J. Leech, Professor of Engineering, Auckland University College.
Professor F. G. Soper, Professor of Chemistry, Otago University.
Professor F. W. G. White, Professor of Physics, Canterbury University College.
Mr. N. A. Marris, Department of Scientific and Industrial Research (Secretary).

Professor F. G. Soper has been appointed Chemical Adviser on Munitions and Chairman of the chemical panel of the above Committee.

Numerous and urgent problems have arisen in connection with the supply, overseas transport, and storage of foodstuffs, and the provision of substitutes for imported industrial materials now unavailable or in short supply, and the Department is applying its full resources in the necessary technical investigations.

The following is a brief review of some of the salient features of the year's work and the research progress made :—

Plant Research.

The work of the Plant Research Bureau has been concentrated on minimizing losses in pasture, arable and horticultural crops by the intensification of control measures; the maintenance of full supplies of certified pasture and crop seeds; the propagation and collection of important medicinal plants to help supply emergency requirements in Great Britain and locally; local substitutes for imported plant materials—*e.g.*, seaweed products such as agar and carageen the most efficient methods of preparation and conservation of supplementary fodders; the maintenance of aerodrome turfs under heavy service conditions; and instructional and research work required by the administration of the Termites Act, 1940.

Dairy Research.

The Dairy Research Institute has been occupied with urgent problems relating to the storage and transport of dairy-produce under war conditions, and with the particular objectives of prolonging the keeping-quality of dairy-produce likely to be stored for long periods, and methods of packaging and processing butter and cheese to conserve shipping-space and weight and packing-materials. Special starter-rooms embodying the Institute's recommendations for preserving the vitality of starters were erected by some fifteen dairy factories during the past season.

Plant Chemistry Laboratory.

The destruction of the laboratory and the greater part of its equipment by fire during the year was a severe set-back. Nevertheless, very good work has been done under difficult circumstances in supplying a considerable quantity of alkaloidal material from perennial rye-grass to the Department of Agriculture for animal experiments at Wallaceville in connection with facial-eczema studies, and in obtaining valuable chemical data on the digestibility and nutritive value of hay and silage from selected pastures.

Soil Survey.

Field-work on the general soil survey of the North Island was completed, and the preparation of the soil maps and supporting data begun. This survey is producing data of considerable usefulness under existing conditions, and its value will be still further enhanced in the reconstruction period following the war. In the South Island, mapping for the general soil survey was undertaken chiefly in the high-country runholds, special attention being given to the incidence and severity of soil erosion. Surveys in South Otago and Southland are being conducted to delimit soils suitable for linen flax. At the Cawthron Institute the main project has been the continuation of soil surveys of tobacco lands to provide soil data for increased tobacco acreage.

Wheat Research.

The process devised by the Wheat Research Institute for the incorporation of up to 10 per cent. of wheat-germ in white bread by pre-fermentation of the germ with yeast, so as to produce a highly palatable loaf containing the important vitamin B, has been extensively adopted in New Zealand and elsewhere. This work has led up to a further discovery that the same process of pre-fermentation can be applied to produce from 80-per-cent.-extraction flour a loaf practically as good as that from 70-per-cent. flour. The importance of this discovery in wartime lies in the fact that its application would increase by 12 per cent. the proportion of the wheat grain that can be used for human food, and at the same time increase to some extent the nutritive value of white bread.

Fruit Research.

The outstanding problems in fruit research have been concerned with methods of storing under the best possible conditions the surplus of fruit thrown on the local market as a result of cessation of export. This has meant resorting to orchard storage on a greatly increased scale to supplement cold-storage facilities. From an extensive series of experiment undertaken in co-operation with the Cawthron Institute, valuable practical information has been obtained as to the optimum conditions of temperature and humidity in orchard stores, the best methods of wrapping and packing, and the varieties and grades of fruit best suited for orchard storage.

Tobacco Research.

Mr. R. Thomson, of the Agronomy Division, who was appointed Tobacco Research Officer to replace Mr. J. M. Allan, resigned, has been sent to Canada and the United States of America to gain experience in flue-cured-tobacco production before taking up his duties at the Research Station. The Cawthron Institute has further extended tobacco-soil surveys, investigated the incidence and control of magnesium deficiency in tobacco soils, and continued its work on disease control and the correlation of chemical composition of tobacco with smoking-quality.

Fertilizer experiments at the Research Station, Umukuri, are now producing results of practical value to the tobacco-growers in indicating optimum rates of application of standard fertilizer, and the best methods of placement.

Timber Protection Research.

The passing of the Termites Act, 1940, marked the beginning of an intensive campaign for the eradication of the Australian white-ant pest. The administration of the Act is in the hands of the State Advances Corporation. The Plant Diseases Division and the Entomology Division of this Department are actively assisting the Corporation by providing a course of training for Inspectors appointed under the Act, undertaking the identification of specimens, studying the life-history and habits of termites, and advising as to control measures. Chemical work required is being undertaken by the Dominion Laboratory.

Mineral Resources Surveys.

Surveys of minerals of strategic value and special economic importance in war-time have been intensified. This work, which requires close collaboration with the Mines Department, is being co-ordinated by a Committee comprising representatives of the Mines Department, the Geological Survey, and the Dominion Laboratory. Surveys have been made of local resources of such minerals as serpentine, magnesite, oil-shale, sulphur, sands, and clays, and the ores of such strategic metals as nickel, copper, manganese, mercury, tungsten, and iron.

Serpentine-superphosphate and Potash Substitutes.

A special Committee was set up by the Council to co-ordinate investigations by the Departments of Agriculture and Scientific and Industrial Research, Cawthron Institute, and Canterbury Agricultural College on the manufacture and agricultural value of a reverted phosphatic fertilizer made by incorporating ground serpentine with superphosphate. Valuable data have been obtained concerning available supplies of serpentine, the technique of manufacture, and the responses given by pasture and arable crops to applications of the serpentine-superphosphate mixture. The same Committee has initiated surveys of local resources of greensand and a variety of seaweed with a high potash content as possible emergency sources of agricultural potash.

Research for Secondary Industries.

The activities of the research associations servicing the tanners, the boot and shoe manufacturers, and the wool manufacturers have been directed specially to war manufacturing problems, among which the provision of satisfactory substitutes for imported materials now unavailable has been not the least important. Other manufacturing industries have been helped with similar problems—*e.g.*, local substitutes for imported pottery materials, adhesives, and agar and carageen (Irish Moss) have been suggested. The services of the Dominion Laboratory and the Physical Testing Laboratory have been extensively drawn upon for testing the quality and performance of a wide range of locally-manufactured materials.

Supply Problems.

Close liaison with the Ministry of Supply on general supply problems has been maintained, and investigations required in connection with specific problems of substitutes are being dealt with through a Substitutes Committee representing the Departments of Scientific and Industrial Research, Industries and Commerce, and Customs.

Physical Testing Laboratory.

The demands on the Laboratory by the defence services, Government Departments, and industrial firms of physical testing and precision-instrument construction, testing, and repair have increased during the year to such an extent as to require an increase in staff, and the provision of additional equipment and accommodation. Much valuable work has been done. The Laboratory is extending its operations in regard to standards of reference for use in connection with munitions-manufacture and to provide for the needs of industry generally.

Dominion Laboratory.

War conditions have given rise to a considerable increase in the volume of chemical service work required by Government Departments. Regular tests of milk-supplies and water-supplies for military camps have been made, and a large variety of materials have been tested in connection with the purchase of defence stores. The Chemical Engineering Section has been largely occupied on the investigation of producer-gas as an emergency fuel for motor-vehicles. Semi-commercial trials on the gas storage of apples to improve their keeping-qualities for local consumption are producing valuable data. A large volume of chemical work has been required in connection with the survey of national coal resources. In general, almost every section of the Laboratory has been engaged in special work relating to war requirements.

Geological Survey.

Surveys of strategic and economic minerals have been intensified. Data obtained in the course of the coal-resources survey is proving of considerable help to co-operative mining parties, and in the more economic use of coal-supplies under war conditions. Continued assistance has been given to the oil companies at present carrying out boring operations in New Zealand. Special geological and geophysical surveys have been carried out for the Public Works Department in the Waikato in connection with hydro-electric developments.

Observatories.

A resurvey of magnetic stations throughout New Zealand is being made to provide data required by the defence Services.

Publications.

The dissemination of research information to all sections of industry has been continued by means of the Department's official journal, special bulletins, monthly letters, and special reports.

Staff.

I desire to record the praiseworthy way in which each and every member of the staff has faced and carried out increased duties and responsibilities arising from the war effort.

E. Marsden, Secretary.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

DAIRY RESEARCH INSTITUTE.

Dairy Research Management Committee.—Mr. A. Morton (Chairman), Professor H. G. Denham, Messrs. T. C. Brash, A. H. Cockayne, C. H. Courtney, G. A. Duncan, H. E. Johnson, A. Linton, C. A. Marchant, A. J. Murdoch, J. Murray, G. M. Valentine. Secretary: Dr. E. Marsden. Director: Professor W. Riddet.

The Committee held five meetings during the year at approximately two-monthly intervals, when it considered reports on research work in progress and projected, and means by which research could be used to assist the Dominion dairy industry. Problems affecting the industry as a consequence of the war were kept constantly under review, and every attempt was made within the limits of finance and staff available to utilize the Institute to the best advantage in making preparations for exigencies that might arise.

Work Undertaken.

Substantial progress was made towards the solution of problems concerned with the manufacture and storage of cheese; the manufacture, wrapping, and storage of butter; and dairy husbandry.

Cheese studies included—

(*a*) The determination of practicable measures in cheese-factories for preventing the contamination of starters with bacteriophage, which had been shown in previous years to be the principal cause of loss of vitality in starters and responsible for widespread difficulties in cheese-manufacture.

(*b*) Investigation of two possible causes of bitter flavour in mature cheese, to which increasing attention has been drawn in recent years.

(*c*) Determination of methods of adding to cheese milk under factory conditions selected bacteria that have been proven by past work at the Institute to improve the flavour of cheese.

(*d*) Methods of effectively controlling mould growth on and shrinkage in cheese stored in factory curing-rooms.

Butter projects included—

(*a*) Investigations of methods, which could be carried out on a large scale in butter-factories, of eliminating land-cress taint from affected cream; and of grazing practices that might reduce the intensity of or entirely avoid the taint in freshly-drawn milk, since this defect affects a substantial quantity of butter made in the South Auckland district, especially in the spring and early summer months.

(*b*) The causes of variation in the hardness of butter, since this has an important bearing on its spreading properties in cold weather and on its ability to keep firm in warm weather.

(*c*) The extent of seasonal and district variations in the colour and composition of butterfat and the diacetyl content of butter.

(*d*) The production of clarified butterfat.

(*e*) Investigation of the usefulness of Pliofilm as a wrapping-material for butter.

The dairy-husbandry projects were carried out to determine—

(*a*) Differences and variations in the yield, composition, and flavour of milk produced by cows grazed respectively on mixed pasture species, perennial rye-grass - white clover and cocksfoot - white clover swards.

(*b*) The influence of the plane of nutrition of milking-cows at pasture on the yield and composition of their milk.

(*c*) The frequency of weighing, sampling, and analysing the milk of individual cows to obtain prescribed degrees of accuracy in the results.

(*d*) The benefits, if any, of feeding meal to calves being reared on skim-milk and grazed on good pasture.

A number of miscellaneous investigations were carried out, including the cause of pitting in milk-cans and the relationship of the period of continuous running of farm separators to the fat content of the skim-milk.

At the instigation of the Institute and with the aid of a grant provided by it, Mr. P. O. Veale made a survey of the extent to which different types of rivers in Taranaki are contaminated by dairy factory effluent.

The land-cress investigations were carried out with the assistance of Messrs. Murray Deodorisers Co., Ltd., at the Tauranga Co-operative Dairy Co.'s butter-factory, to the directors and executive officers of both of which companies the Institute is greatly indebted for their valued assistance. Some of the land-cress grazing trials were also carried out in the Tauranga district with the kind co-operation of the staff of the Fields Division of the Department of Agriculture.

The Plant Research Bureau collaborated in the Institute's dairy-husbandry grazing projects, and the Wallaceville Animal Research Station examined the milk of individual cows at weekly intervals for the presence of mastitis. The experimental cows were used for part of the season by the Animal Research Station for their work on grass staggers.

The following statements on the respective projects give a brief account of the results achieved during the year. More detailed accounts are given in published reports on some of these projects; others will be published as the work becomes sufficiently advanced to place on record in technical literature.

Cheesemaking Projects.

(*a*) *Cheese Starters* (H. R. Whitehead and I. R. Sherwood).—Work during past seasons had shown that contamination with bacteriophage (usually air borne) accounted for most of the failures of single-strain cheese starters in dairy factories. The provision of a building for the preparation of starter entirely separate from the main factory had proved most successful in eliminating trouble. The past season was devoted almost entirely to work in the field in an attempt to help factory-managers to put into operation the most successful methods for starter maintenance. There are now in existence at factories in Taranaki and Wellington Provinces fifteen buildings specially erected for the maintenance of starters. At numerous other places alterations to existing buildings have been made with the object of minimizing the risk of contamination of the starter with air-borne phage. In general the factories concerned have experienced an enormous improvement in the ease with which starters could be maintained without failure, but there have occurred difficulties on various occasions which have necessitated visits from members of the Institute staff. Investigations have so far shown that the principles on which we are working are sound and that the difficulties which still occur are due either to faulty layout or to faults in technique. It has been found during the course of the season that air-borne phage can spread at least 17 yards in the open air outside a factory building and that the air-filters so far used in starter-rooms are not completely effective in retaining phage. Improvements in the air-filters are still being tried out, and the value of distance from the main factory in the protection of starter is being stressed wherever the construction of a starter-room is contemplated. Various details in starter equipment, particularly the lids used for starter cans, are still being tested with various modifications under practical conditions, and it is evident that a standardized practice will be evolved only gradually.

Summarizing the whole position, it may be stated that all the results indicate that, provided contaminant bacteriophage can be excluded, starter cultures retain their activity over very long periods and give regularity of performance in normal milk in the cheese-vat from day to day.

(*b*) *Occurrence of "Bitter" Flavour in Cheese* (W. Riddet and H. R. Whitehead).—Bitter flavour is apparently a common fault in mature cheddar cheese wherever it is made. Comments on New Zealand cheese from London frequently mention bitterness. During the past season experiments have been carried out in the Institute factory in an endeavour to throw some light on the cause of the fault, or to discover a means of overcoming it. The experiments were designed to test two hypotheses:—

(*a*) That bitterness is due to too low a salt content in the cheese. American workers suggest that this is the case.

(*b*) That bitterness occurs when the most desirable types of flavour-producing bacteria do not happen to be present in the milk or when they have been destroyed by pasteurization.

The first hypothesis was tested by salting different fractions of the same batch of curd at different rates. The second hypothesis was tested by—

(i) Comparing the flavour of cheese made from milk flash-pasteurized at 155° F. with the flavour of cheese made from similar milk pasteurized at 130° F. and 140° F.

(ii) Comparing the flavour of cheese made from milk to which desirable strains of flavour-producing lactobacilli had been added with the flavour of control cheese made from similar milk with no addition of bacilli (see next section of report).

Since the incidence of bitter flavour can be judged only on the mature cheese, it is too early to give any complete results from this work, although it appears so far that there has been very little bitterness in the control cheeses this season.

(*c*) *Cheese Flavour* (I. R. Sherwood).—Experiments described in earlier reports have shown that the flavour of cheddar cheese is improved through the addition of certain types of lactobacilli to the cheese-milk. These findings have not yet been applied to commercial cheesemaking practice on account of the difficulty which has been experienced in maintaining pure cultures of lactobacilli under factory conditions.

It was with the object of facilitating the commercial use of lactobacilli that the experiments outlined below were carried out. During the whole season dry powdered cultures of suitable lactobacilli were prepared and used in practical cheesemaking trials in the Institute experimental factory. Powder preparations were made by centrifuging yeast-milk cultures of the organisms and vacuum drying the curd in admixture with precipitated calcium carbonate. The resulting dry powders were usually found to have a count of approximately 100 million organisms per gram.

The use of lactose in place of calcium carbonate, as commonly employed in the preparation of powdered starter cultures, was found to lower considerably the numbers of viable lactobacilli.

Two vats (80 gallons) were used in the manufacture of the cheese. Vat No. 1 served for the manufacture of control cheeses; vat No. 2 in a separate room and run under closely similar conditions was inoculated with the powdered cultures. The percentage inoculation, calculated on the weight of milk, ranged from 0·005 to 0·04. While most of the cheeses manufactured have not yet been examined at maturity, results so far to hand show that inoculation of the milk led, in general, to an improvement in the flavour of the cheese.

The simplicity of the method suggests that an adaption of this procedure would be practicable under commercial conditions.

Buttermaking Projects.

(*a*) *Land Cress Taint in Cream* (F. H. McDowall).—The previous work on the treatment of cream for the removal of land-cress taint had been carried out during November and December. An attempt to repeat the experiment during the months of September and October did not meet with success. It appears that during the early spring, when the plant is in the less mature growth stages, the cream becomes more strongly tainted than in the later months when the plant is mature. By an indirect process, an oil has been obtained from the plant material consisting of almost pure benzyl isothiocyanate, and therefore differing from the oil obtained by direct distillation—viz., benzyl cyanide. Addition of benzyl isothiocyanate to cream, however, did not give the true cress taint in the cream or butter. Benzyl isothiocyanate is obtainable from the mature plant, and when added in quantity to the diet of a cow does not cause cress taint in the milk or cream. It is proposed to continue the study of the chemistry of the plant during the early spring months when the taint causes most trouble in the factories. In co-operation with Mr. A. V. Allo, of the Fields Division, Department of Agriculture, some grazing trials were made at Tauranga. It was found that removal of cows from land-cress-tainted pastures at 12 noon have a considerable reduction in intensity of cress taint in the cream, but was not completely effective in preventing the delivery of tainted cream. With badly-infested pastures, grazing for one hour between 9 a.m. and 10 a.m. only was sufficient to give a taint in the evening's cream. In the case of badly-infested pastures, therefore, there seems to be no alternative to grazing by dry stock or mowing the herbage until the cress disappears with progress of the season.

(*b*) *Hardness of Butter* (R. M. Dolby).—Determinations of hardness of butter have been made again this year, in conjunction with the studies on butterfat composition carried out by Mr. G. A. Cox, on monthly samples from nine New Zealand factories. A statistical analysis has been made of the results for one season. For convenience in calculation "softness" (reciprocal of hardness) was used instead of hardness. It has been shown that the iodine value and the softening-point of the butterfat each have independently a highly-significant effect on the softness of the butter. The Reichert-Meissl value of the butterfat has no significant effect.

The iodine value and softening-point together account for nearly half the variance in softness. The remaining variance is accounted for by—

(*a*) Seasonal effects due to variation in manufacturing conditions or in composition other than that shown by iodine value and softening-point.
(*b*) District variations in manufacturing conditions or composition independent of iodine value and softening-point.
(*c*) Random variations and experimental error.

Factors (*a*) and (*b*) are of approximately equal importance, while factor (*c*) is of rather less importance. The exceptional softness of spring butter is only partly accounted for by the analytical figures obtained for the butterfat. There is a general tendency, independent of composition as shown by the analyses, for butter from the southern factories to be softer than that from the northern factories.

(*c*) *Variations in the Composition of Butterfat* (G. A. Cox).—Samples of butter from nine representative factories are being analysed for a third season in a study of seasonal and district variations in the composition of the fat. The chief differences noted have been due to seasonal variations. Iodine values were highest in winter, with a marked drop during October and November to low levels, followed by a gradual rise from February till winter. Hardness determinations showed that the butter was softest from June to September, corresponding with the high iodine values, and then markedly increased in hardness during October and November, the months in which the iodine values fell very decidedly. The high iodine values obtained in mid-winter, when feed is scarce, may be related to the plane of nutrition, as it is known that the iodine values rise when the animals are on subnormal rations. Opposite seasonal trends in iodine values have been recorded in European trials, where the cows are fed indoors in winter.

Colour intensities of the butter were lowest in autumn and early winter, and rose to a maximum about November, and then gradually decreased to low autumn values. The increase in the colours would probably be due to the fresh spring pasture grass, and possibly to the lactational factor. King-country values were lower than those of Manawatu and Waikato. Butters from Canterbury and Otago were very low in colour values.

The diacetyl content of the butters was generally low, about 0·01 to 0·06 parts per million, but in those cases where the butter had been made from acid cream there was a definite increase in the diacetyl content of the butter.

(*d*) *Packing of Butter* (F. H. McDowall).—A study is being made of the protective capacity of Pliofilm, a new wrapping-material with a rubber base, when used for the wrapping of butter. The indications are that this material gives a very good protection both against the development of primrose colour and against the absorption of wood and other taints.

(*e*) *Manufacture of Clarified Butter* (F. H. McDowall).—The manufacture of clarified butter is being developed to a commercial scale. Dr. Barnicoat has already shown that dry butterfat can be obtained by use of a special centrifugal clarifier.

It has been found that a large proportion of the water from melted butter can be removed by passage through two ordinary cream-separators in tandem, provided that the bowls of the separators are first filled with warm water. The remaining 2 per cent. of moisture can be removed if the fat is passed at a high temperature into the second unit of a tandem Vacreator. The various subsidiary problems of cooling, filtering, and packing of the clarified fat are being studied.

Mycological Projects.

(*a*) *Cheese Storage* (T. R. Vernon).—The experimental work on the curing of cheese under controlled conditions, which was carried out during the 1939–40 season, has been repeated. The experiments were designed to give a measure of the effect of controlled temperature and humidity on (*a*) mould development, (*b*) shrinkage, and (*c*) quality.

The work was carried out at three factories in the Manawatu district with curing-rooms representative of the three main types found in New Zealand—(1) Uninsulated; single windows; uncontrolled. (2) Insulated; double windows; uncontrolled. (3) Insulated; temperature and humidity controlled. Standard export cheese from a single vat were used throughout the season. Weights were recorded ex press and at fourteen days, and gradings made on arrival at grade store.

Results show a complete absence of mould from the controlled room (humidity 80 per cent. to 85 per cent.), very occasional mould in the uninsulated room (humidity 50 per cent. to 95 per cent.), and considerable mould in the insulated uncontrolled room (humidity 65 per cent. to 95 per cent.).

Shrinkage losses were smaller in the controlled room by roughly 1 lb. per crate.

Quality was better in the controlled room by half a point.

The design of curing-rooms has progressed slowly; insulation and double glazing alone distinguish the new from the old. Refrigerated rooms, in spite of the obvious advantages of low temperatures, have suffered in popularity on account of "mould." The results of the present work suggest a new design: insulated, low ceilings, no windows, and automatic temperature and humidity control.

(*b*) *Casein* (T. R. Vernon).—Many preservatives have been suggested and many used for casein adhesives, but few have given entirely satisfactory results. In order to determine the value of different preservatives, a standardized technique has been developed using a constant inoculum of test organisms. These organisms have been isolated from defective adhesives and are representative of the two main types: (*a*) liquifiers without gas, and (*b*) gas-producers.

A number of preservatives that have been recommended in the literature have been tested, and discarded as unsatisfactory. β-naphthol at a concentration of 3 per cent. gives control, but causes discoloration, and the chlorinated phenols show promise of good results.

Similar work is being carried out with casein paint. Again the chlorinated phenols are promising and, in addition to preserving the paint, are increasing its resistance to mould attack. The trials are being conducted on wood, brick, and concrete surfaces.

(*c*) *Ultra-violet Radiations* (T. R. Vernon).—The control of mould by means of ultra-violet light has been under test in storage rooms at 45° F. Unfortunately it was not possible to equalize the humidities of the experimental and the control rooms, and the absence of mould in the experimental room may be partly explained by low humidities. In spite of this, the freedom from mould under ultra-violet radiations was remarkable, and when alterations to the method of humidity control are completed the experiment should be repeated.

Miscellaneous Projects.

(*a*) *Rusting of Milk-cans* (R. M. Dolby).—During recent years there have been a considerable number of complaints concerning the premature rusting of milk-cans. A report from one New Zealand canmaker that he had had difficulties in tinning steel sheet obtained recently suggested that defects in the finished cans might be due to a lowering in the quality of the basis metal used. An investigation of one batch of steel sheets showed the presence of black spots on the surface of the metal. When the sheets were dipped the tin failed to adhere to these areas unless the previous process of pickling had been greatly prolonged. Samples of the steel were sent to the International Tin Research and Development Council, who reported that the tinning difficulties were due to the presence of a film of polymerized grease which could be completely removed only by burning off in an annealing furnace.

When later shipments from the same rolling-mills were examined it was found that the defects were no longer present. Samples of the steel were tinned by the same process as used for milk-cans, and when tested the coating was found to be perfectly satisfactory.

A survey was made of a large number of milk and cream cans at factories in the Manawatu district. In none of the cans showing premature rusting was there any evidence of faulty tinning. In most cases the rust spots appeared where the tin coating had been penetrated by scratches. In order to

improve the resistance to such mechanical damage it would be necessary to increase the thickness of the tin coating. The thickness of tin at present applied to cans approached the maximum obtainable by hot dipping, but some improvement might be possible by reducing variations in thickness between one part of the can and another. The thickness of coating may be increased almost indefinitely by electroplating with tin. This method has been used in England with very satisfactory results for equipment subjected to hard wear. Laboratory experiments on similar lines in the Institute gave promising results. Such a treatment would, however, considerably increase the cost of a can.

(*b*) *Farm Separator Fat Losses* (A. K. R. McDowell).—A study of the effect of time of continuous running of a separator on the completeness of skimming showed that over two hours there was little significant change in efficiency.

(*c*) *Dairy Factory Drainage* (P. O. Veale).—During the season 1939–40 a study was made of the volume and composition of drainage waters from three cheese-factories of different sizes, one butter-factory, one dual-plant casein and butter factory, and one casein-factory. The results show that the volume of drainage varied from 0·26 to 0·84 gallons per pound of cheese made, 0·71 to 1·35 gallons per pound of butter made, and 1·68 gallons per pound of precipitated lactic casein curd. The morning and afternoon volumes of discharge were approximately the same. For all factories except the smallest in output, New Zealand factories discharge less drainage per unit of produce than those overseas. The drainage for lactic-casein factories was the highest in polluting-power, that for cheese-factories was intermediate, while butter-factory drainage was the least harmful. The greatest daily variation in quality of drainage occurred in the butter-factory at times when butter-milk was incorporated.

During the season 1939–40, and during the months of December and January, 1941, a study was made also of the effect of the discharge of factory drainage on the waters of a number of streams and rivers in Taranaki. It has been shown that the effect of factory drainage on the quality of the water in the natural streams is smaller than has been supposed. Where a stream is free-flowing and the dilution considerable, the stream may recover completely within a distance of 400 yards from the drainage outlet. With smaller dilutions the stream may be affected to a distance of one mile, and in one instance where the dilution was only 1 in 100 the effect of the drainage on the water of the stream was evident for 3½ miles from the drainage outlet. These results were obtained from factories where care was taken to remove coarse and fine suspended particles from the drainage, and where whey, skim-milk, and buttermilk were not discharged into the drains.

Dairy Husbandry Projects.

(*a*) *Suitability of Different Pasture Types for Milk-production* (W. Riddet and S. L. Green, of Dairy Research Institute staff, and E. B. Levy and W. G. Thurston, of the Plant Research Bureau).—At the beginning of the period under review three grazing-areas were sown out respectively with seed mixtures consisting of (*a*) mixed pasture and clover species, (*b*) perennial rye-grass and white clover, and (*c*) cocksfoot - white clover. Each area comprised a number of small fields so chosen as to make soil differences equally applicable to all three. Towards the conclusion of the period a further area was seeded down with the same mixtures in order to provide a total area of approximately 50 acres, capable of carrying and providing supplementary hay and silage for three groups each of twelve to fourteen milking animals. Attempts to measure differences in production in this first year were upset by the incidence of land cress in some of the young pastures and the ravages of grass grub in others, but this is not viewed as detrimental to the experiment as a whole, since the aim is to secure information from the pastures in their established state, and they have now developed good and typical sward. It is confidently expected to secure measurable results in the next grazing season.

(*b*) *The Influence of the Plane of Nutrition of Milking-cows on Pasture on the Yield and Composition of Milk* (W. Riddet and S. L. Green).—In attempts to seek an adequate explanation for the falling-off in the cheese-yielding capacity of milk during dry weather, it has been shown in trials carried out in recent years with cows kept indoors that the casein content of milk is depressed by a low plane of nutrition of the milking-cow. It has also been observed, again with cows kept indoors, that cows fed *ad lib* quantities of pasture may be on a low plane of nutrition. Accordingly an experiment was carried out between January and May in which a number of cows were maintained on a positive plane of nutrition at pasture by providing them with a supplementary ration of meal, fed according to their production, and a corresponding number balanced in respect of production were allowed to drop to whatever plane of nutrition the pasture and usual farm supplement of silage could provide. Records were kept of the live weight of the cows and of the daily production and composition of their milk. The results are now being worked up graphically and statistically.

(*c*) *The Relation of Frequency of Weighing, Sampling, and Analysing Milk to Degree of Accuracy in Results* (I. Dick and W. Riddet).—In connection with project (*b*) an attempt is being made statistically to secure accurate information from data recorded daily on the errors that may be expected in recording milk weights and analysing milk samples taken at varying intervals.

(*d*) *Feeding Meals to Calves being reared on Skim-milk and grazing Good Pasture* (S. L. Green and W. Riddet).—Twelve pairs of calves of the Friesian, Jersey, and Ayrshire breeds were used in an experiment to determine whether calves grow better fed on calf meal in addition to skim-milk when they are at pasture. The ration of milk fed to the "milk only" group was increased in amount to make it equivalent in digestible nutrients to the meal fed to the other group. Both lots were rationed according to weight and made satisfactory growth. The results showed that, when treated statistically, there were no differences in the two groups in respect either of increase in live weight or height at the withers. There were no obvious differences in the outward appearance of the two groups.

Staff.

The need for men for the armed forces depleted the staff of several members. Four joined the overseas forces, and four others spent from three to five months continuously with the Territorial Force undergoing training.

Three senior members of the staff resigned to take up other duties in the Dominion. No permanent appointments were made to fill the vacancies created, but steps were taken to fill the posts temporarily and as far as possible with female assistants.

Pasteurization and Bottling of Milk for Schools.

The Institution has continued to pasteurize and bottle the milk supplied to schools in the Palmerston North district. The Department of Health has borne the cost of this work.

Dissemination of Results of Work.

As in past years, the research work carried out during the season was reviewed at the Dairy Factory Managers' Week. This took place from 6th to 8th May, 1941. Approximately eighty persons attended this gathering, including dairy factory managers and first assistants and several others connected with the dairy industry.

The following technical publications have been issued during the year:—

Institute Publication No.	Title.	Author.	Journal.
127	The Action of Chemical Disinfectants on Bacteriophages for the Lactic Streptococci	G. J. E. Hunter and H. R. Whitehead	*J. Dairy Research.*
131	A Note of the Influence of High-temperature Short-time Pasteurization on the Phosphatase Reaction and Creaming of Milk	W. J. Wiley ..	*N.Z. Jour. Sci. & Tech.*
132	An Accurate Constant Temperature Bath and Storage Cabinet for Operation below Room Temperature	R. M. Dolby ..	*N.Z. Jour. Sci. & Tech.*
133	Studies in the Chemistry of Cheddar Cheesemaking—VII: The Measurement of the Acidity of Cheese and the Relation of Acidity to Grading Score	R. M. Dolby, F. H. McDowall, and W. Riddet	*J. Dairy Research.*
134	Causes and Prevention of Foaming of Lactic Casein	W. R. Mummery ..	*N.Z. Jour. Sci. & Tech.*
135	Annual Report, 1939–40	..	..
137	The Control of Acid Development in Cheddar Cheesemaking	R. M. Dolby ..	..
138	Starter Cultures for Cheese Manufacture: Further Attempts to eliminate Failures due to Bacteriophage	H. R. Whitehead and G. J. E. Hunter	..

The following are in the press:—

Institute Publication No.	Title.	Author.
136	The Cleaning of Dairy Equipment—Part I: Cleansers for use in Dairy Factories	F. H. McDowall.
139	The Organization of a Survey of the Incidence of Mastitis in New Zealand and a Field Outfit for the Bromthymol Blue Test for Mastitis	C. M. Hume.
140	Studies on the Detection of Mastitis in New Zealand Milking Herds—II: Factors influencing the Bromthymol Blue Test for Mastitis	F. H. McDowall.
141	Studies on the Detection of Mastitis in New Zealand Milking Herds—III: An Investigation into the Application of the Bromthymol Blue Test for Mastitis in the Field	F. H. McDowall, J. P. James, and A. H. Ward.
142	Studies on the Detection of Mastitis in New Zealand Milking Herds—IV: An Examination of the Hopkirk Assessment and of the Breed Cell Count Method of estimating the Leucocyte Content of Milk Samples	J. P. James and F. H. McDowall.
146	The Progress and Present Position of Research on Cheese Starters in New Zealand	H. R. Whitehead and G. J. E. Hunter.
147	Cracked Rinds in Cheddar Cheese	R. M. Dolby.
148	Estimation of Lactose in Milk	A. K. R. McDowell.
149	The Rheology of Butter—I: Methods of measuring the Hardness of Butter ..	R. M. Dolby.
150	The Rheology of Butter—II: The Relation between Rate of Shear and Shearing Stress; the Effect of Temperature and of Reworking on Hardness and on Structural Viscosity	R. M. Dolby.
151	The Rheology of Butter—III: The Effect of Variation in Buttermaking Conditions on the Hardness of the Butter	R. M. Dolby.
152	The Relation of Plane of Nutrition to Milk Production and Milk Composition in New Zealand—Introduction and Part I: Effect of Subnormal Feeding	W. Riddet, I. L. Campbell, F. H. McDowall, and G. A. Cox.
153	The Relation of Plane of Nutrition to Milk Production and Milk Composition in New Zealand—Part II: Effect of Subnormal Feeding	W. Riddet, I. L. Campbell, F. H. McDowall, and G. A. Cox.
157	The cleaning of Dairy Equipment—II: Cleaning Operations in a Dairy Factory	F. H. McDowall.
158	On the Origin of Bacteriophages for the Lactic Streptococci	H. R. Whitehead and G. J. E. Hunter.

The Institute is much indebted to the Massey Agricultural College for the use of the college herds, buildings, and plant, and it is desired to express to the Board of Governors the thanks of the Institute for this privilege. It is also desired to acknowledge the ready co-operation afforded by the Dairy Board, by the Directors and staffs of the Dairy Division and Animal Research Division of the Department of Agriculture, the Grasslands Division of the Plant Research Bureau, the Primary Products Marketing Department, and by a number of commercial organizations.

PLANT RESEARCH BUREAU.

Plant Research Bureau Committee. Mr. A. H. Cockayne, Chairman; Dr. F. W. Hilgendorf, Vice-Chairman; Professor G. S. Peren, Massey Agricultural College; Professor E. R. Hudson, Canterbury Agricultural College; Sir Theodore Rigg, Cawthron Institute; Dr. E. Marsden, Department of Scientific and Industrial Research; Mr. R. B. Tennent, Fields Division, Department of Agriculture; Messrs. C. A. Marchant and Alan Grant, representing North Island and South Island farmers respectively; Mr. F. R. Callaghan, Secretary and Chief Executive Officer.

The Plant Research Bureau now comprises five Divisions, viz.:—

	Location.	Director.
Agronomy Division	Canterbury Agricultural College, Lincoln	*Mr. R. A. Calder (Acting Director).
Botany Division	58 Bowen Street, Wellington	Dr. H. H. Allan.
Entomology Division	Cawthron Institute, Nelson	Dr. D. Miller.
Grasslands Division	Massey College, Palmerston North	Mr. E. Bruce Levy.
Plant Diseases Division	Owairaka, Auckland	Dr. G. H. Cunningham.

* Mr. J. W. Hadfield, Director, was seconded to Linen Flax Section, Industries and Commerce Department, as from 1st June, 1940.

Participating in the Bureau are (1) the Department of Agriculture and its various Divisions; (2) the Department of Scientific and Industrial Research and its several research sections; (3) Massey Agricultural College; (4) Canterbury Agricultural College; and (5) Cawthron Institute.

The Bureau is organized so as to arrange for co-ordination of all researches relating to plants at present being conducted throughout New Zealand and to associate this work appropriately with the teaching and extension work of the agricultural colleges and the Department of Agriculture.

Quarterly meetings of the Plant Research Bureau Committee have been held during the year, when programmes and progress of the research work have been reviewed.

AGRONOMY DIVISION, LINCOLN.

Acting-Director: Mr. R. A. Calder.

The normal policy of this Division is to make available to the farmer improved types of arable crops and is effected by three main approaches—plant introduction, plant breeding, and pure-seed production. It is proposed, however, that, until conditions became more settled, no further long-term investigations should be undertaken and that the main effort should be directed towards the production of pure seed.

Wheat. Pure and smut-free seed of those varieties for which there is a demand and which are eligible for certification is raised annually by this Division. The seed is passed over to Canterbury Agricultural College, where it is further multiplied once before being distributed under certification. The following varieties were grown during the past season: Cross 7, Dreadnought, Tainui, College Hunters, Jumbuck, and Taiaroa.

Oats. Over the past few years approximately 120 oat varieties have been introduced from overseas and their behaviour under local conditions investigated. It was considered that the following varieties were sufficiently promising to be increased for further extensive trials, and multiplication areas of these were grown last season.

Binder and Line 834 are two continental, white-grained, high-yielding oats with short to medium-length straw which tends to be resistant to lodging.

Elder is a white Scottish oat which gives a high yield of small but good-quality grain, is somewhat resistant to lodging, and shows promise of being a useful green feed type.

Victoria × 524: Three strains of this North American hybrid have been increased. They give a fair yield of grain, but their chief feature is that they are practically immune to leaf-rust, to stem-rust, and to smut.

In addition to increasing these recently introduced varieties, reselected lines of Gartons Abundance, Algerian, and Resistance were raised.

In the oat-breeding work the main objectives have been to develop by hybridization varieties which might be resistant to the rusts or which might show some improvement in respect either to yield and quality of grain, to resistance to lodging, or to green-feed yield. The work has been progressing slowly, but, as it is a long-term project and as seed material can be retained for some time, only a few of the best selections are being maintained either for trial purposes or for further observation.

Two Scandanavian varieties, Primus and Jotul, were received and increased for trial purposes.

Barley. During recent years a large number both of two-rowed malting barleys and of six-rowed feed barleys have been introduced and studied, but it is upon the latter group that efforts are now being concentrated. From amongst approximately seventy six-rowed varieties, two—namely, Oderbrucker and Newal, which were obtained from Canada—were definitely superior to the controls—Cape and Black Skinless—in rapidity of growth for green feed and gave satisfactory grain yields; Newal is also smooth-awned.

These two varieties were grown for increase in the past season, and the seed obtained will be used for further multiplication and for more extensive trials.

An additional supply of Newal was obtained from Canada in order that this variety might be increased more rapidly, but no seed of Oderbrucker could be secured from the same source.

Garden Peas.—Seed stocks of garden-pea varieties become mixed and deteriorate very rapidly, and consequently require much attention and periodic renewal. This Division undertakes the raising of pure lines of the more important commercial varieties and makes them available to merchants. The following varieties were grown the past season: Greenfeast, Onward, Stratagem, William Massey, Little Marvel, and Harrison's Glory.

Breeding-work has been confined to testing the behaviour of several lines developed from a cross between Greenfeast and Greatcrop. One of these, a high-yielding, green-seeded Greenfeast type, is particularly promising and is now to be multiplied for distribution.

Field Peas.—Blue peas are either packeted and sold for domestic use in the dried state or canned to provide a superior and more easily prepared article of food. It is estimated that in England over 140,000,000 cans are processed annually. Unfortunately, New-Zealand-grown peas are not very acceptable in Great Britain, due to their variable hardness and the toughness of their skins.

White peas are used almost entirely for the split-pea trade, but the yielding ability of the standard variety, White Ivory, is rather uncertain.

Some years ago breeding projects were initiated by this Division with the object of developing varieties of both the blue and the white types which might be more acceptable to the British trade or more suitable for New Zealand conditions. As a result several very promising lines have been raised and in the past season increase areas of the following ones were grown:—

Blue type, Line 5/7/1/6 (Harrisons Glory × Blue Prussian): Yields better than Blue Prussian, the standard blue pea, and peas are larger and greener.

White type, Line 3/42/3 (Greenfeast × Blue Prussian): Yields better than White Ivory and quality as good.

These are to be multiplied once more before being distributed.

The breeding-work has now been restricted to testing further selections of each type. 12/10, a cross between Victoria and Stratagem, and a white type seems to warrant particular attention on account of large seed-sized combined with a good yielding ability.

Linen Flax. For several years now this Division has conducted a considerable amount of preliminary investigational work in connection with methods of production of linen flax, a crop which has suddenly sprung into a position of prominence. Its product, linen fibre, is essential for certain war purposes, and in order to provide Great Britain with a proportion of her requirements an industry has been established in the South Island.

The investigations initiated by this Division are being maintained, and during the year trials were carried out to determine:

(1) The optimum rate of seeding for fibre-production:
(2) The best method of sowing—broadcasting, 3½ in. drilling, 7 in. drilling, or 7 in cross-drilling.
(3) The most satisfactory manurial treatment:
(4) The relative merits of such varieties as Liral Crown, Liral Prince, Stormont Cirrus, Concurrent, and Giza Purple:
(5) Processing requirements in connection with deseeding, retting, and scutching (for this purpose an experimental processing plant has been erected). The unit is used also for extracting the fibre from material harvested from experimental plots grown either by this Division or by the Fields Division, Department of Agriculture.

In the past year increase areas of Stormont Cirrus, Stormont Gossamer, Liral Prince, Blenda, and Hercules were grown, the last three being raised from hot-water-treated seed.

Rape. As Great Britain recently placed an embargo on the export of rape-seed, the commercial production of the Giant and Broad Leaf Essex types reselected by this Division and grown under certification by the Fields Division, Department of Agriculture, has now become an undertaking of added importance. The nucleus and mother seed of the varieties grown under certification is raised annually at this Division.

In addition, this year a small increase area was grown of a type which was received from the Plant Diseases Division and which has proved to be considerably resistant to club-root. The produce will be used for trial next season.

A new cross (Giant × Broad Leaf Essex) × Broad Leaf Essex, which is intermediate in behaviour between the two standard types, was distributed for trial in several districts.

Further work is being confined, in the meantime, to testing the behaviour of a cross between Giant rape and Chinese Cabbage, which shows promise of being a quick-maturing form.

Marrow-stem Kale.—Apart from the green- and purple-stemmed types there are no distinct varieties of marrow-stem kale available, but an attempt is being made to develop different strains which might be suited for different purposes. Two distinct green-stemmed types have been isolated and increase areas were grown for seed-production this past season. Field trials are also being carried out and it will depend on the reports from these as to whether or not the selections will be distributed.

In addition to strain selection, many crosses have been made in an endeavour to produce improved forms.

Turnips and Swedes.—Work on these crops has been concerned mainly with an attempt to raise disease-resistant types by hybridization. The effort has been handicapped, however, by the difficulty experienced at Lincoln in overwintering selected bulbs and is now being confined to testing out a few lines which were able to be maintained.

Lucerne.—The first pedigree strain raised from a combination of several plants of the Marlborough variety selected on the behaviour of their inbred progenies was multiplied last year for the first time, and the seed obtained distributed to several districts for field trials. Another seed crop has been harvested this year, and the produce will be used for the establishment of further increase blocks if the reports on the field trials are satisfactory.

Further breeding-work on the Marlborough type has been suspended in the meantime, but a project has been initiated with the object of developing a satisfactory pasture type from Medicago glutinosa.

Potatoes.—The certification of potatoes undertaken by the Fields Division, Department of Agriculture, ensures that the quality of the main commercial varieties, particularly as regards purity and freedom from virus diseases, is maintained. This Division, on the other hand, is concerned with the production of improved types by hybridization.

It has been fairly definitely established that certain "wild" potato species from South America are resistant either to late blight or to frost. Some of these "wild" types have been introduced through the Imperial Bureau of Plant Genetics, Cambridge, and have been used for crossing with our cultivated varieties. A number of promising hybrids have been obtained, but further back-crossing to commercial types is yet required to improve the quality.

Lupins.—The ordinary blue lupin, due to a relatively high alkaloid content, is rather bitter, and at certain stages is not relished by stock. By intensive selection methods, German and Russian workers were able to isolate a few seeds both of the blue and of the yellow species in which the alkaloid content was greatly reduced. From these have been propagated sweet blue and sweet yellow strains, and during recent years small supplies of both these types have been introduced and are being multiplied as rapidly as possible. From trials already conducted the claims in regard to their palatability have been substantiated, but it would seem that the yellow type is better suited to the warmer conditions of the North Island than to the South and that for southern conditions the sweet blue is likely to be preferred.

Linseed.—In view of the possibility of the re-establishment of linseed-oil production in New Zealand studies have been made of a large number of imported linseed varieties. Of these a type known as Rio has proved to be outstanding in regard to yield and to resistance to disease, and its oil-quality is satisfactory. An increase area of this variety was grown this year.

In addition, a trial to compare the relative seed-yields and oil-quality of several varieties of both linseed and linen flax was carried out.

Mangels, Carrots, Chicory, and Coriander.—During the past season small areas of mangels, carrots, chicory, and coriander were grown for seed.

Co-operation with other Institutes.—Grasslands Division: A section of the Grasslands Division has been established at the Agronomy Division and an officer stationed here to investigate the behaviour of pasture species and strains under Canterbury conditions. Stocks of herbage species reselected and raised by the Grasslands Division are also increased at Lincoln. The Grasslands Division reciprocates by carrying out certain trials for this Division at Palmerston North.

Plant Diseases Division: An officer of the Plant Diseases Division is stationed at Lincoln mainly for the purpose of investigating diseases of arable crops. The Agronomy Division receives considerable assistance and advice from this officer and from his Division in Auckland, particularly in connection with diseases of oats, peas, potatoes, brassicas, and linen flax.

Fields Division, Department of Agriculture: Close co-operation between the Fields Division and the Agronomy Division is maintained. The Agronomy Division is dependent on the Fields Division for carrying out field trials with new material, and the Fields Division receives from the Agronomy Division nucleus seed of several crops grown under certification.

Canterbury Agricultural College: The Canterbury Agricultural College has priority in obtaining supplies of pure-seed wheat raised by this Division and makes small areas available either for preliminary trials or as isolation blocks.

Wheat Research Institute: The programme of work in connection with wheat is discussed fully with officers of the Wheat Research Institute before being finalized.

Entomology Division: An area of pasture plots has been established to enable a study to be made on the habits of Porina.

Cawthron Institute: Cawthron Institute has co-operated with the Agronomy Division in conducting garden pea trials and in a seed-production undertaking.

BOTANY DIVISION, WELLINGTON.

Director: Dr. H. H. Allan.

Only the work of more immediate importance under present conditions is reviewed here.

Seaweed Utilization.

A bulletin, "The Economic Importance of Seaweeds," has been published, containing concise information concerning fertilizers, food, potash, and iodine sources, production of agar-agar and alginic acid, &c. The important New Zealand seaweeds are described and discussed, and an illustrated key given to the chief species of brown algae.

Macrocystis as a source of potash. Assistance was given in the survey of areas at Cape Campbell, Tory Channel, D'Urville and Stewart Islands. Approximate estimates of the available supplies have now been secured. Extended experiments on regrowth after cutting have been planned.

Carrageen.—Successful preliminary trials of certain species of *Gigartina* were made, resulting in further trials by a large brewery, with such success that arrangements were made for continued supplies.

Agar. Trials proved that a high-class agar can be made from *Pterocladia lucida*, and experimental use by a meat-canning firm proved successful. A survey of the Bay of Plenty, East Cape, and Whangarei areas was made, and the required weed located in considerable amounts. Arrangements have been made for collecting sufficient material for a large-scale processing trial. Test of locally made agar for other purposes have given promising results.

Other economic possibilities, indicated in the bulletin, are being further explored, and a general survey of the occurrence and quantities of the various weeds is in progress.

Medicinal Plant Culture.

Digitalis purpurea.—A sample of local foxglove was ground to a 22/60 powder. An assay of the British Pharmaceutical Society was satisfactory, and the Ministry of Health has asked for a quantity of dried leaf. Dried leaf from imported seed gave a test of twice the strength required by the British Pharmacopœia. Air-drying of the leaf did not impair the active content, as measured by chemical means.

Atropa belladonna.—From imported seed eight hundred plants were raised. Growth was excellent, but in late summer there was a severe attack of root-rot. Flowering shoots yielded 0·88 per cent. of total alkaloid, calculated as hyoscyamine, stem-leaves 0·38 per cent. The British Pharmacopœia standard is 0·3 per cent. Seed-yield has been fair.

Datura stramonium.—Several hundred plants were raised from English seed. Growth was rapid and each seed production abundant. Leaves from flowering plants gave 0·34 per cent. total alkaloids, calculated as hyoscyamine (British Pharmacopœia standard, 0·25 per cent.). Plant raised from local seed were superior in height and leaf-production, but not in alkaloids.

Hyoscyamus niger.—A small number of the annual variety and some one hundred and fifty of the biennial variety were raised. Growth was excellent, and also seed-yield from the annual variety. The biennial variety became infected in the rosette stage with root-rot in the late summer, with considerable mortality. Leaves from flowering annual plants yielded 0·05 per cent. total alkaloids, calculated as hyoscyamine; rosette leaves of biennial plants yielded 0·13 per cent. (British Pharmacopœia standard for both, 0·05 per cent.).

Ricinus communis.—Castor beans from New-Zealand-grown plants yielded 56·5 per cent. of oil (normal yield is 55 per cent. to 60 per cent.). Plants from American seed have grown over 6 ft. in the first season, with abundant seed-production.

Seed and other propagating material have been saved. Some species have not yet reached the testing stage. Further supplies of seed have been obtained from overseas, and will be planted out in the spring, including *Barosma betulina*, *Ephedra*, and *Polygala senega*.

Phormium.

The new experimental area (Paiaka) on the Moutoa Estate is now in operation. Seed-sowing has been completed for the season, including some seven acres in swamp flax for thickening and extending the flax areas. The demonstration area of different varieties and forms has been almost completely planted up, and will include practically all sorts of importance or interest. Nursery work has been continued, and seedlings of promising types are being raised, while the sorts established earlier are being tested as they mature. Breeding-work has been confined to crosses between *Phormium colensoi* and *P. tenax*, with a view to securing an improved soft fibre. The experiments being laid out include spacing, cultivation, manurial, yield, age of plant at cutting, and seedling-variation trials. Fibre tests on established plots are being made as the stands mature. Fans have been provided and planted out on different areas on the Estate.

The Director assisted in a survey of the phormium resources and possible utilization of the west coast of South Island, all important areas from Karamea to Bruce Bay being studied. A full report has been prepared for submission to the Flax Industrial Committee. During the survey numerous collections of seed from individual plants were secured, and are being put under observation on the experimental area.

Nassella Tussock.

A preliminary survey of the areas affected by this weed has been made, and an interim report submitted. The weed occurs over some 200 square miles, and the chief centres of infestation have been located. It is clear that the tussock is a serious menace, has already put out of production many acres of valuable land, is spreading rapidly and has established itself in certain localities distant from the main area. Further investigation is in progress, with especial reference to methods of spread and means of control. Full discussions, formal and informal, have been held with the farmers concerned, who are evidently resolved to do all they can to assist in controlling the pest. A bulletin covering the whole situation is in preparation.

Miscellaneous.

Weed Investigations.—These have continued as opportunity offers. A scythe with swab attachment for experiments with control of ragwort and other weeds by this method of sodium chlorate treatment has been received and will be tried out in the coming season. The "Handbook of the Naturalized Flora" has been well received, and is proving useful in many directions.

Lavender.—Inquiries and tests have shown that while there are at present no commercial areas, crops of good oil content can be grown should sufficient demand occur.

Hemp.—A small trial of Ferramington and Hungarian Hemp has been made, and seed saved for an extended trial.

Tanning Barks.—A survey of the available wattle-bark resources is being made.

TECHNICAL PAPERS, 1940–41.

ALLAN, H. H. (1940): "Natural Hybridization in Relation to Taxonomy." In the *New Systematics*, edited by Julian S. Huxley, pp. 515–528.
——— (1940): "A Handbook on the Naturalized Flora of New Zealand." *Bull. No. 83, Dept. S. I.R.*
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ENTOMOLOGY DIVISION, NELSON.

Director: DR. D. MILLER.

The work of the Division is referred to under the following headings:—

(1) Entomological service and routine.
(2) *Plutella maculipennis* (diamond-back moth).
(3) *Pieris rapae* (white butterfly).
(4) *Oxycanus* sp.
(5) Grass grub.
(6) Cheese mites.
(7) Clover thrips.

(1) ENTOMOLOGICAL SERVICE AND ROUTINE.

The number of insects received for identification during the year is about 90, and of these, 60 were from the Fields Division, 4 from the Niue Islands, and the remainder from private individuals and Government departments. Of these insects, 20 were attacking stored products, 30 from agricultural crops and pastures, 15 from vegetable gardens, and the rest miscellaneous, in which group is included those attacking noxious weeds, timber, and linen flax, also animal pests. Many grubs and larvæ of insects received have been bred through to the adult stage. All available information upon these has been supplied, together with advice regarding control measures or prevention.

Of the insects received, some are of special interest. *Coleophora spissicornis*, a small introduced moth is appearing as a likely pest of white clover. Last year the larvæ appeared in large numbers on some clover crops in Hastings and North Auckland. It has been recorded as damaging clover in Denmark. *Aphodius tasmaniae*, a beetle, was evidently prevalent in Spotswood, North Canterbury, recently. This beetle occurs periodically in Canterbury, but it is of interest since it is a pasture pest in certain localities in South Australia. *Phaulacridium marginale*, a grasshopper, occurred in large numbers this summer in Mid-Canterbury and severely damaged turnip and rape crops. Last autumn *Cirphis unipuncta*, an army-worm, did considerable damage to maize areas in Hawke's Bay. Two stored product beetles, *Necrobia ruficeps* and *Silvanus surinamensis*, were heavily infesting a shipment of imported copra. A weevil was received from the Niue Islands and its host was bananas. It is of interest to note that cutworms have been recorded as attacking linen flax and hemp.

Two generations of a native species of Noctuid, *Leucania nullifera*, have been reared to maturity during the year. Its life-cycle is of interest, and also the fact that, although it normally feeds on a native plant, it readily attacks carrots, the large caterpillar living in the root.

A great deal of time has been spent during the year indexing lantern slides, photographic plates, also drawing up a list with information upon the economic insect pests in this country.

(2) PLUTELLA MACULIPENNIS (DIAMOND-BACK MOTH).

Two important parasites of the moth are now well established. These are *Angitia cerophaga* and *Diadromus collaris*.

Angitia cerophaga.—This parasite attacks the moth in the larval stage. It is now established in the Hawke's Bay, Manawatu, and Wairarapa districts in the North Island, and occurs from Nelson to south of Oamaru in the South Island, and will no doubt be found in Central Otago, where supplies were bred and liberated during the season.

This parasite was bred in large numbers during the first half of the season, but it was later decided to curtail this work temporarily, due to the activities of a hyperparasite, *Eupteromalus* sp. Although the hyperparasite reduces the efficiency of *Angitia* under laboratory conditions there is no reason to suppose that its activities will seriously interfere with the parasite in the field. All the material of *Angitia* bred for distribution was, with the exception of one consignment, sent to Alexandra. The following are the numbers of parasites sent out:—

District.	Pupæ.	Adults.	Dates of Liberation.
Alexandra	7,800	300	26/9/40 to 28/12/40
Auckland	2,400	..	26/9/40 to 25/10/40
	10,200	300	26/9/40 to 18/12/40

During the season, supplies of a form of *Angitia cerophaga* from Canada were received. Although this strain was successfully bred for several generations it finally weakened and has now died out.

Field-survey work conducted during the present season has not been completed, consequently a proper picture of the results cannot be presented at present. We have found, however, that *A. cerophaga*, which was liberated in the North Island in 1936–37 and which apparently failed to become established there, is now common and appears to be fairly widespread. Again in the South Island this parasite has increased and spread at a considerable rate. We cannot say what the full effects of the presence of *Angitia cerophaga* will be, but the position now is far more hopeful than when we made the first liberations, and the hyperparasite referred to above, which we felt might reduce the good effects of *cerophaga*, appears now to have little influence on the position. *A. cerophaga* is now playing a part in reducing the diamond-back-moth population, but whether the reduction will be sufficiently low to be economically important we do not yet know. Our field-work to date, however, gives everincreasing evidence of the effect of the parasite. In Hawke's Bay during the season, in Nelson, and as far south as Amberley the diamond-back moth at the time of making the field surveys was very little in evidence. From Ashburton, however, to south of Timaru the position was different. In the vicinity of Ashburton itself a good deal of variation occurred. Some of the crops were relatively clean, though a few were severely attacked by the moth. Considering the very dry season which occurred there, however, it was surprising that the crops had not suffered far more than was observed. In Hawke's Bay a comparison of the population density from 19th to 26th January, 1941, for a similar period in 1940 and 1939 gave a figure of 1·9, as compared with 51·5 and 15·4 respectively for the previous two years. We cannot say, of course, how much the drop in population was due to climate or other circumstances.

Diadromus collaris.—This parasite attacks its host in the pupal or chrysalid stage. During the past season an effort was made to breed sufficient for liberation in the main crucifer-growing areas in the North Island where no previous liberations have been made. Although the numbers of parasites obtained was below the figure estimated at the beginning of the season, liberations were made in the selected areas, and, in addition, in one area of the South Island.

The following are the districts in which liberations have been made, and the numbers liberated :—

District.	Pupæ.	Adults.	Dates of Liberation.
Auckland	5,500	3,900	25/10/40 to 18/12/40
Levin	..	4,100	6/1/41 to 10/2/41
Ashburton	..	2,400	12/3/41 to 26/3/41
Alexandra	..	650	26/9/40
Totals	5,500	11,050	26/9/40 to 26/3/41

From both Auckland and Levin, satisfactory recoveries of parasites have been made in the areas of liberation.

Again, in the field surveys, *Diadromus* was found to be common in the Hawke's Bay and parts of the Masterton area. It is well established in Nelson, Marlborough, and has reached as far south as Amberley. Efforts are being made to get it spread as far and wide as possible through artificial rearing and distribution.

Comment.—It is quite likely the results from this work will be far-reaching. It is too early yet to say what the final position will be, but as time goes on it appears more hopeful. It is advisable, and perhaps necessary to introduce other species in order to improve the position. When we are successful in getting both of these parasites thoroughly established throughout New Zealand, and possibly some other closely-allied species, the effect on the population density of diamond-back moth should be conspicuous.

(3) Pieris rapae (White Butterfly).

Reports have come in during the season of the presence of white butterfly in various localities, and in many cases severe damage was alleged. It has not been possible to investigate the position in every case, but when possible an examination was made, and in practically every case damage thought to be due to the white butterfly was due to the presence of the diamond-back moth.

There is little doubt that *Pteromalus puparum* is maintaining good control of the butterfly. There are places, of course, where the butterfly is able to increase to serious proportions, but, fortunately, these are very limited, and as a rule the parasite is able subsequently to overtake its host. It is felt, however, that the introduction of further species of parasites should be undertaken, and in this connection we hope to receive supplies of *Apanteles rubecula* and *Compsilura concinnata* for the coming season. In the past small supplies of *A. rubecula* have been received, but, unfortunately, success in establishing a colony was not realized. Both of these parasites should prove helpful in reducing the butterfly in those localities where the present parasite is less effective.

(4) Oxycanus sp.* (Subterranean Grass Caterpillar).

Field Surveys.—Field surveys in the autumn of 1940 disclosed that there was no general infestation in Canterbury, but that the insect was present in pastures throughout Otago and Southland and was particularly serious in North Otago.

Chemical Control.—A comprehensive series of chemical control experiments was laid down in June on two areas near Oamaru. The poisons tested included several arsenical poisons, sodium fluoride, and derris. Three methods of application were tested—viz., poison baits, sprays, and dusts. The final result of the experiments showed that a poison bait containing paris green gave a reduction in insect population of 80 per cent. at a cost (for materials alone) which varied between 6s. and 12s. per acre, depending on the rate of application. This treatment, on the score of low cost and high

* Previously known as *Porina*.

efficiency, was much superior to any of the others, and the indications are that a satisfactory and practicable method of control can be developed. A report on these experiments is in course of publication, and the results have been made available to the Agriculture Department.

Paris green is not normally imported into New Zealand in large quantities and is at present in short supply, though enough has been secured to enable a continuation of the experiments in the coming season.

Attention has been devoted to the utilization of mechanical devices for spreading the bait. The plans and specifications of a machine designed in U.S.A. for this purpose have been obtained and the possibility of adapting manure-distributors for this purpose is being investigated.

Residue on Sprayed Pasture.—A programme of sampling of pasture sprayed with arsenical poisons was carried out in order to obtain information on the rate of disappearance of the arsenic residue from the pasture. The estimation of arsenical residues is being done by the Animal Research Station at Wallaceville.

Life-history and Ecology of Oxycanus.—Much information has been accumulated on the time of flight of the moths as revealed by light traps. Observations have been made on the oviposition habits of the moths. A start has been made on the experimental work dealing with the factors influencing the development of the eggs and the relation between pasture composition and damage by *Oxycanus* larvæ. As opportunity offers, observations have been made on the effect of native parasites and diseases on the numbers of *Oxycanus*.

(5) Odontria zealandica (Grass-grub).

Inquiries made in U.S.A. indicate that none of the introduced parasites of the Japanese beetle are likely to be effective parasites of our grass-grub, but the U.S. Bureau of Entomology has supplied information, based on the work of one of their officers in Australia, indicating that several parasites of related beetles in Australia show considerable promise as possible parasites of our grass-grub.

Through the co-operation of the U.S. Bureau of Entomology, arrangements have been made to test a bacterial disease of Japanese beetle larvæ on the New Zealand grass-grub.

(6) Cheese-mites.

A special report has been submitted on this work. This work was carried out as time permitted, though, unfortunately, it was not possible to give it the undivided attention which it warrants. The investigation as far as it went was of value in bringing to light some of the difficulties associated with it. It also confirmed a previous finding that ammonia was an important acaricide, but whether ammonia can be used for fumigating cheese depends on its effect on the cheese itself. Experiments on this phase of the work are being conducted at Massey College. In the event of ammonia not being detrimental to the cheese, further experimental work regarding ammonia concentrations, times of application, and method of employing will have to be carried out.

(7) Haplothrips niger (Clover thrips).

In February, 1941, an investigation into the economic importance of the damage to red-clover-seed production caused by thrips was commenced. The adults of three species have been collected from red-clover flower-heads. *H. niger* (Osborn) appears to be by far the most numerous, and the alleged damage is ascribed to this species. Adults and nymphs of *H. niger* have been collected from the flower-heads of *Trifolium pratense*, *T. repens*, *T. arvense*, and *Plantago lanceolata*.

Publications.

The following papers have been published by members of the staff during the year:—

Dick, R. D. (1940): Observations on Insect Life in relation to Tussock-grassland Deterioration (Preliminary Report)." *N.Z. Jour. Sci. & Tech.*, *22*, 19A.

Dumbleton, L. J. (1940): "*Tortrix postvittana*, Walk. and its Parasites in Australia." *N.Z. Jour. Sci. & Tech.*, *21*, 322A.

—— (1940): "Carpet Beetles damage your Clothes." *N.Z. Jour. Agric.*, *61*, 282.

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——— (1940): "Australian Parasites of *Eriococcus coriaceus* Maskell." *N.Z. Jour. Sci. & Tech.*, *22*, 102A.

——— (1941): "The Grass Grub and Subterranean Grass Caterpillar." *N.Z. Jour. Agric.*, *62*, 180.

Hamilton, Avice (1940): "The New Zealand Dobson-fly (*Archichauliodes diversus* Walk.): Life-history and Bionomics." *N.Z. Jour. Sci. & Tech.*, *22*, 44A.

GRASSLANDS DIVISION, PALMERSTON NORTH.

Director: Mr. E. Bruce Levy.

The work of the Division has been well maintained throughout the year despite the serious loss by fire of the main building and heavy draw on staff for military training. The change-over from the city lease property of 11 acres and the breaking-in of the newly acquired Conway property of 28 acres has placed a large additional burden on the field staff of the Station. The acquisition of the Conway property is an outstanding boon to the work of this Division, and when fully broken in will more than justify its purchase.

Owing to present conditions some considerable reduction of the Divison's activities as far as field-work is concerned, but this has enabled a fuller concentration of staff on to the more fundamental problems of pasture-production, herbage-utilization, and conservation. Collaboration with the Plant Chemistry Laboratory and Animal Research Division in providing suitable plant materials for their studies into causes of animal unthrift has been a feature of the year's work. In the plant-breeding programme more and more emphasis has been laid in breeding towards provision of pedigree strains adapted to particular styles of farming rather than to those applicable only to permanent grassland soil types. Temporary-pasture leys and short-rotation and long-rotation pastures are under consideration as well as the truly permanent pasture, and, incidentally, the more the programme of work impinges on the former three types the greater the influence breeding will have on primary production.

The call for pedigree seeds is undoubtedly growing, and the more the breeding programme adapts itself to the agricultural demand the more instant will the call be. Evidence to date clearly indicates that pedigree seeds have very considerable bearing on the maximum exploitation of fertilizers, fences, farm labour, and in these days of war effort and conservation of materials and labour they must play a large part towards fulfilment of a war production programme by the farmer.

Plant Breeding and Strain Ecology.

Perennial Rye-grass.

Breeding programme continued with special reference to extension of growth period, palatability, vigour, and disease-resistance. A new glasshouse isolation has been made, and seed from this has been sown in the nursery to provide a new nucleus stock area on the Conway property.

Single-plant studies are being continued, and the number of these involved, including progeny tests and additional original plants, exceeds ten thousand.

Short Rotation Rye-grass.

Some ten thousand single plants, including perennial and Italian crosses, hybrid crosses, and open pollinated plants, have been under study. A selection from such plants will form the 1941–42 breeding programme.

An increase area of $\frac{1}{3}$ acre was harvested this year to provide seed to sow a 2-acre area at Lincoln. A further glasshouse isolation has been made, and seed from this is now in the nursery to plant an increase area on the new Conway property.

Fifty perennial-Italian crosses and twenty hybrid crosses have been made to give material for additional study and selection. Ten thousand plants will be put out from these for this purpose.

Italian Rye-grass.

Four thousand single plants have been critically studied during the year, and selections from these formed the basis of a glasshouse isolation. Plants from this seed are now well advanced in the nursery, and an extended area for nucleus seed-production is being planted.

Further crosses have been made with plants selected from F_1 families and from these three thousand five hundred plants are now ready for planting for selection of material for the following year.

White Clover, Type 1.

The present standard of this type is extraordinarily high and the main line of work is to maintain seed-supplies. A glasshouse isolation has been made and plants are now ready to establish a new nucleus seed block on the Conway area.

White Clover, Type 2.

A new glasshouse isolation has been made of this type and an increase area will be planted.

Montgomery Red Clover.

Ten thousand single plants have been under study and plants have been selected for further crossing and progeny study. An increase area for seed-production was planted in November on the Conway property, and a seed crop is now ready for threshing. Crossings and open pollinations will yield seed for a further block of six thousand single plants.

Broad Red Clover.

Six thousand three hundred single plants studied yielded some fifty-nine selected plants to provide a glasshouse pollination group. Seed from this has been harvested and will provide for an increase nucleus stock area to be planted in the spring.

Additional crossings and open pollinations will yield some six thousand five hundred single plants for further study.

Timothy.

Approximately two thousand four hundred and fifty single plants of timothy, representing forty lines, have been planted out for observation prior to selection and breeding.

Crested Dogstail.

Seed increase has been made on selections of crested dogstail handed over to this Division by Mr. Jacques, Massey Agricultural College, and sufficient seed has been harvested to test this selection out on a field scale prior to further increase under certification. Single-plant study is being continued.

Other Breeding-work.

(*a*) *Alkaloid of Perennial Rye-grass.*—Crosses have been made with the object of determining the mechanism of hereditary of the alkaloid with the ultimate objective of producing a perennial or hybrid rye-grass free or low in alkaloid.

(*b*) *Cyanogenetic Glucoside in White Clover.*—Further crosses have been made to study mechanism of hereditary with a view to production of a strain, free or low, in this glucoside should the results of feeding trials warrant such work.

(*c*) *Blind-seed Disease of Perennial Rye-grass.*—Four hundred plants of various lines were inoculated with the spores of the blind-seed disease under controlled atmospheric conditions to study relative degree of resistance of any plant or strains.

Strain Testing and Certification.

Two thousand one hundred and seventy-nine samples covering the following species, perennial rye-grass, cocksfoot, browntop, white clover, red clover, Italian rye-grass, timothy, subterranean clover, and *Phalaris tuberosa* have been sown for trial, mainly for certification purposes.

Species and Strains Trials.

In co-operation with the Department of Agriculture and, more recently, with the young farmers' clubs, species and strains have been laid down and reported on. In all, thirty-two standard trials were laid down in the present year. Numerous requests have been received for the popular "school" series of trials. Large-scale field trials have been made in Southland with British indigenous rye-grass and pedigree perennial rye-grass, while in Canterbury and Manawatu areas have been sown with short-rotation rye-grass.

Pedigree Seed-production.

Nucleus stocks of pedigree seed have been produced on an increased scale, harvestings during the present season comprising perennial rye-grass, Italian rye-grass, short-rotation rye-grass, type 2 white clover, Montgomery red clover, crested dogstail, and British indigenous rye-grass. Single plants have been raised in the nursery planting new areas of the latest selections of perennial rye-grass, Italian rye-grass, and short-rotation rye-grass, pedigree white clover, type 2 white clover, and Montgomery red clover. A broad red clover selection has also been made and will be increased for seeding next season.

Plant Introduction.

A further fifty samples of various species have been received and raised in the nursery for general observation and seed-production or for chemical analysis. Small plots of one hundred and fifty recently introduced species were sown down in the autumn and subjected to grazing. Data were taken on palatability, growth, and recovery from stock grazing. *Agropyron* sp. did not germinate favourably under autumn conditions, but when spring sown produced a good ground cover.

Blind-seed Disease.

The perennial rye-grass increase areas were particularly free from infection with the blind-seed fungus. One block has 10 per cent. infection and the main block 2 per cent. infection. This latter area carried a heavy crop, which lodged badly, completely covering the soil surface, a factor which would prevent the dissemination of spores from the rupturing apothecia. Undoubtedly the low percentage infection was also due to the favourable climatic conditions during the flowering and seed-ripening period.

The date of closing the crop for seed appears to have some influence on preventing heavy infection. To confirm this observation, blocks of a paddock were closed at weekly intervals over a period of ten weeks from the beginning of October. The whole paddock was given four manurial treatments, so that the yield from each block was affected by date of closing and manurial treatment. Data have been collected and will be analysed.

Manurial Trials on Seed Production Areas.

Various mixtures of artificial manures and organic manures were applied to grass-seed crops to determine the value of organic manures such as blood-and-bone, dried blood, and their combinations with super and sulphate of ammonia in increasing the seed-yield.

SUBSTATION AT LINCOLN.

Work has been continued at Lincoln, where collateral tests with those conducted at Palmerston North on selected and bred material have been continued. Five acres of nucleus stock Italian rye-grass yielding some 164 bushels, and 2 acres of short-rotation rye-grass yielding 76 bushels of dressed seed, were successfully grown and harvested by the Agronomy Division.

Reciprocal service at Palmerston North on behalf of the Agronomy Division has been continued at Palmerston North.

FIELD ECOLOGY.

Pasture Surveys.

The pasture-survey work suffered a very grave set back in the recent fire, the whole of the maps and records in connection with the Matakaoa County, Banks Peninsula, and Central Hawke's Bay being lost. An effort is being made to resurvey the Central Hawke's Bay area, but surveys of Banks Peninsula and the Matakaoa County will remain in abeyance until the end of the war.

Sheep Pasture Research.

(1) *Sheep-nutrition Area run in collaboration with Massey College.*—To date records have been made of botanical composition, yield of pasture and amounts available to the grazing flocks at set intervals.

Owing to an exceptional season and the lack of provision of a suitable "flying flock" the herbage has not been kept down right through the season and unbalanced cattle-stocking resulted in unfortunate stock-fertility differences appearing. The cattle have now been eliminated as a control method, and Massey College has arranged to carry the extra sheep when necessary.

Unless each block is stocked to keep each strain and each manurial block at the same grazing height the value of this experiment is largely lost, for the reason that if the grass gets away on the high-producing areas it soon develops into feed of markedly different chemical and botanical composition to that where efficient grazing control has been practised.

(2) *Digestibility Trials with Sheep.*—A shed equipped for controlled feeding of sheep was completed in mid-September, and to date trials have been conducted on pasture of the following types:—

(*a*) Young new pasture:
(*b*) Short high protein pasture:
(*c*) Pasture as cut for silage of early stage:
(*d*) Pasture as cut for silage of intermediate stage:
(*e*) Pasture as cut for hay.

Later on the silage and hay made from the above materials will be fed in comparative trials.

Apart from the digestibility figures obtained from such trials, much useful information has been obtained on the general feeding requirements of sheep. Cleanliness of the feed offered to the animal is a vital factor contributing to ingestion, and the animals have adequately demonstrated the fact that they would rather starve than eat food contaminated with dung and/or otherwise polluted by dead bottom, &c. It would appear as if their sense of smell is very well developed and while they have refused dirty feed of good quality they have in all our trials where an effort is made to present clean food, eaten an average of over 3 lb. dry matter per day.

Sheep-grazing Trials to determine Effect of Dung and Urine on Pasture.

This trial has now been in operation since last July and has demonstrated even in this short time that very large differences occur in high-producing pastures subjected to the following treatments:—

(*a*) High phosphate and lime with full return of excrements:
(*b*) High phosphate and lime with no return of excrements:
(*c*) High phosphate and lime with return of urine only:
(*d*) High phosphate and lime with return of dung only.

After three to four months of differential treatments as above there developed considerable botanical differences, and while total yields were not very different due to original fertility, total D.M. yields for the latest month (March, 1941) shows a 55 per cent. increase due to dung and urine both, a 30 per cent. increase on the urine return paddocks, and a 6 per cent. increase due to dung. The urine paddocks have run to rye-grass dominant, the dung only return to a clover dominant, while the full return is well-balanced rye-clover pasture. The no return is low producing and of an open clover-rye type of sward. All this has occurred on high-fertility land and with pedigree swards with high top-dressing. It is considered that results would be much more spectacular on poorer soils, and in view of the general shortage of artificial manures the results of the trial will prove of considerable value to instructional bodies in driving home to the farming community the great value of animal droppings if adequately utilized.

The results of the trial are being prepared for publication, and articles have been given to papers with a farming circulation.

Dairy-cow Pastures.

The observational and recording work on the area run in collaboration with the Dairy Research Institute has continued. On account of the war the indoor feeding has been discontinued and the work is confined to outdoor grazing of rye-white, cocksfoot-white, and complex mixtures. Nearly all of our data on this work was lost in the fire. Due to difficulties of measurement work on the main dairy farm, it has been decided to carry out most of the detailed measurement on our own area using dry stock for control of the pastures. The work on Massey College property in the future will be mainly observational using dairy cow production figures.

Several new pastures and mixtures have been seeded down on the dairy-farm with the object of studying short rotation rye-grass, pedigree rye-grass, and clovers, together with special-purpose species, such as prairie-grass and cocksfoot.

With the object of determining the value of certain forage crops for autumn milk-production two paddocks were sown into various crops after different cultivation treatments. Due to the exceptional season, the experiment could not be carried out in full, but some very useful figures for total nutrient values have been obtained.

Ensilage.

Last year's programme of work has been completed. Most of the data were saved from the fire and has been written up. The work has shown that there are very large losses in the actual making, and because of this and consequent interpretational difficulties publication has been postponed until this year's work has been completed.

The following types of herbage have been ensiled in this year's experimental programme: (*a*) Young high protein herbage; (*b*) medium protein herbage; (*c*) low protein herbage. These have been ensiled both with and without added sugars, and measurements are being made of pit losses with and without suitable coverings. Stacks of medium protein herbage have been made and a trial is being made of a proprietary paper stack mould.

Trials to determine the minimum size of the experimental silo have shown that a two-foot drainage-pipe and oversilo proves satisfactory. This will mean that a much better layout is possible than having to use full-size pits.

A digestion trial of silage fed to milking-cows has been carried out, and the results sent for publication.

A survey of stack silage was conducted over a large number of farms in the Manawatu, Taranaki, and Waikato districts. The survey showed very low-quality silage in the main, and it is worthy of note that the best by a long way of all stacks was that made on the Massey rotation area from young rye-white pasture. The results of the survey have been prepared for publication.

A large-scale mowing trial to determine the total yields of nutrients from high-fertility pasture shut at different times and cut at different stages has been completed. Results are not conclusive, however, due to the exceptional season experienced at Palmerston North. The trial will be extended this year to bring in the effect of late autumn and winter management.

Hay.

An experiment to determine losses in haymaking methods has been carried out. Due again to excellent haymaking weather, the results do not show much in the way of conclusive results. All the hays produced were of excellent quality.

Herbage Dissection.

The large numbers of samples submitted for analyses have been maintained and extended in the past year. Samples are now received from all parts of New Zealand from trials run in collaboration with the Department of Agriculture and other organizations.

Considerable data on technique, sample sizes, and paddock variation was lost in the fire.

Most of the samples from outside stations are from the Animal Research Division and the Marton Experimental Area. In all these trials this Division has access to the data secured and so this herbage analysis service performs the double function of both giving and receiving valuable information.

Simple versus Complex Mixtures.

Of recent years with more and more attention being directed towards balanced rations for stock the question of whether the trend towards simplicity of pasture swards in the use of simple mixtures, high fertility maintenance, and a full grazing utilization technique is in the best interests of animal thrift must be reviewed. The programme of pasture-plant improvement by this Division and the general observations over a wide field of study has tended rather to the impression that simple pastures, dominated by perennial rye-grass and white clover, represent the ideal to aim at from a production point of view at least. Against that claim a good deal of criticism has been levelled from the aspect of a balanced animal nutrition.

There is at the moment absolutely no experimental data on which to base criticism, nor is there any possibility for any one at the moment to refute such criticism.

The question of simple mixtures versus complex is not merely a matter of the seed-mixture sown. Question of soil fertility and pasture utilization are involved, and the whole gamut of plant competition within the association under varying degrees of soil fertility and methods of grazing have to be studied. Yields of the component species alone and in combination and under varying management need to be worked out, and in the ultimate the digestibility factor at their varying stages of growth must be determined before much light can be thrown on whether sward complexity is more to be desired than sward simplicity.

An approach to this study is being started on a 6-acre block of the Conway property.

Facial Eczema.

Close touch has been maintained with the main investigation under the direction of the Animal Research Division, Department of Agriculture. Some field assistance was given in pasture surveys in the Waikato and on the East Coast. A general pasture-growth survey has been made through the co-operation of the Fields Instruction service of the Department of Agriculture. Pasture analyses have been made of fields grazed and of feed fed to animals in stalls. Close collaboration with the Plant Chemistry Laboratory has been maintained in the growing and collection of herbage for this chemical work.

Meteorological Data.

This section has now taken over the meteorological observation station at Palmerston North, previously handled by the Dairy Research Institute of the Massey Agricultural College.

Aerodrome-turf Production.

Mr. Madden, Senior Agrostologist has been seconded to the Public Works Department to advise, particularly on aerodrome-turf production and to carry out research work where particular difficulties in turf construction are met with. Most aerodromes have been visited on two occasions at least, and several have been visited three times. Reports on condition of turf and programme of work necessary

have been issued at each visit. From observations to date there is fairly clear-cut evidence that the type of turf most suited to aerodromes which are required to stand hard wear is that class of turf most closely approaching a playing green or lawn. The pasture species such as rye-grass and white clover are definitely unsuited to hard regular wear. Some rather drastic treatments will be necessary to convert the pasture type of turf to a good hard-wearing mat. Some considerable expenditure will also be necessary to control white clover which up to now has been fairly well established, but is already proving to be quite dangerous. Supplies of grass-seed suitable for aerodromes have been secured, the main species needed for this work being Chewing's fescue, certified brown-top, *Poa pratensis*, and yarrow. In addition, according to soil type and climate, there is need for some creeping-bent seed and dryland brown-top seed. At one particular aerodrome-site *Puccinellia* was sown, and a further quantity of this seed is to be sown this autumn.

Due primarily to the unusually dry season, there has been little success so far from spring sowings.

From a grassland point of view, and particularly in so far as ecology is concerned, this aerodrome turf work is very interesting and enlightening. The aerodromes are situated from the far North to Invercargill and from altitudes just above sea-level to some two or three thousand feet. Climatic factors are extremely variable. Rainfall and temperatures are two very important factors governing the grass-growth, and these seem to be of as much importance as does soil type. The soils vary from practically pure sand to gumland clay, volcanic loams, pumice ash, peaty soils, and reclaimed salt-marsh country. Numerous photographs illustrating the turf work for aerodromes are, by permission, being secured, and these permanent photographic records will be of great assistance in the future not only for aerodrome work, but in connection with grassland research in general.

Most of the travelling between aerodromes has been done by aeroplane, and particularly good opportunities of studying the various classes of country and the vegetation types thereon have been afforded. In addition to turf problems, such major works as reclamation of land on sea-mud flats, the stabilizing of sand, the consolidation of peaty soils, and the better drainage of heavy clays are being studied. Several important factors have been observed, and these are closely associated with the greenkeeping research work of former years. For example, high-fertility soils are not necessary, acid soils of low fertility are usually more suitable to the development of good tough turf. The terrific amount of wear-and-tear of aerodromes, particularly at the training-stations, necessitates a very tough, hard-wearing turf. Some difficulty was experienced in securing satisfactory machinery for the distribution of seed and manure, but the position is now fairly satisfactory in view of some recent improvements to New-Zealand-made machines.

Greenkeeping Research.

This work has been continued, and during the year the work has been reviewed and published. The Annual Greenkeeper's Conference was again held, and Diploma Examination conducted.

Lectures and Demonstrations.

Assistance has been given to young farmers' clubs and other organizations in the matter of lectures and demonstrations to visitors to the area have been made.

Publications.

The following papers have been published by members of the staff during the year:—

Gorman, L. W. (1940): "Perennial Rye-grass," *N.Z. Jour. Sci. & Tech.*, *21*, 345A–347A.
——— (1940): "Blind Seed Disease Investigations." *N.Z. Jour. Sci. & Tech.*, *22*, 79A–83A.
Corkill, L. (1940): "Cyanogenesis in White Clover—I." *N.Z. Jour. Sci. & Tech.*, *22*, 65B–67B.

PLANT DISEASES DIVISION, OWAIRAKA, AUCKLAND.

Director: Dr. G. H. Cunningham.

For the purposes of continuity, an outline of the work is presented in the form followed in previous years, investigations being grouped under five main headings:—

(i) Diseases of Plants;
(ii) Plant-protection;
(iii) Timber-preservation;
(iv) Pomology;
(v) Miscellaneous.

I. Plant Diseases Investigations.

General.

Several new diseases were identified during the year, those of economic importance being:—

Bacterial-spot of Plums (*Bacterium pruni*).—Found on several varieties of Japanese plums in Hawke's Bay; probably introduced from the United States of America, where it is a serious disease of plums, peaches, and apricots.

Virus of Beet (*Beta Virus 2 of Smith*).—Isolated from sugar-beet and mangels in the Manawatu. Elsewhere a serious disease of these hosts, and likely to prove so in the Dominion.

Virus of Rhubarb.—Identity not yet established. Forwarded this year from Canterbury, where it is said to have been prevalent for ten years or more. A survey showed that upwards of 75 per cent. of the plants in established beds were infected, about one-third of these being killed outright. Unless immediate remedial measures are applied, it will destroy the profitable rhubarb industry of Canterbury.

Black Currant Big-bud Mite (*Phytoptus ribis*).—One of the most destructive pests of currants and gooseberries in England, this disease has recently been isolated from currants at Greytown.

Ring-spot of Carnations (*Heterosporium echinulatum*).—Isolated from carnations grown in a few private gardens in Auckland City. A highly destructive disease if left unchecked.

All these diseases have been introduced with plants or seeds from overseas.

Brassica Diseases.

Diamond-back Moth (*Plutella maculipennis*).—Work of the previous season has been continued, tests in control being made with nicotine sulphate, lead-arsenate, and calcium-arsenate sprays, and mixtures of rotenone-bearing dusts.

When applied at intervals of fourteen days, nicotine sulphate, even at the high concentration of 1–200, gave inadequate control. Both arsenates at a dosage of 4 lb. per 100 gallons of water, with a wetting agent, proved inferior to nicotine sulphate.

Weekly applications of nicotine sulphate 1–200 gave good control, but at lower concentrations proved unsatisfactory. Both arsenates at a dosage of 3 lb. in 100 gallons of water proved to be practically worthless.

Rotenone-bearing dusts were employed with rotenone contents of 0·25 per cent. and 0·5 per cent. All were applied at a dosage per acre of 25 lb. and 50 lb. Six applications at ten-day intervals of 0·75 per cent. and 1·0 per cent. rotenone dusts were required to give adequate control.

Diseases of Grasses.

Blind-seed Disease of Rye-grass (*Helotium* sp.).—The fungus which causes the disease does not perennate within the vegetative tissues of the plant, and slime-conidia, after drying, lose their power of germination within one month.

Infection of the new seed crop must therefore be entirely from ascospores produced by blind seeds shed or sown in the previous autumn.

The disease has been found on tall fescue (*Festuca arundinacea*) and meadow fescue (*F. elatior*). Attempts to procure apothecia in pure culture have not been successful.

Endophyte of Perennial Rye-grass.—Microspores have been secured in pure culture which morphologically resemble those of the blind seed fungus and *Endoconidium temulentum*, isolated from darnel in France by Delacroix and Prilleux. No other spore stages have been produced in culture, so the identity of the fungus is still obscure.

Endophyte of Tall Fescue and Meadow Fescue.—Both have been found to be permeated with a seed-borne endophyte very similar in appearance to the fungus of perennial rye-grass. A survey made with the co-operation of the Fields Division of the Department of Agriculture has shown that plants of tall fescue in all parts of the Dominion—save one or two localities in Otago and Southland—are invariably infected, but no outward sign of the fungus has been detected. The organism has been cultured from seeds and stems and has shown a conidial stage identical with that of *Epichloe typhina*, though the conspicuous fructifications of the latter have not been observed in New Zealand.

Ergot (*Claviceps purpurea*).—Experiments on production of ergot from rye on a commercial scale have been undertaken with promising results. It was found that strains which infect tall fescue, rye-grass, and ten other common grasses did not attack rye. A strain isolated from commercial ergot of Hungarian origin—probably from rye—was found to give heavy infection when a suspension of conidia was sprayed on rye blossoms.

Using this strain on small field plots one spray yielded 115 lb. per acre, two sprays 140 lb., and three sprays 176 lb. of air-dried ergot.

Unfortunately, a sample analysed by the Dominion Analyst proved to be entirely lacking in alkaloids, and hence valueless. Until it is ascertained whether this unexpected result has been caused by locality, season, strain of the fungus, or variety or rye it would be unwise to encourage commercial ergot-production. Experiments to this end will be undertaken.

Potato Diseases.

Virus of Dakota Potatoes.—Inarching tests made in the glasshouse with healthy Up-to-Date and President potatoes yielded a combination of a mild mosaic and a necrotic virus. The former appeared in Dakota plants, while the other varieties showed necrotic markings on stem and leaf, plants eventually dying. Tubers from artificially-infected plants showed necrotic areas both on the exterior and in the flesh. Symptoms do not correspond with any recorded solanum virus.

Legume Diseases.

Bacterial-wilt (*Bacillus medicaginis*).—Twenty-nine varieties of dwarf and runner beans (including resistant varieties from Germany, Holland, England, America, and Australia) were sown for studies of resistance to this disease. Although some lines of Canadian Wonder were heavily infected, wilt did not develop in any variety. Owing to this negative result the experiment will be repeated.

Pea-mosaic.—Several crosses of the pea varieties Greenfeast × Yorkshire Hero × William Massey, forwarded by the Agronomy Division, were tested for resistance to pea-mosaic in the glasshouse. Seeds from apparently resistant plants were then selected and grown in the field, and from these in turn were made selections of Greenfeast type showing apparent immunity.

Lucerne Nodule Organism.—Cultures sufficient to inoculate 149,460 lb. of lucerne-seed were distributed to 1,620 farmers. This shows an increase of 2,240 lb. over that of the same period for last season.

Clover Nodule Bacteria.—Continuation of this work has suggested two major conclusions:—

(*a*) Efficient strains of bacteria should be selected from the district in which inoculation is intended; and

(*b*) Media on which the bacteria are grown should contain sufficient available calcium, as where calcium deficiency pertains the organisms are liable to lose their power to promote high nitrogen content and growth of host-plants.

Other experiments have shown that nodule bacteria of various legumes are capable of forming nodules on host-plants of different genera.

Linen-flax Diseases.

Disease surveys of the commercial areas under linen flax (approximately 14,000 acres) have been made during the growing season and the following diseases found to be present. The first three are carried with the seed.

Browning (*Polyspora lini*).—General in crops in Southland, but troublesome only in those which were sown in October. It has been collected also on *Linum monogynum*.

Rust (*Melamspora lini*).—Present in most crops in Marlborough and Canterbury, but not seen in any Otago or Southland area. Infection was slight so little, if any, damage to the fibre was reported. The rust is also present on the indigenous *Linum monogynum*.

Wilt (*Fusarium lini*).—The fungus has been isolated from diseased material taken from one crop at Oxford in Canterbury and three in the Winton district of Southland. No trace of the disease has been noted in Marlborough or South Canterbury.

Foot-rot (*Cause unknown*).—First noted in crops when 3 in. to 6 in. tall. This condition appears to have been present to some extent in all lines examined, save those grown from certified Canadian seed.

Despite many attempts, a pathogen has not been isolated, so that in all probability foot-rot has been induced by unfavourable soil conditions, possibly aggravated in many cases by contact of plants with superphosphate in the soil.

Pasmo (*Sphaerella linicola*).—Isolated from plants grown at Owairaka from seed procured from commercial lines grown at Blenheim. Symptoms so closely resemble those of browning that it is possible that pasmo may have been mistaken for the former in the field during the course of the survey.

Fruit-tree Diseases. (See Fruit Research Report, p. 42.)

Small-fruit Diseases.

Tomato Diseases.—(*a*) Tomato-necrosis: Following inoculations with severe-streak-infected tomatoes a combination of tobacco-mosaic and an unidentified necrotic virus appeared. The latter has been studied as to host-range, longevity in vitro, dilution end-point, and thermal death-point.

(*b*) Tomato Leaf-mould (*Cladosporium fulvum*): Tests were made in the new commercial type glasshouse of three varieties of tomatoes said to be immune to mould. The standard commercial variety Kondine Red was used as a check, duplicate plots of which were sprayed with Shirlan Ag. to ascertain the effect of the spray on mould control.

Results are most significant, Kondine unsprayed producing 2 lb. 5 oz. per plant, Kondine sprayed 3 lb. 4 oz., one immune variety 5 lb. per plant, a second 5 lb. 11 oz.

One immune variety proved to be shy-setting and was discarded. A second appears to be unfixed as about 5 per cent. of plants developed mould. Selections have been made, and they, together with the most productive variety, will be grown in numbers sufficient to produce commercial quantities of seed.

(*c*) Verticillium-wilt (*Verticillium albo-atrum*): Control of this soil organism was undertaken in a glasshouse the soil of which had been artificially inoculated. In the check plots 100-per-cent. infection was secured, whereas in those treated with formalin solution 1–50 and 1–80 complete control was attained. It was found necessary to apply 50 gallons of solution to 15 square yards of soil as the ground must be saturated to give adequate results.

II. Plant Protection.

Therapeutant Testing.

Mercury Compounds.—Two proprietary organic mercurials were tested against the standard acidulated mercuric chloride steep for control of *Corticium vagum*. Both proved ineffectual, as they did not kill the sclerotia even when employed at concentrations in excess of those recommended by the manufacturers. They did not injure tubers, however, as did the standard treatment.

Copper Compounds.—Three were tested against standard bordeaux mixture. Copper naphthenate was found to be about equal in toxicity per unit of copper, but too costly to employ commercially. A proprietary copper oxide and copper oxychloride have given promising results, the former proving such a useful bordeaux substitute that it has been certified as a spray for tomatoes.

Sulphur Sprays.—A number of proprietary compounds have been tested biologically. Work has been continued on the study of particle size as affecting toxicity, a matter which has a practical bearing on disease control in the field. The work has confirmed field trials in demonstrating the comparative worthlessness of the coarse sulphurs which are still being sold to orchardists.

Derris Products.—Work is proceeding on standardization of biological testing of these products, since it has not been possible to ascertain the rotenone content by chemical analysis. Considerable numbers of insects have been tested, and several of the most suitable have been chosen for toxicity trials.

Correlated field trials have shown that commercial derris products are too costly to be employed on a field scale if applied in the form of dusts.

Certification of Therapeutants. (See Fruit Research Report, p. 42.)

Improvement in Spray Programmes. (See Fruit Research Report, p. 42.)

III. Timber Preservation.

(See Timber Protection Research, p. 51.)

IV. Pomology Investigations.

(See Fruit Research Report, p. 42.)

V. Miscellaneous.

Pyrethrum Production.—Two areas of freshly propagated cuttings of some six to seven thousand plants were set out at Owairaka and Oratia for a test harvest next season on a commercial scale. Cuttings were taken from the high-yielding pyrethrin strain produced in former years.

Experiments in kiln-drying of the flowers have been undertaken, and samples are now awaiting analysis to ascertain effects on the pyrethrin content.

Kumara Varieties.—Samples of the more promising varieties were distributed to Orchard Instructors in various kumara-growing districts for trial. Nucleus lots of all lines have been carried on at Owairaka.

Linen-flax Retting.—A large number of rets under controlled laboratory conditions but following factory procedure have been carried out to study the organisms associated with retting. With three sources of linen flax three organisms are consistently found in all rets. One, comparable with *B. butyricus* and *B. felsineus*, is occasionally present. The latter group is usually considered to be the chief agent in successful retting. Experiments with addition of inoculum containing this type of organism have shown a marked reduction in objectionable odours, and also in retting-time, of twelve to twenty-four hours. Identification of the organisms associated with retting is now in progress.

Plant-growth Substances. (See Fruit Research Report, p. 42.)

Castor-oil Plants.—Small scale field trials of different varieties of *Ricinus communis* have been undertaken at Owairaka over the past two years. Although growth was vigorous, yield of seed was very small.

It is considered that production of seed for oil would not be economic in the Dominion, as apart from the necessity for a long warm summer to mature the seed, the latter ripen very unevenly and the labour of harvesting would be considerable.

Experimental Areas.—Owairaka: The flat was extensively tile-drained and subsoiled during the winter, treatment which has markedly improved tilth and fertility.

A rotary hoe was purchased in November, and has since practically paid for itself in the saving of labour formerly required to keep the farm free from weeds. The large tractor has been completely overhauled, after four years of continuous running, and is again in first-class condition.

One commercial type of glasshouse, 50 ft. by 28 ft., was erected on the area for grape culture. A combined fruit and produce store has also been completed by our carpenters.

The hop garden has been demolished as plants did not thrive under Auckland conditions. It was found necessary to remove the passion-fruit area to higher land behind the laboratory, as plants suffered severely from frost injury in their former exposed position.

All roads were bitumen-sealed in the late spring by the Public Works Department. Advantages was taken of the presence of their equipment to seal the car-park area at the rear of the glasshouses and strips of land between each house.

Oratia: Fourteen and one-half acres were acquired for a quarantine station about one mile and a half from Henderson Township in the Oratia district. It had formerly been in orchard, but trees were so neglected that most have since been pulled out and burned. The land has been ploughed and will be planted this and next winter with apple, peach, and citrus varieties worked on standard rootstocks.

Three glasshouses are on the area and will be employed in quarantine work.

The spray pump installed at Huapai, has, with the closing of that area, been moved to Oratia and will be installed as soon as the pump shed has been completed to contain it.

Publications.*

The following papers have been published by members of the staff during the year:—

Atkinson, J. D. (1940): "Die-back of Lace Barks caused by *Myxosporium hoheriae*, n.f. sp." *N.Z. Jour. Sci. & Tech.*, *22*, 115A–120A.

Baylis, G. T. S. (1940): "Flax wilt (*Fusarium lini*) in New Zealand." *N.Z. Jour. Sci. & Tech.*, *22*, 157A–162A.

Brien, R. M. (1940): "'Leak,' A Watery Wound-rot of Potatoes in New Zealand." *N.Z. Jour. Sci. & Tech.*, *22*, 228A–231A.

——— (1940): "'Foot-rot' of Tomatoes caused by *Phytophthora cryptogea*." *N.Z. Jour. Sci. & Tech.*, *22*, 232A–236A.

Chamberlain, E. E. (1940): "Varieties of Garden and Field Peas Immune to Pea-Mosaic." *N.Z. Jour. Agric.*, *60*, 250.

——— (1940): "A Masked Virus of Aucklander Short-top Potatoes." *N.Z. Jour. Sci. & Tech.*, *22*, 57A–71A.

——— (1940): "Severe-streak of Tomatoes." *N.Z. Jour. Sci. & Tech.*, *22*, 181A–186A.

——— (1940): "Tomato-necrosis." *N.Z. Jour. Sci. & Tech.*, *22*, 186A–197A.

Cunningham, G. H. (1940): "The Genus *Mesophellia* in New Zealand." *N.Z. Jour. Sci. & Tech.*, *22*, 124B.

——— (1940): "*Richoniella pumila*, a Rare Gasteromycete." *N.Z. Jour. Sci. & Tech.*, *22*, 62B.

Gibbs, J. G., Baylis, G. T. S., and Blackmore, L. (1940): "Experiments in Control of Onion Smut (*Urocystis cepulae* Frost)." *N.Z. Jour. Sci. & Tech.*, *22*, 162A–166A.

* Note.—For papers on Fruit Research Projects, see Fruit Research Report, page 42.

PLANT CHEMISTRY LABORATORY, PALMERSTON NORTH.

Director: Dr. J. Melville.

On account of the war the work of the Plant Chemistry Laboratory has been materially changed. All investigations which had no immediate practical application have been in abeyance except in cases where only a very short time was necessary to complete a section of the investigation.

Fire Losses.

Owing to the unfortunate fire which completely destroyed the Laboratory and its contents the work of the latter five months of the year has been greatly hampered. The only accommodation available on the spot was a rough Laboratory in a concrete building at the rear of the destroyed building. This building also housed a store-room containing a limited range of equipment and chemicals. The Laboratory is indebted to the Dairy Research Institute and to the Massey Agricultural College for facilities which enabled analytical work to be carried out. Records of a considerable amount of work which had not been quite completed were lost in the fire. This constituted one of the most serious losses involved. War conditions have been responsible for the non-arrival of apparatus and chemicals ordered prior to the fire. In spite of such difficulties a considerable amount of work has been completed.

Cyanogenetic Glucosides of White Clover.

The work on this project as reported in the last annual report has been completed. It was concluded that two glucosides were present—viz., lotaustralin and linimarin. These glucosides are so closely related in properties that no pure preparation of each was attempted, but a quantity of the mixed glucosides containing approximately 80 per cent. of lotaustralin and 20 per cent. of linimarin was prepared with a view to having toxicological studies made. Unfortunately, this preparation was destroyed in the fire. Three papers on the subject are about to be published.

Marton Mowing Trials.

An eight-year study of soil and pasture samples from trials conducted by the Fields Division, Department of Agriculture, has been completed. These comparatively long-term trials were laid down with a view to deciding (1) the comparative advantages between heavy infrequent applications of carbonate of lime and lighter and more frequent applications, (2) the relative efficiency of coarse and fine fractions of carbonate of lime, (3) the rate of loss of lime from pasture top-dressings, (4) the comparative efficiencies of super, slag, and Gafsa phosphate as suppliers of P_2O_5 to pasture, (5) the effect of addition of carbonate of lime on the availability of P_2O_5 added as super, slag, and Gafsa phosphate, (6) whether it is more advantageous to use a soft limestone as compared with a hard one as a pasture top-dressing.

The following are the main conclusions: (1) From an application of 2 tons per acre of ground limestone there was no leaching below 10 in. for about five years. (2) There was no advantage in using lime in small amounts frequently. On this soil one ton of lime applied each four years was as good as 5 cwt. applied annually. (3) The application of super at 4 cwt. per annum appears to maintain the lime status of the soil at its original level. (4) The loss of lime from treatments supplied with 2 tons of carbonate of lime and an annual application of 4 cwt. of super would appear to be about 350 lb. annually. (5) If super is not applied the yearly loss would probably be of the order of 500 lb. to 600 lb. annually from the soil provided with 2 tons of lime initially if the lime status is maintained at this level. (6) There was a close correlation between yield and the amount of exchangeable lime in this soil. (7) There was no significant difference either in yield of herbage or in the lime status of the soil between treatments receiving a soft limestone and treatments receiving a hard limestone. (8) Over a period of years samples of commercial limestone in which 50 per cent passed a 30-mesh sieve were just as effective as the same limestones which had been screened through a 60-mesh sieve. In the first year the finer material was slightly more effective, but this advantage was not maintained. It was concluded that the extra cost of grinding to the finer condition was not justified. (9) Over a period of eight years equivalent amounts of super and slag applied as top-dressings were about equal in their effect, though slag reduced the acidity of the soil appreciably and also increased the percentage of exchangeable lime in the soil. Gafsa phosphate was only slightly less efficient. (10) The addition of carbonate of lime in separate applications increased the yield of the super treatment considerably, but had only a slight effect on the slag treatments. Gafsa phosphate also showed an improved yield as a result of lime applications. It is considered that the sulphur in superphosphate was probably largely responsible for the increased yield given by super and lime as compared with slag alone or with lime. (11) The application of carbonate of lime had no marked effect on the availability of the added P_2O_5 as measured by solubility in 1 per cent. citric acid.

Hay and Silage Survey.

In conjunction with officers of the Grasslands Division, a hay and silage survey of the three main dairying districts of the North Island was carried out. The conclusions reached in this work show that in the main the silage made is poor. This is largely due to the use of herbage which is too mature giving a silage of low protein content and poor feeding value. The use of herbage from low fertility pastures has also resulted in the making of poor-quality silage. The losses due to overheating as a result of insufficient compaction are great and there was a serious lowering of the digestibility of the protein as a result of the overheating as well as a loss in palatability.

Digestibility and General Pasture Production Trials.

In conjunction with the Grasslands Division several trials to determine the digestibility of pasture herbage at different stages of growth have been carried out. Trials of herbage from very short to mature hay stages have not shown any considerable variation in digestibility. The sheep used consumed over 3 lb. of dry matter per day on all the types. The digestibilities of all the main constituents were all high, ranging between 70 per cent. to 75 per cent.

A trial to determine the total yield of nutrients from pastures shut up at different times and cut at different stages of growth for silage or hay was carried out, but the analytical data is not yet complete.

A trial to determine the effect of animal droppings on pasture is in the course of study. Marked differences in terms of total dry matter have been measured, and chemical analyses of the pasture samples is under way. The trial is showing a progressive increase in yield and composition due to the effect of the animal droppings.

Phytohormones.

Chemical studies on the effect of naphthalene acetic acid on the composition of cuttings were carried out and the results submitted for publication. The hormone treatment had a considerable effect on the soluble nitrogen content of the lower ends of the cuttings.

The relationship of "accessory substances" such as auxins, vitamins, &c., to soil fertility was given some attention. Estimations of the content of auxin, of vitamin B1, and of ascorbic acid in sheep's urine were made. Pot trials, using a sand-bentonite mixture, in which urine was compared with synthetic mixtures containing the same amount of nitrogen in the form of urea, together with additions of heteroauxin, vitamin B1, and ascorbic acid in the amounts found in urine, showed that with the complete synthetic mixture the growth of rye-grass was as good as that obtained with urine. The addition of heteroauxin to straight urea solution had little effect, while the presence of vitamin B1 in the urea-heteroauxin solution produced quite a marked increase in yield. Further addition of ascorbic acid produced no visible response. Further work on this subject is contemplated.

Facial-eczema Investigations.

The work on the rest-nitrogen fraction of rye-grass mentioned in the last annual report has resulted in the isolation of several components exhibiting basic properties. These substances show all of the properties of alkaloids, but none of them correspond to any previously recorded alkaloids.

One of these alkaloids has been prepared in a pure state, and work on the production of a quantity of this alkaloid is being continued. The alkaloid is rather unique in giving coloured salts. The base exhibits marked fluorescence in various organic solvents. The chemical properties of this alkaloid have been studied closely, and a method of estimation in grass has been developed. This alkaloid has been found only in perennial rye-grass or hybrids of this and in very small quantities in timothy. The common weeds of pasture were negative, as were clovers and other grass species.

Five other alkaloids have been isolated, four of which have been crystallized. Owing to the small quantities obtained it has not been possible to attempt repeated recrystallization. One of these five alkaloids resembles closely in optical properties the above described alkaloid. The work on these is being continued.

Close collaboration is being maintained in this project between this Laboratory, the Grasslands Division, and the Animal Research Division of the Department of Agriculture.

Publications.

The following papers have been published, or are about to be published, in the *New Zealand Journal of Science and Technology* :—

"Cyanogenesis in White Clover"—
- Part 2: "Isolation of the Glucosidal Constituents," by J. Melville and B. W. Doak.
- Part 3: "A Study of Linamarase, the Enzyme which Hydrolyses Lotaustralin," by I. E. Coop.
- Part 4: "Methods of Determination and General Consideration,," by J. Melville, I. E. Coop, B. W. Doak, and I. Reifer.

"Movement and Loss of Lime from a Soil under Pasture," by B. W. Doak.

"Effect of Fineness of Grinding and Hardness of Limestone on its Efficacy as a Pasture Top-dressing": Part 1, by B. W. Doak.

"The Micro-estimation of Betaine and Choline," by I. Reifer.

"The Effect of Naphthalene Acetic Acid on the Chemical Composition of Cuttings": Parts 1 and 2 by B. W. Doak.

"Silage Studies—Part 1: The Quality of Stack Silage in the 1939-40 Season," by I. E. Coop (Plant Chemistry Laboratory), P. D. Sears, W. G. Thurston, and F. B. Sill (Grasslands Division).

ANIMAL RESEARCH.

Reports on researches relating to animal problems are included in the sections of this report referring to the work in progress at the agricultural colleges and Cawthron Institute.

SOIL SURVEY.

Land Utilization Committee.—Sir Theodore Rigg, Director, Cawthron Institute (Chairman); Mr. A. H. Cockayne, Director-General, Department of Agriculture; Mr. E. J. Fawcett, Assistant Director-General, Department of Agriculture; Mr. R. B. Tennent, Director, Fields Division, Department of Agriculture; Mr. R. P. Connell, Land Utilization Officer, Department of Agriculture; Professor W. Riddet, Massey Agricultural College; Mr. G. A. Pascoe, Factory Controller, Department of Industries and Commerce; Dr. L. I. Grange, Director, Soil Survey Division, Department of Scientific and Industrial Research; Mr. R. G. McMorran, Under-Secretary, Lands and Survey Department; Mr. F. R. Callaghan, Chief Executive Officer, Plant Research Bureau, Department of Scientific and Industrial Research; Dr. I. W. Weston, Agricultural Economist, Canterbury Agricultural College; Mr. F. J. A. Brogan, Assistant Secretary, Department of Scientific and Industrial Research (Secretary).

REPORT BY DIRECTOR (DR. L. I. GRANGE).

The general soil survey of New Zealand, commenced during the previous year, has been continued. Field-work on the soils of the North Island is now completed and a comprehensive legend containing 131 main soil types compiled. In the South Island, mapping for the general soil survey has been carried out chiefly on the high-country runholds at the headwaters of the Waitaki, Rangitata, Rakaia, Waimakariri, and Waiau rivers.

In the Waikato lowlands a detailed survey now covers the district extending east from Hamilton to Motumaoho and south to Cambridge. Towards the close of the year, classification of soils in the South Otago and Southland lowlands was commenced with the object of providing information on soil conditions for flax growth.

The chemical work of the Division, which was formerly located at the Cawthron Institute, Nelson, at the Dominion Laboratory, Wellington, and at a small laboratory of the Division in Wellington, has now been unified into one laboratory, situated in Wellington.

GENERAL SURVEY, NORTH ISLAND.

In the general survey of the North Island, 131 main soil types were identified by their field characteristics and were classified into nine groups: Recent soils, Rendzina soils, yellow-grey loams, podsolic soils, brown loams, ground-water soils, saline soils, skeletal soils of the steep slopes, and mountain soils.

Wherever sufficient evidence was available, the types within each group were assembled into stage divisions according to the development the soil has reached. Soils of the moderately-steep hills were mapped as phases of closely-related types covering the rolling country.

The Recent Soils.

The Recent soils are derived from alluvium, which is still being added to from time to time by present-day floods and from recent volcanic showers. The Recent soils from alluvium floor the main valleys; they are for the most part fertile loams and clay loams, and are most extensively developed in the Hawke's Bay, Gisborne, and Manawatu districts. Less-fertile gravelly and sandy Recent soils from alluvium and poorly-drained types are widely scattered throughout the Island. The Recent soils from volcanic ash are of three main types: The fertile sandy loam of the Rotomahana mud, the gravelly sand formed from Tarawera lapillæ (both of which were erupted in 1886), and the sandy loam ash that covers the roughly-circular area of about thirty miles radius around Ngauruhoe Volcano. These ash deposits are important in that they cover older pumice soils which are free from bush sickness wherever a thin layer of the recent ash is present.

The Rendzina Soils.

The Rendzina soils are lime-humus soils developed on limestone rocks and are confined mainly to North Auckland. They have deep dark-grey clay topsoils with a strong crumb-structure, and heavy brown and gray mottled subsoils containing free calcium carbonate. These fertile soils are used for dairying and sheep-farming. Related soils occur north of Raglan and in Hawke's Bay.

The Yellow-grey Loams.

The yellow-grey loams are confined to the lower rainfall areas (35 in. to 50 in.) of Hawke's Bay, Wairarapa, and Manawatu, the native vegetation being light forest, scrub, and bracken fern. They are formed largely from calcareous mudstone and argillaceous sandstones. The true yellow-grey loams are fertile soils with a high pH and are well saturated with bases. In their mature stage they show a grey A_2 horizon and a marked accumulation of clay in the subsoil, but the topsoil is still high in bases. Other soils included tentatively in this group are derived from indurated mudstone and sandstone. They are light in texture and much less fertile, being moderately acid and less saturated with bases.

The Podsolic Soils.

The podsols are in two main divisions: The podsolic soils derived from pumice ash, and those derived from sedimentary and massive acid igneous rocks.

The Pumice Podsols.—The pumice podsols are developed on comparatively recent showers of pumiceous volcanic ash covering the central North Island plateau and contiguous areas. Of these showers, the Taupo and the Kaharoa are the most important. These soils are peculiar in that normal leaching is proceeding simultaneously with geological weathering of raw pumice present in all parts of the soil profile. Mineral deficiency diseases (bush sickness) in stock are a feature of the pumice soils.

The Kaharoa soils cover the western part of the Bay of Plenty and extend south to the Mamaku Plateau. Farther to the south and east they reappear from beneath the Tarawera ash in the neighbourhood of Galatea and Te Whaiti. Three main divisions are recognized—viz., the scrub soils, the slightly more leached soils under bush, and those in which a grey A_2 layer is developed under the heavier rainfall on the Mamaku Plateau. All the Kaharoa group have medium sand topsoils and gravelly subsoils, and hence are inclined to be droughty. They are most fertile where the ash is thinnest and the gravelly subsoil least developed, as on the shores of the Bay of Plenty.

The Taupo soils cover a much larger area, extending from Putaruru in the north to the neighbourhood of Napier in the south, and from Taumarunui in the west to the summit of the ranges north-east of Gisborne. Older Taupo showers extend still farther to the north-east. As with the Kaharoa, three main stages are recognized—viz., the immature soils of the scrub and tussock country, the browner soils of the forest zone, and the mature soils of the wetter uplands where the profiles show both a leached A_2 horizon and in places a well-developed humus pan.

The Podsolic Soils from the Sedimentary Rocks.—These are well developed north of Auckland, in the neighbourhood of Wellington and parts of southern Wairarapa, and on the very extensive areas of hill country from which the later showers of volcanic ash have been eroded and where the rainfall is over 60 in.

Young podsolic soils on recent sand-dunes fixed by vegetation are developed extensively on the west coast. The largest area is in the Manawatu, where the soils carry a good mixed pasture. The subsoil is loose and overdrained. Closely-related soils on sandhills fixed by weathering occur near the west coast from Raglan northwards. These fertile soils are slightly acid and are well supplied with bases. The subsoil is loamy, and hence they retain the moisture well.

Young and immature podsolic soils derived from calcareous sandy mudstone are best developed in the King-country and in the Gisborne area, where the rainfall is more than 60 in. per annum. These fertile soils are neutral or slightly acid and are well supplied with bases. Immature podsols derived from sandstone and greywacke cover relatively large areas, especially in North and South Auckland. These soils, which have developed under a forest cover, are normally clay loams in texture with brown clay subsoils. The topsoils are moderately acid and have a moderate supply of bases. Hence they need top-dressing with lime as well as phosphates. The subsoils are strongly acid and are poorly supplied with bases, consequently even moderate sheet-erosion on hilly land greatly reduces the general fertility.

Heavy grey and brown flecked clays representing the semi-mature stage of podsolization are well developed in North Auckland. They are markedly acid and fairly low in bases. Because of their heavy texture and high base exchange capacity these soils improve but slowly. For pasture they need heavy dressings of lime and phosphate.

The mature soils (gum lands) are practically confined to North Auckland. These have well-developed posdol profiles with strong grey A_2 horizons. They are strongly acid and well leached of bases. Owing to their low capacity, pasture responds well to lime and phosphates where the topsoil is loamy. Where, however, the topsoil is a sand and pans are well developed, even heavy top-dressing does not greatly improve the fertility because of the wide fluctuations in soil moisture.

The podsolic soils derived from acid igneous rocks occur on the eastern side of the Coromandel Peninsula and scattered throughout the North Auckland Peninsula. Although immature soils are found, most of them are semi-mature and mature. They closely resemble the soils from the sedimentary rocks described above.

The Brown Loams.

The brown loams are in three main sub-groups—viz., the yellow-brown loams derived from andesitic volcanic ash, the brown granular clays derived from andesite and dolerite rocks, and the red-brown loams derived from basalt. All the brown loams are characterized by a low silica/sesquioxide ratio, and show marked powers of phosphate fixation.

The Yellow-brown Loams.—The yellow-brown loams are developed in fine-textured ash of andesitic and rhyolitic composition which formerly covered the North Island from near Wanganui and Napier in the south to Auckland in the north. In the central part they are overlain by later volcanic ashes which do not give rise to yellow-brown loams. The yellow-brown loams are all friable soils with a fine granular to "fluffy" structure; the soil clay is high in alumina and moderately high in iron.

Stretching from the Northern King-country to the Waikato River mouth are free silt loams derived from the Mairoa ash of mixed andesitic and rhyolitic composition. On the scrub and fern-covered lowlands, where the rainfall is less than 60 in., the soils are but slightly acid and moderately saturated with bases. They respond well to phosphate top-dressing. Where the rainfall is heavier (60 in. to 80 in.) and the cover is forest, subsoils are more compact. On the wetter uplands (rainfall over 80 in.) the soils are markedly leached of bases with faint A_2 layers in the profile and in places thin iron pans.

To the east of the Mairoa ash, in the Tirau, Waihi, and Tauranga districts, ash beds lighter in texture and more rhyolitic in composition mantle the surface. The Tirau sandy loam and its finer counterpart in the Morrinsville district are developed under a moderate rainfall. They respond well to phosphate. The Tauranga-Waihi soils are coarser in texture and they show well the progressive stages of leaching. The least leached are the black coastal soils and the brown sandy loams of the rolling and moderately-steep hills, formerly covered with mixed bush. On the Waihi plains and the foothills south of Katikati the soils are more leached and respond to phosphate and potash top-dressing. A similar series of soils covers the rolling and moderately steep land in the eastern Bay of Plenty, East Cape, and northern Gisborne districts.

Darker-brown soils derived from andesitic ash beds are well developed on the easy land of Western Taranaki and along a strip extending from Ohakune to Taihape and towards Napier. These soils are slightly to moderately acid and show well the stages of leaching under increasing rainfall. The most fertile of these soils are those covering the low-rainfall areas of South Taranaki, where the topsoils are black. The most-leached soils occur closer to Mount Egmont, where the rainfall rises to 100 in.

Yellow-brown loams are also developed on areas covered by alluvium derived from volcanic ejecta. On a large area bordering the south shores of the Manukau Harbour the soils resemble closely the immature soils from the Mairoa ash. In the lowlands of the Waikato and the Matamata districts, semimature yellow-brown loams, responding well to phosphate covers the low gravel ridges and plains bordering former courses of the Waikato River. Here the yellow-brown soils form a complex with heavier meadow loams and peats occupying the former river channels and backwaters. In the Wellington and Wairarapa districts silt loams derived from greywacke, and other sediments, composed in part of tuff, give rise to a further series of yellow-brown loams.

The Brown Granular Clays.—The brown granular clays cover large areas of hill land between Dargaville and Kaitaia, in the Waitakere district near Auckland, and in the Coromandel Peninsula.

The topsoils are granular and fairly free, in the more-leached types the subsoils are compact and sticky. In the immature stage the soils are fertile and resemble the red-brown loams. In the well-leached stages they are strongly acid and infertile, and the profile resembles that of a podsol. Brown granular clay derived from andesitic ash covers the low rolling hills of the Hamilton district and much of the rolling land to the north. These soils farm well.

The Red-brown Loams.—The red-brown loams are confined entirely to the Auckland district, where they are developed on basalt sheets under conditions of intermittent drainage. The young and immature soils are neutral to slightly acid, and are well supplied with bases, but on some areas the soils are too shallow and rocky for good farming. The semi-mature soils are moderately acid and need heavy dressings of lime and phosphate to support a good pasture. The mature soils ("ironstone" soils) are well developed in the Bay of Islands district. These infertile soils, although well leached of bases, are still but moderately acid. Nodules of ironstone occur throughout the profile.

The Ground-water Soils.

The ground-water soils include the meadow soils, where the subsoil develops under the influence of ground water, and the peaty soils.

The Meadow Soils.—For the most part the meadow soils are confined to the South and North Auckland districts, although small areas are to be found at Hawke's Bay and other low-lying plains. They are best developed in the Hauraki depression, where their textures range from a sandy loam in the south to heavy clays in the north. Most of these soils are acid and have but a moderate base supply. The meadow clays close to the shores of the Firth of Thames are high in both bases and phosphate. On all these soils drainage is needed.

The Peaty Soils.—The peaty soils are best developed in the Waikato and Hauraki lowlands, the Bay of Plenty, parts of North Auckland, and the Wairarapa. They are divided into three divisions—viz., the mellow peaty loam, the acid peaty loams, and the peats and loamy peats.

The mellow peaty loams are moderately acid and have a moderate base supply. They are good farm lands. The acid peaty loams and peaty sands require top-dressings of lime and potash in addition to phosphates. The peats and loamy peats are very acid and are poorly supplied with bases. Their high base capacity and their dry crumbly nature when deeply drained make them difficult to farm.

Saline Soils.

The saline soils occupy only small coastal areas in the Hawke's Bay, Hauraki, and North Auckland districts. Formerly mud-flats and mangrove swamps, these soils have been protected against salt-water flooding. They are usually clays with a high fertility, although some years have to elapse before the salinity can be lowered to a point when pastures can be established. The soil structure improves as the salinity falls, and drainage, an essential factor is facilitated.

Skeletal Soils.

The skeletal soils cover the steep hill country and are, for the most part, shallow soils closely related to the parent rock. Under the natural bush cover they have thin fertile topsoils, but the subsoils vary widely according to the type of rock underlying. Where they are derived from such rocks as calcareous sandstones and mudstones the subsoils are neutral in reaction and are well supplied with bases, but where they are derived from poorer rock types such as greywacke and siliceous sandstone the subsoils are poor and acid.

Skeletal soils with a fertile subsoil are found in the Taumarunui area, near Taihape, and at East Cape. Those with an acid, infertile soil occur mainly on the steep land from Wellington and Cape Palliser northward to near East Cape, and in the North Auckland Peninsula. The mid-part of the Wanganui River flows through an extensive area of skeletal soil derived from sandstone which gives a subsoil of moderate to poor fertility. In the central part of the North Island, where the steep land has been covered with pumice ash, the skeletal soils usually include much sub-aerial material. Skeletal soils derived from intermediate and basic igneous rocks are confined to the Auckland district and East Cape, reaching their greatest development in the Coromandel region.

Much of the steep land is still covered in forest. Where the land has been cleared the thin topsoil has, for the most part, been lost by erosion, and hence only those areas with fertile subsoils have been successfully farmed. Where the subsoils are poor and acid, much land formerly grazed has now been abandoned and has reverted to fern and scrub.

Mountain Soils.

Soils of the steep and broken country over 3,500 ft. above sea-level are classed as mountain soils. They are unsuited to permanent agriculture.

General Survey, South Island.

Early in January the general soil survey of the South Island was commenced on the tussock lands of Canterbury which lie westward of the plains and downs, and which would not be suitable for work during the winter months. At the end of March, 1941, the soil types of the high-country portions of Tawera, Selwyn, Ashburton, Mackenzie, and Geraldine Counties had been identified and outlined.

The soils may be divided into four main groups:—

(1) *Recent Soils.*—These comprise the recent river flats and consist mostly of infertile gravels, though some deeper phases are of moderate fertility. Small areas of peaty soils are included in this group:

(2) *Grey Soils.*—These are developed on easy country from material derived from glaciers or glacial streams. They occur as hummocky moraines and terraces formed by streams issuing from the ancient ice-fronts in areas of moderate rainfall *i.e.*, 25 in. to 40 in.:

(3) *Yellow-brown Soils.*—These are of similar origin to group (2) but developed under a higher rainfall—*i.e.*, 40 in. to 140 in. They are much less fertile than the previous group:

(4) *Skeletal Soils.*—These soils, which lie on steep slopes, occupy the greater part of the area examined, and are derived from greywackes and argillites. Three divisions of this group are made: (*a*) Grey-brown soils which are light silt loams and sandy loams found in areas of rainfall between 25 in. and 50 in.; (*b*) yellow-brown soils which are light silt loams found in areas of rainfall between 50 in. and 150 in.; and (*c*) soils on the ranges flanking the Canterbury Plains, where the greywacke has been covered by a veneer of wind-blown loess.

Soils of Waikato Lowlands East of Hamilton.

On the accompanying map the main kinds of soil are shown. Some of the types recognized during the course of the survey occupy a small area and are not differentiated; they will be separated on the detailed map which will be published later.

Brown loams cover a fairly large area, mainly on the western portion of the area, and are similar in every respect to the brown loams found in the Waipa district. There is very little Ohaupo silt loam in the whole area, and what small patches there are, are very scattered.

The brown-loam complex forms the hills on the extreme eastern margin and does not cover a very large area. A profile is:—

6 in. to 7 in. dark-grey fine sandy loam.
2 in. to 3 in. light-brown free sandy loam.
12 in. light-brown heavy sandy loam.
On yellowish-brown very heavy clay.

On the margin and steep faces of the soils of this complex are patches of Tauwhare silt loam. The Tauwhare soil is generally found on the lower foothills and steep faces of the complex. This type is sometimes found adjoining, and apparently covering in patches, the Hamilton clay loam. A profile is:—

3 in. to 4 in. black sandy loam.
12 in. to 14 in. greyish to dirty creamy-yellow silt loam.
On heavy, dirty creamy-yellow, fairly heavily iron-mottled silt loam.

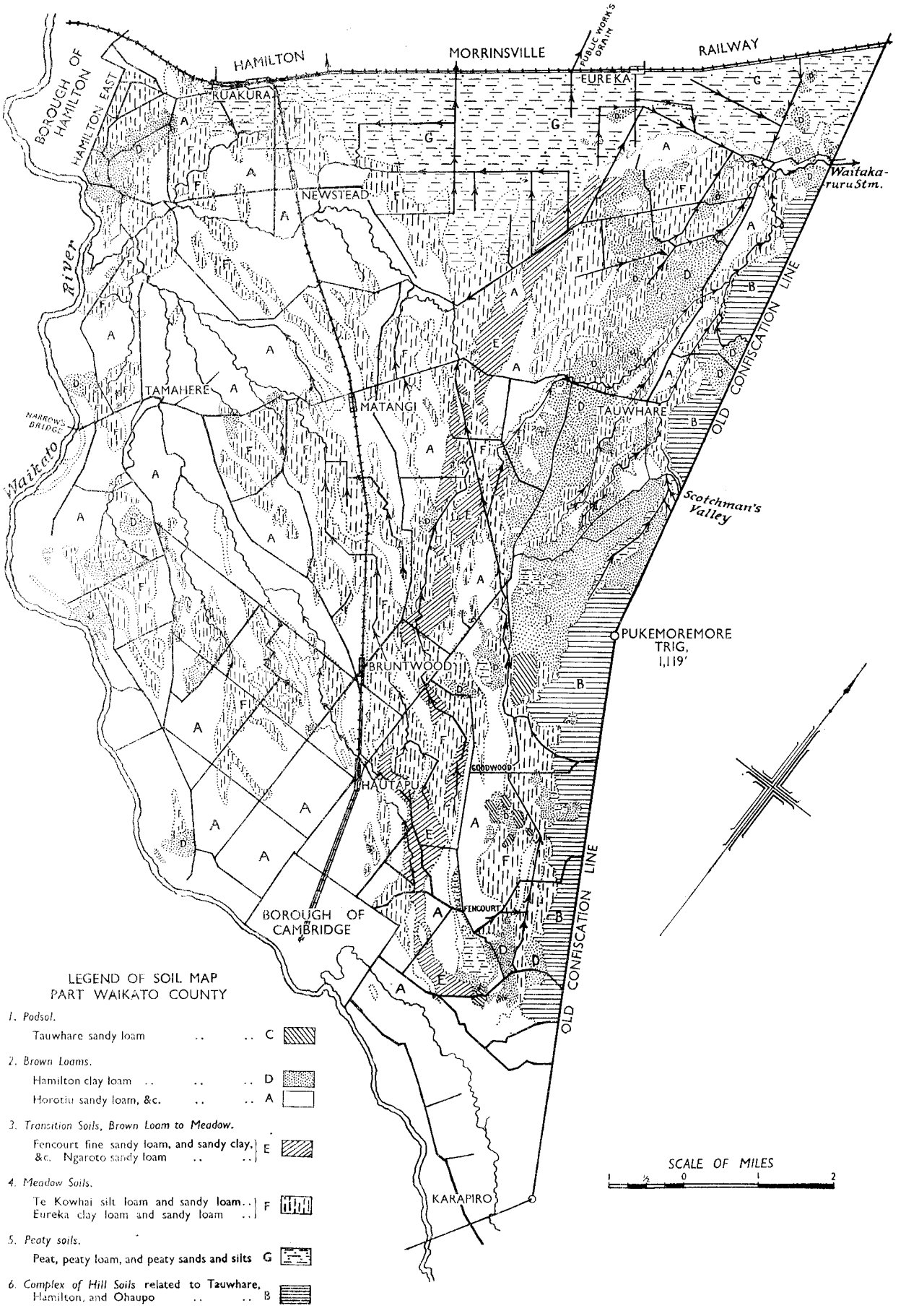
Brown granular clay—Hamilton clay—loam covers a large area on the eastern portion of the map. It is the same type as encountered in the Waipa area. The transition soils are extensive in area, and vary considerably in texture from fine sandy loam, with patches of pan, to heavy coarse sandy clay. This type is found generally on the eastern side of the area between the Hamilton–Cambridge Railway and the hills on the eastern margin.

The meadow soils are similar to those found in the Waipa district, with the exception of the Eureka clay loam, which is found on the eastern part of the area. In texture Eureka soil is much heavier than the usual meadow soils, and in the northern portion heavy iron pans exist at a depth of from 18 in. to 24 in. A profile is:—

6 in. dirty brown clay loam (sometimes reddish) with patches of creamy-grey clay loam.
12 in. creamy-white heavily mottled clay.
4 in. to 6 in. yellowish very heavy, sticky sandy loam.
2 in. to 5 in. dark-brown iron pan.
On yellowish clay (shingle at from 3 ft. 6 in. to 4 ft.).

The peat soils are common in this district, and cover practically the whole of the northern portion. There are also a few small patches scattered throughout the area mainly adjacent to the hills. They include peat, peaty loam, and peaty sands and silts. The area of deep peat is comparatively small and occurs near the Hamilton-Morrinsville Railway. The drainage of much of the land occupied by meadow and peat soils needs to be improved.

SOIL MAP
PART OF WAIKATO COUNTY



LEGEND OF SOIL MAP
PART WAIKATO COUNTY

1. *Podsol.*
   Tauwhare sandy loam C
2. *Brown Loams.*
   Hamilton clay loam .. .. .. D
   Horotiu sandy loam, &c. .. .. A
3. *Transition Soils, Brown Loam to Meadow.*
   Fencourt fine sandy loam, and sandy clay, &c. Ngaroto sandy loam .. .. E
4. *Meadow Soils.*
   Te Kowhai silt loam and sandy loam .. Eureka clay loam and sandy loam .. F
5. *Peaty soils.*
   Peat, peaty loam, and peaty sands and silts G
6. *Complex of Hill Soils related to Tauwhare, Hamilton, and Ohaupo* .. .. B

Linen-flax Soils.

A survey of the soils that have grown linen flax in the past season was commenced in February, 1941. Very little was known of the soil requirements of linen flax grown under the conditions existing in this part of New Zealand, and it was necessary to make a fairly full examination of numerous individual crops in order to assess the part played by the soil and other factors which were mainly agricultural (cultivation, previous cropping, fertilizer applications, &c.,) but also included aspect, shelter, local rainfall, &c. This latter stage of the investigation was greatly facilitated by the Agricultural Instructors, who were able to point out where the agricultural practice was affecting the growth of the crop. The object of the survey is to provide a soil map of each flaxgrowing district showing in particular which of the soils are likely to be suitable for flax. Detailed mapping is practically completed in the Balclutha and Clydevale districts.

The main soil factors that adversely affected the flax crop during the past season in South Otago and Southland are—

(1) Shallow silt loams and sandy loams overlying river shingle. When the shingle approached to within 15 in. of the surface the flax crops were very uncertain. A few succeeded, but the great majority ripened without making sufficient length of fibre. In the case of loam and clay loam topsoils overlying shingle, the critical shallowness of the soil was in the region of 12 in. These soils are locally regarded as being very suitable for wheat and oats, but this is a case where good cereal land is not the same as good flax land:

(2) Shallow and stony soils over rock. The unsuitability of these soils was due obviously to insufficient moisture-holding capacity in the topsoil and the absence of a moisture reserve in the subsoil:

(3) Stony soils developed on fan debris formed by mountain torrents. This type of soil accounted for most of the failures in the Crookston district:

(4) Soils on the rolling hills at an altitude of 1,000 ft. above sea-level. Here the main factor is probably exposure. The soil itself does not appear to be unsuitable:

(5) Soils on the steeper slopes of the rolling hill country. Sheet erosion has reduced the depth of the silt loam topsoil, and when the slopes are ploughed the heavier-textured subsoil is brought to the surface. This subsoil is not only poorer in plant foods, but it is less easy to break down and consolidate prior to seeding:

(6) Heavier-textured soils in general. This again, is probably an agricultural problem and concerned with the difficulty of getting heavy-textured soils into a fine enough tilth, particularly when ploughing is delayed until the spring.

Soil Survey Laboratory, Wellington.

General Soil Survey.—The general soil survey of the North Island has absorbed most of the energies of the chemists and no time has been available for the research side of soil work.

For the general survey the following estimations are made on all samples: Available phosphate and potash, pH, carbon, nitrogen, base exchange capacity, total exchangeable bases, percentage base saturation, replaceable calcium and magnesium together with texture analyses, carbonate, and soluble salts contents as required. These data give a fairly complete picture of the soil's likely performance. Over a thousand soils have been examined on these lines, and the results have contributed in no small degree to the reliability of the North Island soil map.

The North Island analyses are practically completed, and a start has been made on South Island soils. Justification for the survey can be found in the variations that occur between different soil types. For instance, citric-acid-soluble phosphate values have ranged from less than 0·001 to 0·10 per cent., potash from 0·009 to 0·21 per cent., pH from 4·1 to 8·1, carbon from 1·2 to 62·3 per cent., nitrogen from 0·06 to 1·92 per cent., carbon-nitrogen from 10 to 50, base exchange capacity from 3·9 to 113 m.e. per cent., total exchangeable bases from 0·09 to 58 m.e. per cent., percentage base saturation from 1 to 100 per cent., exchangeable calcium from 0·6 to 56 m.e. per cent., magnesium from 0·1 to 20·9 m.e. per cent., and soluble salts have been found up to 0·4 per cent.

The main groups found in the North Island survey have been mentioned elsewhere in this report, and in passing it can be said that podsols mapped in the field conform in chemical data to their usual characteristics. Brown loams have a lower acidity than their percentage base saturation would indicate. Brown granular clays tend to show higher than usual magnesium compared with calcium on the maturer soils, and the yellow-grey group, although exhibiting a definite profile, is not strongly leached, percentage base saturation often being of the order of 60 per cent.

Glauconite as a Possible Potash Fertilizer. Samples of glauconite greensand were examined from the viewpoint of their suitably as a source of potash. Analyses showed that the availability of potash in these samples was little different from that of a good soil, and no hope could be held out at present for its use in its natural condition. Treatment with heat and sodium chloride did increase potash availability, but the cost of processing would be prohibitive when other sources of supply are considered.

Effect of Continuous Superphosphate Manuring on Outgo of Magnesium and Potash in the Waikato.—A number of soil samples from untop-dressed areas and from fields top-dressed mainly with superphosphate in a manner which would be considered normal for the Waikato have been analysed. The analyses showed that while the lime and phosphate level had been built up as the result of top-dressing there were decreased amounts of potash and magnesium present in the soil, indicating that the present system of Waikato top-dressing in an unbalanced one. From the analyses it was concluded that gypsum contained in commercial superphosphate was likely to be the main

cause of the loss of magnesium, since it is able to displace this element from the clay complex into the soil solution, and thus readily leached out in the drainage water. Potash is lost mainly in products taken from the farm. It is not suggested that these elements have reached an actual deficiency level, but some alteration in the top-dressing programme may be desirable in the future. Potash and magnesium have been tested in the present instance, but it is possible that other elements are in a similar position.

Linen-flax Soils.—Over a hundred samples have been examined from fields where flax was grown last season to ascertain the characteristics of soils that grew poor and good flax. Results to date indicate no marked nutrient differences, and suggest that if physical and moisture factors are suitable good flax can be grown with suitable top-dressing on soils of fairly low fertility.

Method for Estimation of Magnesium, using 8-Hydroxyquinoline.—During the year a critical examination of the 8-hydroxyquinoline estimation of magnesium in soils was completed and conditions found for estimating with confidence replaceable quantities down to that associated with magnesium-deficiency symptoms in apples and tobacco.

CHEMICAL WORK AT THE CAWTHRON INSTITUTE.

Sir Theodore Rigg, Officer in Charge.

The main work at the Cawthron Institute during the past year has been the continuation of the soil survey of tobacco lands in the Nelson district. Soil maps for the Kaiteriteri and Motueka subdivisions were finalized, and copies taken off for the Tobacco Control Board, the Tobacco-growers' Federation, several Government Departments, and the three tobacco companies operating in the Nelson district. Tobacco maps showing the distribution of tobacco gardens in the Riwaka and Motueka districts were also prepared and have been made available to interested organizations.

The soil survey has been continued in the Motueka Valley and in the Dovedale-Thorpe Valley, and soil maps covering these additional areas are being finalized with a view to their reproduction in the interests of the tobacco industry. The tobacco maps for the Motueka and Riwaka districts have been revised to take into account the increase in tobacco acreage during the past season. Similar maps showing the distribution of tobacco throughout the Motueka and Dovedale Valleys are nearing completion.

In the chemical laboratory, samples of soil representative of the different soil types covered by the surveys have been examined for texture, plant food status, and exchangeable bases.

At the request of the Lands Department, reports have been prepared on the soils of different development projects on the west coast.

During the year the chemical branch of the Soil Survey Division of the Department of Scientific and Industrial Research was transferred to Wellington. This work has been associated with the Cawthron Institute ever since the establishment of the soil-survey organization in 1930. The centralization of the field and chemical work of the Soil Survey Division in Wellington has involved the transfer of two valued officers from the Soil staff at the Cawthron Institute. By arrangement with the Department of Scientific and Industrial Research, the Cawthron Institute will continue soil-survey work in Nelson and Marlborough Provinces.

Soil Mapping.—With the completion of soil maps for the Riwaka and Motueka districts, mapping was continued in the Motueka and Dovedale valleys. The aerial maps have again proved invaluable in the preparation of the soil maps and have greatly accelerated the work. In view of the importance of soil texture and underlying strata in assessing land for tobacco, very systematic soil examinations in the field have been required. For the purpose of the tobacco industry, the soils have been separated into five groups, depending on their suitability or otherwise for flue-cured tobacco.

In the Motueka Valley, including the Waiwhero, Orinoco, and Graham Valleys, over 5,000 acres of terrace and alluvial lands have been mapped and the different soil types delineated. Approximately 1,500 acres have been placed in categories 1 to 3, indicating suitability for the culture of flue-cured tobacco. As the area actually used for tobacco during the 1940–41 season was only 480 acres, it is clear that considerable expansion of tobacco culture should be possible. In the Dovedale-Thorpe Valley, some 2,300 acres of alluvial and terrace lands have been surveyed and separated into different soil types. The total acreage included in soil groups 1 to 3 is approximately 680 acres, of which over 270 acres were in actual use for this crop during the past season.

Land Utilization.—Maps have been prepared showing the present utilization of the land for different crops in the Motueka and Riwaka districts. Similar maps are in course of preparation for the Motueka and Dovedale valleys. The location of the different tobacco gardens, together with the names of the growers, is shown on the maps, enabling the maximum utilization of the soil maps to be made.

During the past season, 1940–41, 2,932 acres of tobacco were grown in the Nelson district. This represents an increase of over 400 acres compared with the 1939–40 season. The increase in tobacco acreage is confined almost entirely to the Motueka-Riwaka district. The distribution of the tobacco acreage according to districts is shown below:—

	Acres.
Motueka and Riwaka district	1,690
Motueka River Valley	428
Orinoco Valley	51
Dovedale and Thorpe valleys	275
Stanley Brook, Tapawera, and Motupiko	240
Wakefield, Waiti, and Waimea	177
Upper Moutere and Mapua	71
Total	2,932

Chemical Work.—Samples of soil, representative of the principal types covered by the soil survey, have been examined in the laboratory. The analyses show that sands and sandy loams are the principal soils used by growers for flue-cured tobacco. Available phosphoric acid is invariably high to very high in tobacco soils, but available potash is generally low and in some cases must detrimentally affect both yield and quality of tobacco. For the most part the tobacco soils have a base saturation of from 50 per cent. to 60 per cent. Occasionally soils are found with a base saturation of over 80 per cent. and in other cases below 30 per cent. With few exceptions, the lime content appears to be satisfactory. The magnesia content tends to be low on soils derived from granite and from the Moutere Hills. On these soil types, figures suggesting the possibility of magnesium deficiency were obtained at Orinoco, Graham Valley, Pangatotara, Dovedale, Stanley Brook, and Baton Valley. The tobacco soils at Tapawera contained very high amounts of magnesia.

SOIL EROSION.

During the course of the general soil surveys the Division has collected data concerning the amount and nature of soil erosion on the various kinds of soils. In the high country on the eastern side of the Southern Alps, where soil loss is proceeding at a greater rate than in any other district of the Dominion, maps showing degree of erosion have been prepared of the area covered to date (p. 32). The classification adopted is: (1) No accelerated erosion; the processes of regeneration are keeping pace with the rate of denudation. (2) Slight erosion; 10 per cent. to 25 per cent. of the topsoil has been removed or disturbed. (3) Moderate erosion; 25 per cent. to 50 per cent. of the topsoil removed or disturbed. (4) Severe erosion; 50 per cent. to 75 per cent. of the topsoil removed or disturbed. (5) Very severe erosion; more than 75 per cent. of the topsoil removed. (6) Extreme erosion; consisting entirely of rock and scree and mostly above 6,000 ft. The gathering of such information is the first stage in the attack on the problem of soil erosion.

SERPENTINE-GLAUCONITE COMMITTEE.

Serpentine-Glauconite Committee.—Sir Theodore Rigg (Chairman), representing Council of Scientific and Industrial Research; Dr. H. O. Askew (Cawthron Institute); Dr. M. M. Burns (Canterbury Agricultural College); Dr. E. B. Davies (Soil Laboratory, Department of Agriculture); Mr. W. M. C. Denham, M.P.; Dr. J. F. Filmer (Acting-Director, Animal Research Division, Department of Agriculture); Dr. L. I. Grange (Soil Survey Division); Mr. R. E. R. Grimmett (Chief Chemist, Department of Agriculture); Dr. C. O. Hutton (Geological Survey); Mr. E. O. Macpherson (Geological Survey); Mr. R. B. Tennent (Director, Fields Division, Department of Agriculture); Mr. F. J. A. Brogan (Department of Scientific and Industrial Research), Secretary.

The above Committee was set up by the Council of Scientific and Industrial Research during the year to co-ordinate investigations on the agricultural utilization of serpentine and certain local potash-bearing materials such as glauconite (greensand) and seaweed. The Committee held five meetings during the year, and the following is a brief summary of its activities.

(1) Serpentine.

Prior to the establishment of the Committee, preliminary experiments had shown that this mineral, of which very large quantities are available in New Zealand, when ground and mixed with commercial superphosphate (usually in the proportion of one part serpentine to three parts of super), had the property of converting the bulk of the water-soluble phosphate into water-insoluble form, and at the same time greatly improving the mechanical condition of the superphosphate. The serpentine-superphosphate mixture had the added advantage of not attacking bags and could therefore readily be stored by the farmer. The magnesium content in the serpentine also opened up a further possibility of beneficial effects from the application of this fertilizer to magnesium-deficient soils. The potential agricultural value of serpentine-superphosphate, particularly in conserving supplies of phosphate in wartime, was therefore great enough to warrant a full investigation of all aspects of its production and utilization. The Committee's work on serpentine has been along the following lines:—

(*a*) *Quantitative Surveys of Serpentine Deposits.*—Geological and geophysical surveys of the deposits of serpentine in the North Auckland district, and also at D'Urville Island, have been carried out, and estimates of the quantities of suitable material available have been supplied to the Departments of Agriculture and Mines.

(*b*) *Chemical Work on the Processes of Manufacture.*—The chemical laboratories of the Department of Agriculture, the Department of Scientific and Industrial Research, and the Cawthron Institute have collaborated in studying methods of incorporating serpentine with superphosphate, the chemical changes involved in the processes, and the effects of various factors, such as the degree of fineness of the serpentine and method of admixture, on the chemical composition of the finished product. The laboratory experiments were supported by larger-scale experiments at certain of the fertilizer-works, and as a result of this work it has been possible to indicate the most satisfactory methods of preparing the mixture under works conditions, and to recommend suitable specifications for the finished final product.

An interesting development of the laboratory experiments is the possibility of securing satisfactory reversion of the superphosphate by mixing ground serpentine with cold superphosphate to which has been added 5 per cent. to 10 per cent. of water. Preliminary experiments have resulted in a product which has good drilling-qualities and which contains over 80 per cent. of reverted superphosphate. Further experimental work will be carried out with a view to the manufacture of serpentine superphosphate at local works, where serpentine is readily available.

(*c*) *Field Trials.*—The Fields Division of the Department of Agriculture, the Cawthron Institute, and Canterbury Agricultural College have collaborated in an extensive series of field trials with serpentine-super as compared with super, super-lime, reverted super, and certain fertilizer mixtures. Observational trials with pasture and yield trials with such crops as potatoes, brassicas, wheat, barley, and tobacco are at present in progress, but it is not yet possible to give the final results. It can be said, however, that so far as the trials have gone, serpentine-superphosphate has on the whole given results at least as good as those obtained from superphosphate.

Observational and yield trials with pasture and certain crops such as potatoes, brassica, wheat, barley, and tobacco, have been made, but final results are not yet available. In general, the results from the pasture trials confirm the work done by the Department of Agriculture in the previous year, indicating that certain districts—namely, Waikii, North Taranaki, and Southland—were associated with a special response when pasture was top-dressed with serpentine-superphosphate. Results at Nelson likewise suggest that certain granite soils gave a valuable response with serpentine-superphosphate when used in the presence of potassic manures. Good results were obtained with tobacco in the control of sand-drown or magnesium deficiency by the use of serpentine-superphosphate. Although yield trials in the case of potatoes and cereals did not suggest any important increase in yield, the results were in many cases comparable to those obtained with superphosphate. Arrangements are being made to continue the experiments next season.

(2) Glauconite (Greensand) and Seaweed (Macrocystis) as Possible Emergency Sources of Agricultural Potash.

(*a*) *Glauconite (Greensand).*—It was thought desirable to explore the possibility of utilizing local deposits of greensand, particularly in North and South Canterbury, as an emergency source of agricultural potash. A number of samples from these deposits were collected and examined, but it was concluded that the low potash content and the cost of concentrating the potash would rule the material out as an emergency source of potash, particularly in view of the greater promise shown by *Macrocystis* seaweed, which is dealt with in the following paragraph.

(*b*) *Seaweed (Macrocystis).*—A variety of large brown seaweed (*Macrocystis*) which grows in fringing beds along certain parts of the New Zealand coast-line contains about 15 per cent. of potash (K_2O) on the dry matter and therefore was considered to be well worth investigation as a source of emergency supply of potash. Roughly quantitative surveys of the quantities of weed available in the Tory Channel, in the vicinity of D'Urville Island, at Cape Campbell, and in Foveaux Strait were instituted by the Committee. The Marine Department gave most valuable assistance by making Mr. A. M. Rapson available to conduct these surveys. Miss L. B. Moore, of the Botany Division, collaborated in certain of these surveys, and has also been studying the rate of regrowth of the seaweed after cutting, which is an important factor in assessing commercial possibilities. During the year surveys at D'Urville Island were completed, and these are to be extended in the coming year to the other areas already mentioned.

At the same time field trials with dried and ground seaweed, as compared with potash salts, have been initiated, but results were not available at the time of writing this report.

MINERAL CONTENT OF PASTURES.

INVESTIGATIONS AT THE CAWTHRON INSTITUTE, 1940-41.

H. O. Askew, Officer in Charge.

Introduction.

During the past year work has been continued on the determination of the cobalt content of samples from pasture and soil surveys of the northern half of the South Island. Further analyses have been made for cobalt content of South Island limestones. A few commercial cobaltized fertilizers have also been analysed. Field experiments and animal trials at Glenhope and Sherry River have been continued.

Arising out of the identification of magnesium deficiency in certain crops in the Nelson District a considerable amount of field and laboratory work has been carried out. Field work has covered trials with various magnesium-containing fertilizers on pasture, potato, and turnip crops. Laboratory work has been largely concerned with an examination of reactions occurring between superphosphate and finely ground serpentine.

Cobalt Investigations.

(*a*) *Pasture Surveys.*

Surveys of pastures and soils of the Marlborough, North Canterbury, and Golden Bay districts have been extended. In Marlborough the soils seem to be satisfactorily supplied with cobalt, the minimum figure found being 3·8 p.p.m. and the maximum 18·8 p.p.m. For pastures the range was from 0·04 p.p.m. to 0·16 p.p.m. Low values have been found mainly for the hill-country or river-terrace pastures. On these soils there does not appear to be much correlation between cobalt content of the pasture and the soil on which it is grown. Unsatisfactory stock health due to the low cobalt of pastures has not been recognized in this district. Farther south on the coast road and along the inland road through Waiau to Christchurch very few samples have given low values for cobalt in either soil or pasture. The lowest two figures for Canterbury soils were 3·6 p.p.m. for a sample from the limestone formation of the Weka Pass and 2·6 p.p.m. for a sample from the rhyolite formation of Gebbie's Pass. The corresponding pasture samples gave 0·05 p.p.m. and 0·08 p.p.m. respectively. Other North Canterbury pastures gave on analysis 0·04 p.p.m. to 0·41 p.p.m. of cobalt, with the majority falling within the range of 0·1 p.p.m. to 0·2 p.p.m. of cobalt. As with the Marlborough samples, there does not appear to be any direct correlation between the cobalt content of soil and pasture.

In the Takaka and Aorere Valleys of Golden Bay, pastures have shown, except in a few cases, satisfactory cobalt content. The exceptional samples containing 0·03 p.p.m. to 0·05 p.p.m. were generally on granite or pakihi soil types. Pastures on the lower part of the Takaka Valley were well supplied with cobalt, their contents being approximately 0·15 p.p.m. In the Upper Takaka Valley some low figures have been found.

(*b*) *Cobalt in Limestones.*

Further samples from South Island vendors have been analysed for cobalt content. Most of the samples contained about 1 p.p.m. of cobalt, but some were as low as 0·2 p.p.m. Samples from Centre Bush, Southland, and Waiau, Canterbury, contained 5 p.p.m. and 12·5 p.p.m. of cobalt respectively. There does not appear to be any relation between the geological age and cobalt content, nor is there any indication that content of calcium carbonate is directly related to the cobalt content.

(*c*) *Cobaltized Superphosphate and other Cobalt-containing Fertilizers.*

Several samples of commercially prepared cobaltized superphosphate have been analysed and found in each case to be satisfactory in cobalt content. A sample of commercial cobaltized superphosphate was held for nearly two years and a half to examine the effect of ageing on the solubility of the cobalt. Over the stated period no change in water solubility occurred. It is unlikely that a supply of this fertilizer will ever be held by a buyer for such a long period, but should cobaltized superphosphate be held for a considerable period no loss in the effectiveness of its cobalt is to be expected.

Ground serpentine from the Auckland District was found to contain 83 p.p.m. of cobalt. Silico-superphosphate prepared commercially from the same serpentine contained 18·5 p.p.m. of cobalt, of which only 0·7 p.p.m. was soluble under the conditions of extraction.

(*d*) *Use of Cobaltized Superphosphate.*

The plots on which cobaltized superphosphate has been used to provide varying amounts of cobalt have been sampled regularly during the year. Relatively few of the samples have been analysed, however. The indications to date are that for applications given early in August, 1939, at rates of 2 oz. and 4 oz. of cobalt sulphate per acre, no benefit in cobalt content of the pasture was recognizable after the beginning of March, 1940. The cobalt content of the pasture treated with 2 oz. cobalt sulphate per acre was not markedly increased after the middle of December. After applications of 8 oz. and 16 oz. per acre, appreciable increases in cobalt content of the pastures were found until the end of March, 1940, when the treated pastures showed approximately three times the content of the control pastures (0·03 p.p.m.).

On a pasture in the same area, applications of a serpentine-derived soil carrying 350 p.p.m. of cobalt have been made at rates of 5 cwt. and 10 cwt. per acre. Very substantial increases in cobalt content of the pastures resulted from these applications, especially with the higher rate. In this latter case the dressing with soil has given, over a period of three months, results at least as good as an application of 8 oz. cobalt sulphate per acre.

(*e*) *Animal Experiments.*

(1) *Role of Cobalt in Animal Metabolism.*—In the autumn of 1939 a number of wether hoggets were sent to Glenhope for use in an experiment designed to give information on the cobalt content of organs of sheep under cobalt deficiency conditions, followed by a period of drenching with cobalt. A number of sheep went "bush sick" when the flush of grass growth came away in November and December. The average weight dropped to 49·4 lb. from the original weight of 72·9 lb. Drenching was commenced on 10th January, 1940, and was continued twice weekly. The animals responded rapidly, so that by the end of the month the average weight was 66·9 lb. Further increases in weight were obtained until the end of season, when the experiment terminated. Animals were killed periodically during the season to obtain samples of organs, &c., but as yet no results of analyses are available.

(2) *Field Experiments at Sherry River.*—At the Sherry River a trial, to run over two seasons, has been established to examine the effect of a high cobalt limestone on stock health under Nelson conditions. Groups of hoggets are being run on areas with no cobalt top-dressing, with applications of low cobalt limestone, or of a high cobalt limestone or of cobaltized superphosphate. Equivalent amounts of superphosphate were used on all plots. In the earlier part of the season, animals on the area top-dressed with a Southland limestone containing 5 p.p.m. of cobalt at the rate of 2 tons per acre grew as rapidly as those on the area top-dressed with 2 cwt. per acre of cobaltized superphosphate. Animals on the other two plots were definitely behind these two groups in weight increment; thus, on 27th October, 1940, the average live weights for the best groups were 75·6 lb. and 75·8 lb., and for the control and low cobalt limestone groups 71·4 lb. and 71·8 lb. respectively. However, after this date the animals on the high cobalt limestone plot did not do so well as those on the cobaltized superphosphate area; thus, on 28th January, 1941, the latter group averaged 20 lb. heavier than the former. By 21st March the average difference had increased to 30 lb. The control and low cobalt limestone groups had begun to go off seriously in condition owing to the development of "bush sickness." Several animals in each of these groups are affected. Some of the animals in the high cobalt limestone group are also now affected with bush sickness. To date, therefore, the indications are that some benefits have been obtained from the cobalt in the high cobalt limestone, but that the effect is of short duration.

Pasture samples have been obtained regularly from these areas for chemical analysis, in order to correlate cobalt content of pastures with condition of the animals.

Magnesium Investigations.

In view of the occurrence of magnesium deficiency symptoms in the Nelson District, field and laboratory work has been initiated to study the effect of various carriers of magnesium on crop yield. This has involved the use of silico-superphosphate, magnesium carbonate, and magnesium sulphate as suppliers of magnesium.

(*a*) *Pastures.*

Two observational trials on pasture, one at Glenhope and the other at Dovedale, using silico-superphosphate in comparison with basic superphosphate, did not suggest that there was any marked difference in the responses from the fertilizers. At Glenhope there was a doubtful increase in clovers, and at Dovedale a slight encouragement of subterranean-clover seedlings, on the silico-superphosphate plots.

At Sherry River a comprehensive series of treatments has been set out embracing silico-superphosphate, magnesium carbonate and basic superphosphate, and magnesium sulphate plus basic superphosphate, basic superphosphate being used as a control. Equivalent amounts of magnesia were used in the mixtures. Sulphate of potash has been used on portions of plots of each of these treatments. The plots are used as a mowing trial and to obtain samples for chemical analysis. No chemical data are yet available, but yield data over most of the season can be summarized. No increase in yield appears to have resulted from the use of magnesium in the fertilizers in the absence of the potash applications. Where sulphate of potash was applied at the rate of 2 cwt. per acre responses were particularly marked on those plots where silico-superphosphate and magnesium sulphate mixture had been used. With the magnesium carbonate mixture the response was much less. In terms of percentage increase over the non-potash plots, the treated areas yield as follows: Basic superphosphate, 111 per cent.; basic co-superphosphate, 125 per cent.; magnesium carbonate and superphosphate, 116 per cent.; silico-superphosphate, 134 per cent.; magnesium sulphate and superphosphate, 135 per cent.

(*b*) *Potatoes.*

Four trials with Sutton's Supreme potatoes were established to compare yields from silico-superphosphate and basic superphosphate when used in conjunction with sulphate of ammonia. Sulphate of potash was also included in the trials on two sandy soils. On the two sandy soils lower yields were obtained with silico-superphosphate mixture than with basic superphosphate mixture; on the coarser soil the decrease was significant. These two trials gave the lowest yield of the four trials. The remaining trials were on heavier soils. One on the Cawthron Institute grounds showed a non-significant increase in yield on the silico-superphosphate plots. On the other trial at Stoke, small but significant increases in yield amounting to about 12 cwt. per acre were obtained for silico-superphosphate and for an equivalent amount of magnesium sulphate. The difference in yield between silico-superphosphate and magnesium sulphate plus basic superphosphate was not significant.

A more complex trial has been arranged at the Sherry River, where silico-superphosphate and magnesium sulphate are used with and without potash. This trial has not yet been dug.

(*c*) *Turnips.*

A small trial at Sherry River with Imperial Green Globe turnips will be used to compare the effect of silico-superphosphate with basic superphosphate and basic superphosphate plus magnesium sulphate. Up to the present the magnesium sulphate plots look the best, having the largest amount of top growth on the plants.

Serpentine and Superphosphate Fertilizers.

In view of the possibility that mixtures of serpentine and superphosphate might be required to be made at locations away from superphosphate-works, laboratory tests have been made to examine the reactions which take place on mixing finely ground serpentine with superphosphate at ordinary temperatures. Four mixtures containing serpentine (32 per cent. MgO and ground for 92 per cent. to pass a 100-mesh sieve) sufficient to revert from one-half to twice the amount of water-soluble phosphate in the superphosphate were made. These were held at ordinary temperatures and sampled periodically. A small rise in temperature occurred after mixing. Some setting also was found to take place, but the lumps were very readily broken up. The amounts of water-soluble phosphate, lime, and sulphate radicle in the mixtures decreased rapidly, whilst water-soluble magnesia increased with time of reaction. After about two weeks' storage only insignificant changes occurred in the proportions of water-soluble constituents. At this stage only 50 per cent. of the original water-soluble phosphate content remained in that state in the two mixtures with the largest proportions of serpentine. The water-soluble magnesia (MgO) was about 2 per cent., which indicated that from one-half to one-quarter of the magnesia in the serpentine had been converted to water-soluble condition.

More recent experiments using similar mixtures to which 5 per cent. and 10 per cent. of water have been added have shown that within three hours from the time of mixing 75 per cent. of the water-soluble phosphate had been rendered insoluble. At the end of seven days the analyses indicated that the interreaction between the ground serpentine and superphosphate was virtually completed.

The results of the experiments suggest the possibility of local fertilizer-vendors and, indeed, farmers preparing a reverted superphosphate with properties similar to silico-superphosphate.

WHEAT RESEARCH INSTITUTE.

Advisory Committee.—Dr. H. G. Denham, Council of Scientific and Industrial Research (Chairman); Mr. C. S. Sapsford, Department of Industries and Commerce; Mr. R. B. Tennent, Department of Agriculture; Mr. R. K. Ireland, Mr. R. J. Lyon, and Mr. J. P. O'Connor, representing flourmillers; Mr. C. E. Boon, Mr. W. H. S. Newsome, and Mr. W. S. N. Rennie, representing bakers; Mr. W. W. Mulholland, Mr. J. Carr, and Mr. P. R. Talbot, representing wheatgrowers; Mr. W. O. Rennie, representing Canterbury Agricultural College; Mr. F. R. Callaghan, Department of Scientific and Industrial Research; and Mr. G. Fleetwood, representing grain-merchants. Director: Dr. F. W. Hilgendorf.

Greenhouse.

The greenhouse at Lincoln was completed. It is lighted and heated by ordinary incandescent lamps, one 200-watt lamp to every square yard. The lights are adjustable so that they can be kept a foot or so above the plants they illuminate. During winter the lights are automatically switched on at 9 p.m. and off at 3 a.m., this timing being suited to the needs of the plants and to the times when current is cheapest.

Owing to building delays the first wheat seed could not be sown in the glasshouse until the middle of May. Important information on growing wheat in winter under glass has been obtained from Canada and the United States of America, but many details as to soil, humidity, temperature, and light had to be worked out for local conditions, and it is satisfactory that reasonable growth was obtained. In late August and early September heads were ready for crossing and 1,230 crossed grains were obtained. These filled and were ripe in October, and were immediately sown in the open; most of the resultant plants ripened in March. Thus two crops have been raised in the year, although the start was late.

The acceleration of the breeding process by the use of the greenhouse, especially when compound crosses are being made, is such that two years are saved out of the first three in the production of a new wheat.

The chief hindrance to the desired rate of progress in the greenhouse was the failure of the plants to tiller freely. More seeds will therefore have to be sown in the coming season, and to provide room for these a third section of the glasshouse, as originally designed, is now almost complete.

Plant-breeding Laboratory.

The genetics laboratory hitherto used at Lincoln is a converted building kindly made available by Lincoln College. A new and commodious laboratory of six main rooms has now been erected specially for the Institute's use. A fire-proof and vermin-proof room is provided for the storing of records and of the most valuable seed material.

Wheatgrowing Practice.

The use of the header harvester is steadily growing, and now a stook-threshed crop on flat land in Canterbury is subject for remark. The last two seasons have been very suitable for the operation of the header. The advent of this method of harvesting has resulted in some changes in the distribution of varieties, those which are not suitable for heading tending to disappear from certain districts. For instance, Amuri County in 1936 sowed 33 per cent. of its wheat area in Hunters; in 1940 the proportion of Hunters was down to 2 per cent. The non-heading wheats are now tending to be restricted to two special areas: (1) Down country where irregular ripening makes heading unsuitable; (2) dairy country where threshed wheat straw has a special value.

Heading reduces harvesting-costs by 40 per cent. to 50 per cent. The Institute had much to do with the rapid spread of this method of harvesting: firstly, by showing that Canterbury's climate was as suitable to heading as that of many American States where heading was well established; secondly, by showing that wheat headed in good condition gave as good a flour as wheat harvested by older methods; thirdly, by providing a moisture-testing service which enabled farmers to judge accurately when their wheat was ready to head; and fourthly, by demonstrating methods by which wheat headed somewhat too early could be cheaply and conveniently paddock dried.

The Fields Division of the Department of Agriculture was good enough to arrange for the irrigation of parts of seven fields of wheat in the Levels irrigation area on plans agreed to after discussion with the Institute. Five of these were harvested, and the average increase in yield due to watering was about 8 bushels per acre. These fields were watered only once, and it is thought that if there had been two waterings, one earlier and one later than the one that was given, the increase would have been greater. More experience is needed to find out the best watering practice.

It was hoped that the increased yield of wheat might pay for the levelling and border dyking of fields ploughed out of old grass and about to be laid down in better grasses. This hope appears to be supported by the trial already made. The cost of applying the water and of harvesting the extra yield would amount to about 8s. or 9s. per acre, while the increased yield in this trial was worth 46s. The balance of 35s. is more than ample to pay for the levelling and border dyking. Farmers may thus find it pays to take a crop of wheat while the land is broken up in preparation for levelling.

Wheat-breeding.

The new laboratory at Lincoln will facilitate early estimation of quality of wheats in the breeding lines.

On the field plots good yields were obtained over most of the area; this is due almost entirely to the drainage work last autumn. However, some plots were drowned out. The most valuable material lost was the F_3 of a cross Jumbuck by Cross 7, and it will take a couple of years to replace this promising cross. A large number of compound crosses and of crosses among high-yielding parents are now coming into yield trials.

Cross 7 now covers more acres and yields more millions of bushels of wheat than any other variety. Tainui and Taiaroa will apparently fill special niches as spring wheats, and are fulfilling nearly all the promise they held out when they were distributed. The loaves from Tainui are practically as good as those from Jumbuck. Fife-Tuscan was grown on nineteen farms, and the threshing returns indicate, as exactly as could be expected, that it will yield better than the original Tuscan. One new wheat (Cross 64), whose quality is equal to that of Marquis, has been brought almost to the point of distribution. Careful consideration of the position, however, has led to the decision not to distribute this variety because its superiority over Marquis is only slight and it is not advisable to multiply varieties unless they fulfil some special function.

Durum wheats have been grown and selected in preparation for the possible manufacture of macaroni in New Zealand.

Laboratory Work.

The service work of the Institute to farmers, millers, and bakers continues to expand, and there is evidence that this, together with the work on wheat-breeding, is steadily improving the quality of New Zealand flour and bread.

The most interesting development from the research work done during the year has been the liberation of the process for incorporating wheat-germ in white bread. The process consists of the destruction of glutathione by preliminary fermentation of the germ with yeast. It has been somewhat extensively adopted by bakers in New Zealand and in other countries as well. The consumption of wheat-germ now indicates that in New Zealand about forty-five thousand 2 lb. loaves of wheat-germ bread are being made each week.

The process aroused a considerable amount of interest overseas, because the fortification of white bread with vitamin B_1 is being discussed in many countries, and the inclusion of wheat-germ is one of the best methods of supplying that vitamin. It has always been recognized, however, that the supply of vitamin B_1 through germ alone has limitations in respect of quantity.

A means has been devised for testing with sufficient accuracy for practical purposes the quantity of wheat-germ added to any loaf.

In an extension of the investigations of which the wheat-germ bread was a result, another factor of fundamental importance was discovered. This is that low-grade flours—*i.e.*, the fraction obtained when 70 per cent. extraction is pushed to 80 per cent.—can also have their glutathione destroyed by pre-fermentation. Thus 80 per cent. flour can make bread practically as good as that made from 70 per cent. flour, if its lowest grade 10 per cent. fraction is pre-fermented with yeast. This fact is of very great importance, especially in war-time, for its application increases by 12 per cent. the proportion of the wheat grain that can be suitably used for human food, it maintains the palatability of the war loaf, and it increases at least to some extent the nutritive value of white bread.

From the research point of view, however, the work is of interest chiefly because it opens up new ideas on the effects produced by yeast during its fermentation of dough. These ideas, if supported by the experimentation now in progress, may cause fundamental changes in our conceptions of panary fermentation.

Consideration of overseas work on the physical properties of doughs, combined with experimentation here, has led to a clearer conception of certain reactions of the dough during fermentation, chiefly during the final proof. This has already led to improvement in practice, especially in making wholemeal loaves.

Further work has been done on the drying of wheat in bins and special driers, in preparation for the possible onset of a wet harvest season.

A method of testing the moisture content of a wheat in the field has been developed. The apparatus required can be made for under 10s., is simple in use, and, while it does not provide an absolute measure of moisture-content, it is sufficiently accurate for the purpose for which it is designed.

Publications.

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"Biological Elimination of Glutathione from Wheat-germ and Flour used in Breadmaking," by E. W. Hullett and R. Stern. (In the press.)

"Convenient Measurement of Gassing Power with Dough under Constant Pressure and with Elimination of Gas Solution," by E. W. Hullett. (In the press.)

"Studies in *Hebe*—II: The Significance of Male Sterility in the Genetic System," by O. H. Frankel. *Journal of Genetics*, *40*, 171. (1940.)

"The Causal Sequence of Meiosis—I: Chiasma Formation and the Order of Pairing in *Fritillaria*," by O. H. Frankel. *Journal of Genetics*, *41*, 9. (1940.)

"A Critical Survey of Breeding Wheat for Baking Quality," by O. H. Frankel. *Jour. of Agr. Sci.*, *30*, 98. (1940.)

"Fife-Tuscan Wheat: A New Variety for 'Tuscan Land,'" by O. H. Frankel. *N.Z. Jour. Sci. & Tech.* (In the press.)

"Field Experiments and War Production," by O. H. Frankel. (In the press.)

FRUIT RESEARCH.

Advisory Committee.—Sir Theodore Rigg (Chairman), Dr. G. H. Cunningham, Messrs. W. Benzies, T. C. Brash, F. R. Callaghan, A. H. Cockayne, J. Corder, W. K. Dallas, A. Osborne, R. Paynter, F. S. Pope, A. M. Robertson, H. E. Stephens, L. W. Tiller (Secretary).

INTRODUCTION.

The principal changes in the research programme are the two extensions forecast in the 1940 annual report. One is the commencement of an extensive series of experiments on the non-refrigerated storage of fruit, and the other is the virtual completion of an experimental gas-store containing two chambers each of 500 bushel capacity. These are described in the section of the present report devoted to "Fruit Cold Storage Research."

The Plant Diseases Division of the Plant Research Bureau has replaced the Huapai orchard by a more extensive property at Oratia, and details of this are given in the report of the Plant Research Bureau.

Fruit research remains a co-ordinated series of investigations carried out by the Plant Diseases Division, the Appleby Research Orchard, the Dominion Laboratory, the Horticulture Division of the Department of Agriculture, and the Cawthron Institute.

APPLES.

Fertilizer Experiments.

Research Orchard.—In the winter of 1939 the trees were heavily pruned, to remove crowded wood, and make them more accessible for field operations. In consequence, the yields for the 1940 season have been somewhat lower than usual. With few exceptions, phosphorus (P) is applied as superphosphate at 4 lb. per tree per annum, nitrogen (N) as ammonium sulphate at 2 lb., and potassium (K) as potassium sulphate at 1 lb.

Cox's Orange: N has continued to give significantly higher yields of fruit than the untreated controls, and this year the "complete" PNK treatment has given a highly significant increase over N. No differences have yet been observed between trees treated with ammonium sulphate and trees treated with dried blood.

Dunn's Favourite: This year the crop increases due to N and PNK have reached the level of statistical significance, with N better than the untreated controls and PNK better than N.

Delicious: PNK trees have consistently carried heavier crops than the untreated controls, whereas the yields from N trees have been relatively very variable.

Jonathan: The yield from PK trees is only two-thirds that from trees receiving 2 lb. ammonium sulphate additional to PK, and no more than half that from trees receiving 4 lb. ammonium sulphate additional to PK. The heavy pruning resulted in a reduced crop of large-sized fruit of rather low overlying colour, and consequently the inverse relationship hitherto observed between high overlying colour and high N has been very much reduced.

Early spring, late spring, and autumn applications of ammonium sulphate are still indistinguishable in the effect produced on the tree.

Higher yield and improved colour following two heavy dressings of 12 lb. potassium sulphate per tree, additional to P and N, are still clearly marked in this year's crop, which is the fifth following return to a normal dressing of 1 lb. per tree.

Sturmer: N has continued to give a significant yield increase over untreated controls, and PN likewise over N. The increase given by PNK over PN has still not quite reached the level of mathematical significance.

Cawthron Institute.—The long-term experiments on Jonathan at Upper Moutere have continued to show the necessity for PNK treatments. All treatments from which one of these three constituents has been omitted have given markedly inferior results. An interesting feature is the rapid decline, during the past three years, of trees receiving no potash; growth and foliage development have suffered severely and fruit has been poor in colour, size, and quality. Trees receiving NK without P are now inferior in growth, foliage development, and fruit yield to PNK trees. Trees getting N alone are now little better than the untreated controls. With P and K requirements supplied, 2 lb. dried blood as an annual dressing is now very much superior to 1 lb.

Rootstock Trials.

The Plant Diseases Division is finding that the more vigorous of the East Malling stocks are maintaining their lead in growth over Northern Spy. In consequence of the information secured in the trials, stocks of M. XII and M. XVI have been selected for planting in the new orchard area at Oratia.

Varietal Investigations.

The Plant Diseases Division has grown strains of Delicious and Cox's Orange on the dwarf M. IX stock. Classification of the Delicious has shown at least fifteen colour-types, which can be broadly grouped into four classes. Differences in flavour, keeping-quality, and susceptibility to russet have also been noted.

In studies of the susceptibility of these strains to mouldy-core it has been found that none possesses a sinus completely closed by living tissue; but with certain strains the passage in a high percentage of the fruits is scarcely visible to the naked eye. The constancy of the passage diameter in each strain is being determined, and the effect of diameter on incidence of mouldy-core is being studied.

A similar classification of the Cox's Orange strains has been completed, and nine colour-forms have been isolated.

In both Cox's Orange and Delicious it has been noteworthy that, with one or two exceptions, the highly-coloured "sports" are inferior in flavour and quality to the parent variety.

Similar studies are being made on the varieties Jonathan, Northern Spy, and Sturmer.

A collection of nearly sixty varieties has been planted on standard dwarf stock during the past three years. Many are now bearing, and a considerable amount of information has been obtained this year on such pomological characters as blossoming period, cropping, harvesting period, and susceptibility of foliage and fruit to spray injury.

Plant Protection.

I. *Mycological Studies.*

(*a*) *Apple-bud Rot.*—A minor outbreak of a bud and blossom rot, caused by the organism *Fusarium lateritium*, was found on the Jonathan variety in the Huapai district by the Plant Diseases Division.

(*b*) *Phoma-spot.*—Work at the Plant Diseases Division has confirmed that overwintering of the fungus *Phoma pomi* occurs on or in the buds. A Bordeaux spray at green-tip greatly reduces foliage infection in the spring.

(*c*) *Mouldy-core.*—Observations on this trouble in Delicious have been noted under "Varietal Investigations."

(*d*) *Eye-rot.*—Further observations have been made on the storage of Jonathan apples showing slight fungous lesions in the calyx. Over two hundred affected fruits from the Appleby Research Orchard were kept in cold storage for eight months, but less than 2 per cent. developed active rots from the lesions. Further support is thus given to last season's findings that very slight, "dry" lesions are not likely to develop further during the commercial storage-life of the fruit.

(*e*) *Black-spot.*—Fruitgrowers in the Nelson District have received from the Cawthron Institute the usual notification concerning the maturity of black-spot ascospores.

II. *Physiological Studies.*

(*a*) *Internal Cork.*—The chief aspect of the Cawthron Institute's work on boron in relation to this disease in apples has been the effect of the treatments on cold-storage quality of the fruit, and this is recorded under the "Fruit Cold Storage Research" report.

(*b*) *Magnesium Deficiency.*—The Cawthron Institute has continued to study this problem from several angles. Injection of magnesium sulphate has given further confirmation that the premature-defoliation symptoms observed are controlled by supplying magnesium to the tree. Chemical analyses of leaf material indicate that leaves possessing a high magnesium content remain free from the disorder. Soil dressings of magnesium compounds have been continued for a second season, and the most marked responses have been obtained from magnesium carbonate at the rate of 2 lb. per tree and magnesium sulphate at 7 lb. per tree. The carbonate has given rather more consistent results than the sulphate. Dolomite at 12 lb. per tree has also produced some improvement in the trees, but not as much as the previously-named compounds. Similar applications, in addition to silico-superphosphate and ground serpentine treatments, have been commenced this season on certain new areas, but no response has yet been observed.

An application of ground limestone, 24 lb. per tree, has increased the severity of magnesium-deficiency symptoms.

Chemical analysis has shown rapid penetration of soluble magnesium salts into the soil. Twelve months after a surface application of magnesium sulphate, marked increases were found in the magnesium content of all horizons to a depth of at least 18 in.

Spraying tests suggest that the application of magnesium salts direct to the foliage may be of value in certain circumstances as a temporary control measure until soil dressings become fully operative. One per cent. Epsom salt was used with a spreader, the first spray being applied on the 31st October and subsequent sprays being continued at fortnightly intervals. One group of trees received three sprays and another seven. Inspection four and a half months later showed that the three sprays had effected considerable improvement, while the seven sprays had brought the foliage back almost to normal. It is to be noted that the trees on which these sprays were successfully used had not received any sulphur or lime-sulphur sprays during the season.

III. *Improvement in Spray Programmes.*

The Plant Diseases Division has continued spray investigations and demonstrations in the experimental areas at Havelock North and Appleby.

At Havelock North it has again been demonstrated that efficient application enables spray concentrations to be reduced below those in general use without impairing disease control. Tree damage and fruit russet have been reduced at the same time, and a considerable saving made in the cost of sprays.

Work on the russet-susceptible periods of apples and pears has been continued. Among other features of interest it has been found that this varies somewhat with season, locality, and variety.

Further trials with the early summer application of summer oil plus Bordeaux have shown the value of this combination in controlling insects and in improving the condition of the trees. It is especially valuable on the Sturmer variety, which is intolerant of lime-sulphur sprays.

At Appleby similar modified programmes have been tested. Here it has been found that tree vigour plays an important part in determining the severity of spray damage.

Further work is in progress on the control of pink-spot (*Neofabraea nalicorticis*) on Sturmer by the use of weak Bordeaux applications.

Control of red mite has been secured on Delicious with summer oil plus Bordeaux spray applied during December.

Derris has been found to equal nicotine sulphate in controlling apple leaf-hopper, but not in combating woolly aphis.

IV. *Certification of Therapeutants.*

(See also Plant Research Bureau report, p. 12).

The Plant Diseases Division, in association with the Dominion Laboratory, has maintained its certification scheme for commercial therapeutant materials.

Of the many products tested during the year, only four have been certified. Two have been withdrawn, since they are no longer procurable owing to war conditions. The latest list contains thirty-four products that have complied with the rigorous conditions of testing.

Samples of certified lines have been taken from the field during the year and analysed. All have compared favourably with the samples upon which certification was based.

STONE-FRUITS.

Varietal Investigations.

Further plantings of peach have been made by the Plant Diseases Division in the trial block at Owairaka, bringing the number of varieties to ninety-four. About one-third of these will commence bearing next season.

Plant Protection.

(*a*) *Boron-deficiency Disorders.*—The Horticulture Division of the Department of Agriculture, in co-operation with the Cawthron Institute, has noted that borax applications have continued to give satisfactory control of "brown-spotting" of apricots in Central Otago.

This season "pitting" of cherries occurred on control trees, whereas on borax-treated trees the fruit has remained free from the trouble.

(*b*) *Brown-rot.*—The Cawthron Institute has given the usual notification of date of maturity of brown-rot ascospores.

SMALL FRUITS.

Strawberry.

The Plant Diseases Division has continued investigations on several diseases of strawberries and raspberries, and, except where otherwise stated, the findings noted are the work of the Division.

(*a*) *Yellow-edge.*—It has been found that the aphid *Capitophorus potentillæ* is a vector, whereas red-spider, *Tetranychus telarius*, is not able to transmit the virus.

Records of the susceptibility of several commercial varieties have been taken during the season. Marguerite has proved the most susceptible, Captain Cook, Royal Sovereign, and a few local varieties moderately so, while Madam Melba has remained practically free.

(*b*) *Crinkle.*—Both forms of this disease recorded in England have been shown to be present in New Zealand. Both are transmitted by the aphid *Capitophorus potentillæ*, but not by red-spider.

(*c*) *Root-rot.*—A fungus (*Cylindrocarpon* sp.) isolated from diseased roots was inoculated into boxes of sterilized soil, and in these were set out numerous plants of the varieties Marguerite and Captain Cook. Although the plants were kept for seven months under conditions favourable to the development of the disease, none appeared. It appears that the organism, common in the dead roots of strawberry and phormium, is not responsible for the diseased condition.

(*d*) *Red-spider (Tetranychus telarius).*—Preliminary work has been undertaken on the control of this pest, which becomes troublesome in the spring months in commercial beds in Auckland. Lime-sulphur solution (15 per cent. polysulphide content) applied at 1–80 just prior to flowering, followed by a second spray at 1–100, has given adequate control.

Less satisfactory results have been secured with summer oil 1–66 and 1–99, alone or combined with nicotine sulphate 1–600. Good control has been secured with summer oil at a concentration of 1–33.

Raspberry.

(*a*) *Crown-gall.*—Plants have been inoculated with cultures of the bacterium *Phytomonas tumefaciens*, but without detrimental effects. Similar results have been secured with peach-trees, but tomato-plants have shown a slight decrease in yield. The results are significant in view of the serious nature of the disease under European and American conditions.

(*b*) *Silver-leaf.*—Inoculations have been undertaken with cultures of the fungus *Stereum purpureum* secured from apple-trees and raspberry-canes, and positive results have been secured with strains from both hosts. In some cases plants have been killed outright, while in others the main canes have been killed but living suckers have developed from the crown. Typical fructifications have been produced on inoculated canes six months after infection.

(*c*) *Mosaic.*—Severe symptoms corresponding with mosaic symptoms recorded overseas have been found in the South Island on the varieties Lloyd George and Preussen. Transmission trials are under way to ascertain if the disease can be transmitted to healthy plants.

(*d*) *Root-rot.*—In August the Cawthron Institute made a survey of the main raspberry-growing centres in the Nelson District to ascertain the extent of this disease. A considerable amount was

found in Riwaka, Pangatotara, and Ngatimoti, but scarcely any in Tapawera and Tadmor. The prevalence of root-rot in some gardens appears to be connected with inadequate manurial treatment and cultivation, while in others the destruction of root fibres by grass grub has facilitated the spread of the disease and has adversely affected the health and growth of the canes.

(*e*) *Bud-moth.*—The Cawthron Institute has carried out spray tests on this pest, a serious one in the Nelson District, with a view to obtaining control in the egg stage. Red oil 1–25 has given complete control, while a proprietary oil compound at 1–600 has been ineffective. Further work is being carried out to ascertain the optimum dilutions of different specifics.

CITRUS.

Rootstock Trials.

Material has been budded in the Plant Diseases Division nursery at Owairaka in preparation for a large-scale trial of Washington Navel orange on various stocks at Oratia next year.

Varietal Investigations.

The numerous varieties of citrus, chiefly sweet orange, that have been noted in earlier reports as under propagation in the Plant Diseases Division nursery will be planted out in the trial block next year.

Plant Protection.

I. *Entomological Studies.*

(*a*) *Dicky-rice Weevil (Maleuterpes spinipes).*—Confirmation has been obtained that this pest is controlled by tree-banding, and control is facilitated by cultivation during critical periods and by removal of branches in contact with the ground.

(*b*) *Soft Wax-scale (Ceroplastes destructor).*—Studies of the egg-laying period of the scale have been continued, and it has been confirmed that eggs are laid between the months of December–February.

II. *Mycological Studies.*

Green-mould (Penicillium digitatum).—Further experiments in the control of this organism have been undertaken in the newly-completed humidity chambers. Fruits were dipped in Shirlan W.S. solutions at concentrations of 0·25 per cent., 0·5 per cent., and 1·0 per cent. The highest infection developing in treated fruits was 6·5 per cent., whereas the untreated samples developed 32 per cent.

III. *Physiological Studies.*

Mottle-leaf.—Samples of citrus leaves from Kerikeri have been submitted to chemical analysis by the Cawthron Institute. Young, chlorotic leaves showed 14·9 p.p.m. manganese, compared with 30·5 p.p.m. for healthy leaves.

PUBLICATIONS.

The following papers on fruit problems and research have been published during the year by officers of the Department or of co-operating organizations :—

General.

Padfield, C. A. S. (1940): "A Note on the Pruning of the Young Granny Smith Apple-tree." *N.Z. Jour. Sci. & Tech.*, *22*, 108A.

Tiller, L. W. (1941): "Make your own Tomato Juice." *N.Z. Jour. Agri.*, *62*, 220.

Plant Diseases Division.

Atkinson, J. D. (1940): "Progress Report on the Control of Mealy-bug on Pears." *Orchardist N.Z.*, *13*, 135.

Cunningham, G. H. (1940): "Certification of Therapeutants: Seventh List." Supplement to *Orchardist N.Z.*, August, 1940.

——— (1941): "Certification of Therapeutants: Eighth List." Supplement to *Orchardist N.Z.*, February, 1941.

Taylor, G. G. (1940): "The Use of Derris as an Insecticide." *Orchardist N.Z.*, *13*, 131.

——— (1940): "Huapai Experimental Orchard, 1939 40." *Orchardist N.Z.*, *13*, 144.

Woodhead, C. E., and Chamberlain, E. E. (1940): "Report on a Survey of Small-fruit Culture in New Zealand, Nov.–Dec., 1939." *Orchardist N.Z.*, *13*, 110, 139.

Cawthron Institute.

Chittenden, E., and Thomson, R. H. K. (1940): "The Effect of Borax on the Storage Quality of Jonathan Apples." *N.Z. Jour. Sci. & Tech.*, *21*, 352A.

Kidson, E. B.; Askew, H. O.; and Chittenden, E. (1940): "Magnesium Deficiency of Apples in the Nelson District." *N.Z. Jour. Sci. & Tech.*, *21*, 305A.

Miller, D. (1940): "The Australian Grape-vine Moth." *Cawthron Institute Publication No. 41.*

FRUIT COLD STORAGE RESEARCH.

Advisory Committee.—Mr. W. K. Dallas (Chairman), Sir Theodore Rigg, Messrs. H. G. Apsey, W. Benzies, F. R. Callaghan, J. T. Cross, F. W. Grainger, H. C. Heays, J. L. Mandeno, A. Powell, A. M. Robertson, H. E. Stephens, and L. W. Tiller (Secretary).

This report gives the main points emerging from the storage investigations of the Dominion Laboratory, the Appleby Research Orchard, the Horticulture Division of the Department of Agriculture, and the Cawthron Institute.

Refrigerated Gas-storage.

Experiments have been continued on the Jonathan and Sturmer varieties by the Dominion Laboratory, and fifteen variations of storage conditions have been employed.

At each of the temperatures 38° F., 40° F., and 42° F. the following atmospheres have been used: (*a*) 10 per cent. carbon dioxide, with 11 per cent. oxygen; (*b*) 8 per cent. carbon dioxide, with 13 per cent. oxygen; (*c*) 6 per cent. carbon dioxide, with 15 per cent. oxygen; (*d*) air; (*e*) air.

As in the previous year, treatments (*a*) to (*d*) have been carried out in cabinets at a relative humidity of 92 per cent. to 93 per cent., while treatment (*e*) has been in the air of the storage chamber at a much lower relative humidity and under much greater air movement.

The fruit has again been of standard commercial type, drawn from the Appleby Research Orchard and the sizes used have been a uniform mixture of 125, 138, and 150 counts in Jonathan, and 125, 138, 150, 163, and 180 counts in Sturmer.

Jonathan.—The Jonathans were stored on the 13th March, 1940, and the maturity was such that at 20° C. the average time for the fruit to reach its climateric was 7·6 ± 0·7 days. (Standard error 0·7.)

The best treatment appeared to be a temperature of 42° F., with an atmosphere containing 8 per cent. carbon dioxide. At this temperature 10 per cent. carbon dioxide induced a small amount of brown-heart later in the season. In 8 per cent. carbon dioxide, the fruit was firmer and greener at a temperature of 40° F. than at 42° F., but had a definite, slight tendency to develop internal breakdown at the lower temperature.

These results confirm the findings of the previous year, when the best results were obtained at 42° F. in an atmosphere containing 9 per cent. carbon dioxide.

At the end of September, after twenty-nine weeks in storage, the Jonathan under the best treatments was still in very good condition. In 8 per cent. carbon dioxide at 42° F. the fruit showed only 2 per cent. of internal breakdown. Subsequent holding of this fruit for two weeks at 68° F. (20° C.), with a relative humidity of 90 per cent., increased the breakdown to 12 per cent. The flavour of all fruit held at 42° F. was good, but at lower temperatures the fruit was almost flavourless.

At the final examination on the 18th November, after thirty-six weeks in storage, the amount of breakdown had not increased, and subsequent storage for two weeks under warm, moist conditions again increased the breakdown to only 12 per cent.

As in the previous year, it has been noted that gas-storage has given complete control of Jonathan-spot.

The results of the two years' experiments suggest that Jonathans can be successfully gas-stored until early October at 42° F. in an atmosphere containing 8 per cent. carbon dioxide and 13 per cent. oxygen.

The work is being taken to the semi-commercial stage during the 1941 season. A small gas-store consisting of two chambers, each capable of holding 10 tons of fruit, has been erected. It is designed on orthodox lines, with sheet-metal lining inside the cork insulation to make the space gas-tight. Cooling is by forced draught over an external cooler, and temperature control is automatic, while gas concentration is controlled manually. In one of the chambers Jonathans are to be stored at a temperature of 41° ± 1° F. in 8 per cent. carbon dioxide with 13 per cent. oxygen.

Sturmer.—The Sturmers were placed in storage on the 18th April, 1940, and the maturity was such that at 20° C. the average time for the fruit to reach its climateric was 12·7 ± 1·3 days.

With this variety, several treatments have appeared to be more or less equally satisfactory—viz., 40° F. and 42° F., in 8 per cent. or 10 per cent. carbon dioxide, with 13 per cent. or 11 per cent. oxygen respectively. The only point of difference has been that at the beginning of December, after thirty-three weeks' storage a slight amount of internal breakdown developed at 40° F. in 10 per cent. carbon dioxide. At 40° F., however, the fruit was slightly harder and greener than at 42° F.

In the previous season the best results were obtained at 42° F. in 9 per cent. carbon dioxide.

By the end of the storage period a small amount of superficial scald was apparent on the gas-stored fruit, but it was not serious. The air-stored controls on the other hand, were quite badly scalded, despite the fact that the fruit was wrapped in oiled wraps. Gas-storage thus gives very good control of superficial scald on the Sturmer.

Under the best storage treatments the fruit remained firm, crisp, and of excellent flavour, and when removed from store had the appearance of freshly-picked fruit. It appears, therefore, that gas-storage should enable Sturmers to be kept in very good condition till December.

The Sturmer is also being tested on a semi-commercial scale during the 1941 season, at a temperature of 41° F. ± 1° F. in 9 per cent. carbon dioxide with 12 per cent. oxygen.

Effect of Fertilizers on Storage Quality.

At the Appleby Research Orchard, studies have been continued on the effect of manurial treatments on cold-storage quality of apples. For the most part the results are similar to those reported in previous seasons, although some differences have been observed.

Cox's Orange Pippin.—Breakdown and fungus have been greatly increased and wilt has been decreased by the use of nitrogen. Fruit receiving the "complete" treatment of phosphorus, potassium, and nitrogen has developed less breakdown and fungus than that with nitrogen alone, but has shown much more than fruit without nitrogen.

Fruit from N and especially PNK trees has shown a little more storage-pit than PK trees or control trees. The incidence of pit seems to reflect the amount of vegetative growth shown by the trees.

Dunn's Favourite.—A heavy dressing of 4 lb. ammonium sulphate has again increased breakdown susceptibility, but to a less marked extent than last year. Nitrogen applications have also increased the incidence of superficial scald. Where the nitrogen application has not exceeded 2 lb. ammonium sulphate and has been balanced by applications of phosphate and potash, breakdown and superficial scald have not been increased.

Jonathan.—This season, applications of nitrogen have not significantly affected the storage quality of the Jonathan. Fruit from trees that had received heavy potash dressings in 1933 and 1934 is still showing very much reduced breakdown and fungus, but rather more wilt, and a little more Jonathan-spot of a slight degree of severity.

Delicious.—Manurial treatments are again without significant effect on the storage quality of the Delicious.

Sturmer.—Phosphate applications have again reduced the incidence of breakdown, and this season the amount of wilt has not been appreciably increased. Nitrogen with or without phosphate has induced a sharp rise in the amount of breakdown, and a small reduction in the amount of wilt. Complete (PNK) treatment has given results similar to those obtained from phosphate alone.

Effect of Boron on Storage Quality of Apples.

The Cawthron Institute has continued studies on the use of borax sprays and soil top-dressings in controlling internal cork in apples. Sprays of 0·1 per cent. and 0·25 per cent. strengths have had no appreciable effect on the storage quality of Sturmer or Jonathan. Soil applications at the rate of ½ lb. and 1 lb. per tree have again given an increased amount of breakdown in Jonathan, but the effect has been less marked than in similar previous tests. A soil dressing of 2 lb. borax per tree on the Lord Wolseley has not increased the susceptibility of the variety to internal breakdown in cold storage.

Superficial Scald on Granny Smith Apples.

The Horticulture Division of the Department of Agriculture has undertaken further work on the control of superficial scald on this variety. The temperature of storage (35° F.) adopted this year appears to have been somewhat high, in that the fruit has ripened and developed lenticel rots at an early date. It is considered that a temperature of about 32° F. would have given more satisfactory storage. Fruit picked at the beginning of April has kept better than fruit picked on the 22nd April. Although fruit of the later picking has remained free from scald, this advantage has been more than offset by a much higher incidence of lenticel rots. The scald that developed in fruit of the first picking has been completely controlled by the use of oiled wraps. A novel effect has been the marked reduction in the incidence of lenticel rots in oiled-wrapped fruit as compared with fruit held in plain sulphite wraps. An identical observation has been made with the Granny Smith held in orchard storage, and this is noted below.

Storage Studies on Jonathan.

The Horticulture Division has carried out further observations on this variety under various storage conditions and on fruit of three different maturities. The results have served to confirm earlier findings on several important points connected with the storage of this variety. For satisfactory storage, the Jonathan should be picked at an early stage of maturity and stored at a temperature not below 38° F. The optimum size is that corresponding to about 163 count. In the season under review, the fruit appears to have been highly resistant to deep scald, but enough has developed to confirm that it is brought on by low storage temperatures (32° F.), and that mid-season fruit is more susceptible than either early- or late-picked fruit. Scald development occurred chiefly between the end of May and the middle of July.

Orchard-storage Experiments.

The cessation of fruit export to Great Britain has necessitated the disposal of New Zealand's fruit crop within the Dominion. This has involved supplementing cold storage by storage on the orchard, and a comprehensive series of investigations has been begun by the Department of Scientific and Industrial Research, in collaboration with the Cawthron Institute, to determine the conditions necessary for successful storage without refrigeration. The tests are being carried out in the Nelson District, and four different types of store have been constructed. In the first season's work the varieties studied have been Ballarat, Statesman, Rome Beauty, Washington, Rokewood, Sturmer, Granny Smith, Dougherty, and Tasma.

The results suggest that the most important consideration in an orchard store is that it shall give as low a temperature as possible. It is probably desirable to have a fairly high atmospheric humidity in the store, but cases and fruit should not be actually wet.

Temperatures within the stores fluctuate with change of external temperatures, and it is therefore possible that the results obtained in orchard storage will vary somewhat from year to year. During the season under review, the varieties Sturmer, Granny Smith, Statesman, Rome Beauty, and Rokewood reached the end of their economic storage life by the end of June, Ballarat by early July, Dougherty by mid-July, and Tasma by the beginning of August.

Good control of wilt in Sturmer has been obtained by using a lining of waxed paper inside the case, but several points need to be investigated before it is known whether the method can be recommended for commercial adoption.

Fruit that it is desired to wrap and pack prior to orchard storage, for marketing without repacking, should be held in orchard storage for only very short periods of a few weeks.

Fruit of commercial grade does not appear suitable for long storage, because the blemish and minor skin-injuries allowed in this grade are potential sources of fungous infection.

Oiled wraps have failed to give control of superficial scald on the Granny Smith, but have very greatly reduced the incidence of lenticel rots. The latter effect has been noted above in another experiment on the refrigerated storage of this variety.

Weak summer-Bordeaux sprays have proved better than lime-sulphur sprays in controlling lenticel rots in Sturmer, but further study is necessary to eliminate certain adverse effects accompanying the use of Bordeaux before full advantage can be taken of this spray.

Superficial scald on the Dougherty has been confined chiefly to the uncoloured portion of the skin, and it therefore follows that the highly-coloured Extra Fancy grade is more suitable for orchard storage than are the Fancy and Commercial grades.

These investigations have been greatly facilitated by the valued co-operation of the Internal Marketing Division of the Marketing Department and the Horticulture Division of the Department of Agriculture.

TOBACCO RESEARCH.

Advisory Committee.—Sir Theodore Rigg (Chairman), Messrs. F. R. Callaghan, W. K. Dallas, N. J. Adamson, L. J. Schmitt, H. L. Wise, Ian Hamilton, C. C. Nash, F. A. Hamilton, B. T. Rowling, and J. F. Balck.

During the year four meetings of the Committee were held. Further progress has been made with the equipment of the Field Station at Umukuri by the purchase of a tractor, plough, and cultivator. The erection of the laboratory building has provided much-needed accommodation for office work and for the examination of seed and plant material. The whare has been extended, and arrangements have been made for the extension of the grading-room.

As a result of the resignation of Mr. J. M. Allan, difficulty was experienced in securing a suitable appointee to act as Director of the Station. Inquiries were made in Australia, Canada, and United States of America, but in no case were the applicants considered entirely suitable for the position of Tobacco Research Officer. After many delays Mr. R. Thomson, of the Agronomy Division, Lincoln, was appointed to the position, and arrangements have been made to send him to Canada and United States of America for nine months to secure first-hand experience of the flue-cured-tobacco industry.

At the request of the Committee, Sir Theodore Rigg has acted as Director of the Station, but owing to the absence of a resident officer considerable curtailment of the research work at the Station was inevitable. The farm foreman, and the field assistant have given invaluable assistance in carrying on the work at the Station under somewhat difficult conditions.

As in former years, tobacco investigations have been carried out partly at the Research Station and partly in the laboratories of the Cawthron Institute. At the Field Station, Umukuri, the work has been concerned mainly with studies of fertilizer requirements of tobacco and methods of placement of fertilizer to give the optimum result in both yield and quality of tobacco. At the request of the Committee a commencement was made in seed selection with a view to providing high-grade New-Zealand-grown tobacco seed for the industry.

Mosaic experiments have been continued at the Station, and further evidence in favour of bed-sown plants as distinct from pricked-out seedlings has been obtained in connection with reduction of mosaic incidence.

At the Cawthron Institute the investigations have included a soil survey of the tobacco lands in the Motueka and Dovedale Valleys, field plot tests to determine the extent of magnesium deficiency throughout the tobacco-growing district, chemical tests of tobacco quality, the extraction of nicotine from tobacco, the control of mosaic and other diseases of tobacco, and germination tests of tobacco seed.

Work at Research Station, Umukuri.

In view of the large plot variation revealed in the yields from the fertilizer experiments of the previous season, the manurial tests have been redesigned and transferred to more uniform soil. It is hoped that a considerable reduction in experimental "error" will result from these alterations, and that the yield data in future years will show significant differences due to the different manurial treatments.

Owing to the delay in the appointment of a Tobacco Research Officer it was necessary to reduce the experimental programme and the acreage of tobacco grown at the Station. This season 12 acres of tobacco were grown, as compared with 13½ acres in the previous season.

With the exception of a very hot dry spell during the Christmas-New Year period, climatic conditions were very favourable for tobacco at the Station. Good growth was obtained over the whole area with the exception of tobacco on the rotational plots, located on a coarse sand which dried out badly during the hot weather experienced early in January. A start was made with the harvesting of the leaf about the third week in January, and this was continued in good weather throughout February and March. Unsettled weather during the latter part of March interfered with seasonal operations, but

the harvesting of the whole crop should be completed early in April. The total yield of ungraded cured leaf should be approximately 12,500 lb. from the 12 acres of tobacco. Good results have been obtained by the farm foreman in the curing of the leaf, and the average quality should be better than that of the previous season.

Fertilizer Experiments.

The main investigations during the season have been confined to tests of standard fertilizer used at rates varying from 600 lb. to 1,200 lb. per acre, variations of the amount of nitrogen and potash contained in a standard fertilizer, and a comparison of different methods of applying a standard fertilizer. Until the weights of the cured leaf from the different plots are available, it is not possible to make a definite statement concerning the results obtained. Observations made during the growing period of the tobacco, however, revealed several marked differences on the plots, growth being decidedly better with the higher rates of application of the standard fertilizer. Notes made on colour, maturity, and texture of the tobacco leaf indicated that early in February the 600 lb. dressing of standard fertilizer gave leaf which was somewhat overmature, the 800 lb. dressing gave the nearest approach to optimum maturity, while the 1,000 lb. and 1,200 lb. dressings tended to be more immature.

The experiment with different amounts of nitrogen and potash in a standard fertilizer showed the great importance of nitrogen in promoting early growth of the tobacco plants. The use of additional potash in the fertilizer had little effect on maturity and colour, but gave the best texture of tobacco leaf. The highest yield of leaf was obtained from the plots which received extra supplements of both nitrogen and potash, but in the early stages of harvesting, colour, maturity, and leaf texture were not so good as with the standard fertilizer.

The experiment relating to the placement of standard fertilizer showed the great importance of placing a considerable proportion of the fertilizer within easy range of the root system of the transplanted tobacco plants. Where the fertilizer was employed as a top-dressing after transplanting, the growth of the tobacco plants was poor.

Mosaic Investigations.

Work on somewhat similar lines to that carried out last year has been continued. Despite stringent precautions to avoid introduction of mosaic, severe infection took place on certain experimental areas at the Station. Initial infection was worst with pricked-out seedling plants as compared with bed-sown plants. Plots located on coarse sandy soil invariably showed a much higher degree of infection than plots located on fine sands or sandy loams. Variation in the amount of fertilizer, and the supply of individual components in the fertilizer mixture, had comparatively little effect on the percentage of initial mosaic infection. Steam sterilization of the seed-bed did not, in this season's experiments, result in any considerable change in the percentage of initial mosaic infection. Using bed-sown plants, negligible amounts of mosaic were found on certain plots where very favourable soil and moisture conditions occurred.

Seed Production.

The services of an officer of the Agronomy Division were secured to initiate studies on methods of harvesting tobacco seed, and to produce, by selection of typical plants, lines of high-quality tobacco seed which could be made available to the industry in future years. So far the work has been restricted mainly to Harrison's Special and "C" varieties. Some 200 typical plants covering four strains of Harrison's Special grown in the district have been selected, and the seed-heads pruned and bagged. In the case of "C" variety, 135 plants in typical gardens have been selected, and the seed-heads bagged. Later in the season the seed-heads will be harvested and the seed graded and prepared for future sowings.

WORK AT THE CAWTHRON INSTITUTE.

Tobacco investigations at the Institute have comprised a wide range of problems relating to soil, plant-food deficiencies, chemical constituents of tobacco leaf, disease surveys, and disease-control studies. The main features of the different investigations are summarized below.

Soil Survey of Tobacco Lands.

Soil mapping during the past year has been continued in the Motueka and Dovedale Valleys. The soils have been classified, and the acreages of those suitable for flue-cured tobacco have been determined. Soil maps covering the Motueka and Dovedale Valleys are being prepared, and these, in addition to those for the Riwaka and Motueka districts, should be available to interested organizations and tobacco companies before the commencement of next season's work.

Maps showing the exact location and acreage of tobacco in the Motueka and Riwaka districts have been revised to bring into account the increase of tobacco during the past season. The survey has shown an increase of approximately 430 acres of tobacco over the 1939–40 season. The following summary shows the position for the 1940–41 season:—

District.	Acreage, 1940–41.
Motueka and Riwaka	1,690
Motueka Valley	427
Dovedale and Thorpe	274
Stanley Brook, Tapawera, and Motupiko	240
Wakefield Sector	177
Orinoco Valley	52
Upper Moutere Sector	71
Total	2,931

The increase in tobacco during the 1940–41 season is confined mainly to the Motueka and Riwaka districts. Soil and tobacco maps of the Motueka and Riwaka districts have been supplied to Government Departments, the Tobacco Control Board, the Tobacco-growers' Federation, and the three tobacco companies operating in the Nelson District.

"Sand-drown," or Magnesium Deficiency.

Experiments conducted last season by the Tobacco Research Officer in the Graham Valley showed that magnesium carbonate at the rate of 100 lb. per acre, and burnt dolomite at the rate of 250 lb. per acre, both controlled "sand-drown," which detrimentally affected both yield and quality of leaf. In this experiment magnesium carbonate gave the best results. Chemical analyses of leaf samples from these plots showed an increase in magnesia content of tobacco leaf as follows: Control (no magnesium), 0·09 per cent. on dry matter; magnesium carbonate, 0·33 per cent. on dry matter; burnt dolomite, 0·12 per cent. on dry matter.

A survey of tobacco soils showed low amounts of replaceable magnesia in a number of areas, while inquiries among tobacco-growers revealed the occurrence of "sand-drown" in several localities. On this account, a series of field plot tests were arranged in different districts using two different magnesium compounds in the fertilizers. The areas selected for tests were located at Umukuri (three), Orinoco (two), Thorpe (one), Dovedale (one), Stanley Brook (one), Graham Valley (one), and Marahau (one). Symptoms of "sand-drown" appeared on six of the test areas. At Stanley Brook and Graham Valley good results accompanied the use of silico-superphosphate and dolomite, the former giving the best results at Graham Valley and the latter at Stanley Brook. At Thorpe and one garden in Umukuri, dolomite gave better results both during the growth of the plants and in the quality of cured leaf. In the other areas the effect of silico-superphosphate and dolomite was not marked, although the quality of the leaf in some cases appeared to be improved by the inclusion of the magnesium compounds in the tobacco fertilizers.

Chemical Criteria and Tobacco Quality.

Work on the correlation of chemical composition of tobacco with quality as defined by the manufacturer has been continued. Analysis of twenty-three Nelson leaf samples has been completed for total reducing sugars, total nitrogen, and the principal mineral constituents. The data confirm the suggestion made in a previous report that a high content of reducing sugars is correlated positively, and a high content of nitrogen is correlated negatively, with quality as assessed by the manufacturer. The following figures for Harrison's Special variety illustrate these correlations:—

Grade.	Total Reducing Sugars.	Total Nitrogen.	Ratio, Sugar/Nitrogen.
	Per Cent.	Per Cent.	
Very good	27·12	1·70	15·9
Very good	25·91	1·66	15·6
Very good	20·96	1·65	12·7
Good–fair	17·50	1·99	8·8
Good–fair	18·44	2·18	8·5
Fair	16·45	2·15	7·7
Good	13·52	1·92	7·0
Fair	8·23	3·19	2·7

Analyses of selected New Zealand and imported American leaf of the same grades show that New Zealand leaf compares favourably in high content of reducing sugars and low content of nitrogen with those for American leaf.

Attention is now being paid to the mineral composition of New Zealand tobacco. Insufficient data are available as yet to make a complete statement, but the analyses suggest that the percentages of soluble ash and lime are high in comparison with data for imported flue-cured leaf from the United States of America.

Moisture Uptake of Tobacco.

Observations on the moisture uptake of American and New Zealand samples of tobacco leaf have been continued. Great variation in moisture uptake of different samples of leaf was found at different atmospheric humidities. At 100 per cent. relative humidity, differences from 128·4 per cent. to 69·5 per cent. moisture were found in different samples. In a New Zealand sample, 10·9 per cent. moisture was found at 70 per cent. relative humidity, 23 per cent. moisture at 80 per cent. relative humidity, and 83·3 per cent. moisture at 100 per cent. relative humidity. The complete results from the investigations indicate that wide variations in moisture content of New Zealand leaf occur at relative humidities normally found in the grading-sheds.

Industrial Recovery of Nicotine.

Work on the nicotine content of Turkish tobacco and the extraction of nicotine from waste tobacco has been continued. Two samples of Turkish tobacco grown at the Research Station in the 1939–40 season gave 6·06 per cent. and 5·18 per cent. nicotine in the leaf and 1·18 per cent. and 1·04 per cent. nicotine respectively in the stalks.

Attempts have been made to extract nicotine from waste tobacco by the use of organic solvents. A suitable solvent with a high distribution coefficient for nicotine at temperatures between 50° C. and 65° C. has been found. Small-scale tests with this solvent gave excellent results in so far as extraction of nicotine was concerned, but unfortunately emulsification of solvent took place, rendering filtration very difficult. Further experimental work on the volume of water used in the original tobacco mash has suggested a method for overcoming the emulsification difficulty.

Damping-off Fungi.

As in previous years, the mycologist regularly inspected tobacco seedlings grown by Nelson nurserymen for commercial use. Although all the nurserymen steam-sterilized the soil used in seedling boxes, much variation in the amount of damping-off occurred. The importance of thorough sterilization of the soil as well as disinfection of boxes and glasshouses used for the propagation of tobacco seedlings must be again emphasized. No less important to success in the rearing of healthy plants is satisfactory ventilation of glasshouses and the maintenance of dry conditions on the floor of the houses.

Semesan and zinc oxide, applied both as seed and soil dressings, were tested to determine their efficacy in the control of damping-off fungi. The use of these disinfectants with seed did not appear satisfactory, but the soil dressings gave promise of success in the control of damping-off. Zinc oxide used at the rate of 10 grammes per box controlled three common fungi associated with damping-off. Equal success was obtained with this chemical when used as a top-dressing to the soil in the box or when previously mixed with the top $\frac{3}{4}$ in. of soil in the box.

Semesan used at the rate of 2 grammes per box gave satisfactory control if the chemical was mixed with the soil to a depth of $\frac{3}{4}$ in. Top-dressings of Semesan to the surface soil did not prove so successful.

Disease Surveys in Tobacco Gardens.

Typical gardens were inspected in different parts of the tobacco-growing district in both January and March. At the time of the first inspection, great variation in the amount of mosaic was found in different gardens. The percentage of mosaic infection appeared to be lowest on the more loamy soil types, while on the coarser sands very high percentages of mosaic were found.

In March, leaf-spotting due to the fungus *Alternaria* was noticed on several crops located on the more loamy soil types. This disease, however, was not of general distribution. "Sclerotinia stem" and "leaf rot" was seen on maturing plants in different parts of the district.

Tests of Mosaic Resistance.

A reputedly resistant variety of tobacco obtained from America and a sport derived from the Ambalema variety were tested by inoculation for mosaic resistance. The Ambalema sport readily developed mosaic symptoms, but the American variety showed freedom from mosaic expression. Similar tests for mosaic resistance were carried out on plants in a private garden at Motueka, but in no case did the plants prove resistant to mosaic.

Germination Tests.

As in former years, germination tests of tobacco seed used by the Tobacco Research Station and by certain tobacco companies were carried out.

TIMBER PROTECTION RESEARCH.

Timber Protection Research Committee.—Mr. L. E. Brooker, State Advances Corporation of New Zealand (Chairman); Mr. R. L. Andrew, Dominion Analyst; Mr. F. R. Callaghan, Chief Executive Officer, Plant Research Bureau; Dr. G. H. Cunningham, Director, Plant Diseases Division, Plant Research Bureau; Mr. R. L. McPhail, Chief Inspector, Housing Construction Department; Dr. D. Miller, Director, Entomology Division, Plant Research Bureau; Mr. E. H. Walden, State Advances Corporation; Mr. N. A. Marris, Department of Scientific and Industrial Research; Mr. A. F. Clark, State Advances Corporation (Secretary).

The Timber Protection Research Committee, set up in June, 1938, to direct investigations relating to the preservation of timber from the attacks of insects and fungi, has again been especially concerned this year with the problem of termites. During the year the Termites Act, 1940, was passed. Regulations under the Act have also been gazetted. Under the Act, certain functions are the responsibility of the State Advances Corporation. These are mainly concerned with chemical treatments against subterranean termites and the training of Termite Inspectors. The Timber Protection Research Committee has been closely associated with this work, the technique for the application of chemical control measures being worked out by the Plant Diseases Division of this Department.

The following is an account of the work which has been carried out during the year:—

Dominion Laboratory.

During the year the Laboratory carried out such chemical work as was required by the Timber Protection Research Committee. In connection with experiments on wood-preservation, many samples of rimu and kahikatea were tested for copper to ascertain the degree of penetration of copper naphthenates dissolved in petroleum oil.

Entomology Division, Plant Research Bureau.

The outstanding activity has been concerned with termites, and assistance was given during the preparation of the Termites Act, which was passed by Parliament. In this respect addresses on the termite problem were given to members of Parliament as well as to the public in Auckland, Wellington, and Nelson.

The termite survey has been continued in Auckland, Wanganui, Hawke's Bay, Manawatu, and Wairarapa. Apart from the native termites found in service timbers in these regions, an important discovery was the presence in a power pole in Hawke's Bay of a colony of another destructive Australian species. This colony was destroyed, and so far no other has been found.

A report has been prepared on the species of termites now found in New Zealand, and systematic and biologic studies have been undertaken; for most of the year this was carried out in Nelson. An assistant was appointed and stationed at Auckland, where he is engaged on the identity of termites under the Act and on the systematic work of termites as a whole. This assistant will also undertake certain phases of the biological studies.

In regard to other timber insects, attention has been given to certain native species, especially the large native *Anobium*, upon which a report is now in the press. This insect is a new species and is very destructive under certain conditions.

Plant Diseases Division, Plant Research Bureau.

Work has been directed chiefly towards the study of insects attacking timber in an endeavour to select those satisfactory for testing timber-preservatives and timber treatments. Test insects should have a short life-cycle and be easy to breed under laboratory conditions. The common borer *Anobium punctatum* complies with one of these conditions in that the life-cycle is completed in one or two years, but is difficult to breed under laboratory conditions, a condition experienced also by overseas workers. One of the wood weevils may prove satisfactory, and work is being concentrated on it at the moment.

Several wood-destroying fungi are being employed as test agents, with a certain amount of success.

A small experimental house has been erected at Owairaka, the timber being of kauri and blocks of old puriri. The house will be infested with the native drywood termite *Calotermes brouni*, with a view to learning more about the biology of this most destructive borer, particularly the conditions under which colony establishment takes place.

In collaboration with officers of the State Advances Corporation, numerous colonies of Australian earth-dwelling termites have been treated with arsenical dust. This work is yet in the experimental stages.

State Advances Corporation.

The State Advances Corporation has continued its section of the work of the Timber Protection Research Committee, concentrating its activities upon field investigations and studies of timber-infesting insects, fungi, and particularly termites.

During the year the Corporation, at the request of Cabinet, drafted and submitted the Termites Bill, 1940, subsequently enacted by Parliament. Subsequently the regulations under the Act were drafted and are now in force. The Act and the regulations are under the control of the Hon. the Minister for Housing, and, while the main bulk of administration is placed upon the local authorities, certain important functions are reserved for the Corporation. These functions are mainly concerned with the application of chemical treatments against subterranean termites and with the training of Termite Inspectors to be appointed under the Act. In the training of Inspectors, for whom two courses have already been held in Auckland, the regulations prescribe that the training shall consist of work in entomology, with special reference to termites and other wood-boring insects: the recognition of field infestations; the drawing of explanatory diagrams in connection with infestations by termites; and a knowledge of the Termites Act and its regulations. The Entomological Division has carried out the first section of training, the Plant Diseases Division have dealt with field infestations, and the Corporation with the remainder of the syllabus. To date six local authorities in Auckland and the Borough of New Plymouth have been gazetted under the Act. In Auckland, Termite Inspectors are already actively engaged in inspections of their districts, and 117 chemical treatments against termites have been given.

Much field data has been collected on the incidence of indigenous termites, *Ambeodontus tristis* and *Anobium domesticum*. The field application of wood-preservatives is being steadily undertaken, and upon an increasing scale, both in the North and South Islands.

RADIO RESEARCH.

Advisory Committee.—Professor J. Shelley (Chairman), Professor P. W. Burbidge (Auckland), Professor D. C. H. Florance (Wellington), Professor R. Jack (Dunedin), Professor F. W. G. White (Christchurch), Squadron-Leader E. M. F. Grundy (Air Department), Major G. H. Heal (N.Z.S.C., Army Headquarters), Mr. E. H. R. Green (Post and Telegraph Department), Mr. J. R. Smith (National Broadcasting Service), Dr. M. A. F. Barnett (Dominion Meteorologist), Dr. E. R. Cooper (Department of Scientific and Industrial Research), (Secretary).

The following is a summary of the work carried out during the year:—

(1) The Reception of Distant Signals Research.

(*a*) *Short-wave Direction-finding.*—These experiments have been continued. A calibration was made using the field oscillator, with reference to true north, in a horizontal plane, the corrections necessary to take account of the proximity of the oscillator being allowed for. The portable Adcock equipment was modified to increase its sensitivity, and with this purpose in view the height of the aerial system was increased. A successful sense device has now been incorporated with the equipment.

(*b*) *Ultra-short-wave Work.*—Ultra-short-wave transmitters in the region from 1 metre to 40 centimetres wave-length have been developed and the effect of reflectors on the propagation pattern has been studied. A receiver for the longer range of wave-length was built and tested. The tests so far have been made over distances up to four miles. On the shortest wave-length the radiation pattern of a long wire aerial arranged in "V" formation, with parasitic reflector wires, is being investigated.

(*c*) *Audio-frequency Analyser.*—An audio-frequency analyser, covering the range from 15 cycles to 15 kc. per second, employing inverse feedback over a three-terminal network was constructed. A calibration of the instrument was made using a Wien Bridge circuit and also a self-excited tuning-fork oscillator. The average selectivity is such that the relative attenuation is 2 db at 1 per cent. off the peak to which the analyser is tuned. By a slight alteration the same instrument can be used as an audio-frequency oscillator covering the same frequency band as above.

(2) Ionospheric Research.

Routine measurements of the critical frequencies of the F and E regions have been made continuously throughout the year.

LEATHER AND SHOE RESEARCH.

Director: P. White. Assistant Director: F. G. Caughley.

LEATHER RESEARCH ASSOCIATION.

Advisory Committee.—Messrs. A. E. Lawry (Chairman), C. Arlington, J. E. Astley, S. L. Wright, R. L. Andrew, and F. Johnson.

During the years that the Research Association has been in existence the work carried out has resulted in a wider knowledge of the fundamental processes of manufacture. This, in turn, has provided new outlooks on factory methods and has established the importance of certain details which previously were regarded as of lesser significance. The value of this work is immediately established when efforts are made to step up production on a large scale as has been the case in recent months. The manufacture of leather is a series of balanced processes, and during the stepping-up of production unless the function of every process is understood, the balance may be upset and failure will result.

Although handicapped by reconstruction and expansion difficulties, by the lack of some of the usual tanning materials, by labour difficulties owing to men being called up for military training, and by machinery difficulties, the tanners have not only increased their outputs and range of products considerably, but have also maintained and increased the quality of their products.

During the year under review five students of a Tanning Class at the Otahuhu Technical College sat for and passed the Examination of the City and Guilds, London, Stage I, in the Manufacture of Light and Heavy Leather. This beginning in the technical education of tannery workers will have important effects on the future of leather-manufacture in New Zealand. It will provide a constant supply of men for the trade, with the necessary knowledge to take charge of processes or to adapt existing methods to new conditions.

Storage of Hides.

The bulk of the hides is produced in a few months of the year. Consequently, as tanners have to produce a continuous supply of leather, some of the hides must be stored until such times as they are required. The condition of hides after storage under varying conditions of temperature and curing has been examined, and the work is still in progress.

Volume of Leather.

Fullness and thickness are important qualities of leather. Factors affecting the changes of volume due to processing have been examined during the year. These have been found to be small individually, but cumulatively may have an important result. These results emphasize the necessity of attention to details in a well-balanced series of processes.

Upper Leather.

The elastin fibres in a skin constitute only a small proportion of the whole, yet they fulfil a definite function in the finished leather. What this function is has not yet been definitely established, but further information on this subject has been obtained as a result of the work carried out during the year.

One of the processes, the function of which has not yet been fully established, is that of bating. The continuation of the work carried out on the natural tightness of the grain-layer has thrown more light on this controversial subject.

Quality of Leather.

Many pairs of worn shoes have been submitted for a report on the alleged defective leathers used in their construction. The causes of the defects may be generally attributed to one or more of the following: Rotting action of perspiration, the so-called "burning" of leather whilst wet, actual burning or charring of the leather, splashing with strong sulphuric acid, rotting action of soluble iron salts, rotting action of milk and its degradation products, rotting action due to nitrogenous compounds—*e.g.*, organic manures, &c. Like all other materials, leather has its limitations, and a fuller realization of these by the general public would result in better value being obtained from the boots and shoes which in the present emergency is very desirable.

SHOE RESEARCH ASSOCIATION.

Advisory Committee.—Messrs. W. Denby, P. E. Edwards, W. S. Livingstone, D. MacDonald, and R. L. Andrew.

The success of an Industrial Research Association depends not only on the efforts of the staff, but also on the degree of co-operation of the industry concerned, which, in turn, depends on the confidence placed by the industry in the research staff. During the year under review the number of problems submitted has increased from 102 in the previous year to 139. The number of factories submitting problems has respectively increased from 28 to 35. Judging by these results, the increasing use made by the members of the services available indicates that the confidence of the industry in the organization has grown, and consequently the sphere of usefulness has increased.

Closing-room Practice.

Arising from observations made overseas and in continuation of previous work an investigation was carried out on the effect on the strength and appearance of seams produced by the use of needles of different size and shape, by different threads, and the size of stitch. The demonstration seams made were of great interest and help to the industry.

Adhesives.

During the year much information on adhesives in their relation to special purposes has been obtained. The importance of the use of the cement or adhesive for the purpose to which it is most suited has been demonstrated or that the purpose for which a cement is required determines the choice of a particular cement suitable for that purpose.

Sole Leather.

The quality of the leather suitable for the cement process and its treatment prior to cementing have been investigated. The results show that if some of the accepted qualities of sole leather are not to be sacrificed unduly, care must be taken both by the tanner and the shoe manufacturer.

Shoe-fitting and Shoe-life.

The examinations of so-called defective leathers and shoes have shown repeatedly that the elementary precautions for the right treatment of boots and shoes are not realized by some members of the general public. The importance of a comfortable fit, especially around the toes, cannot be too highly emphasized, both from the comfort and shoe-life points of view.

Perspiration rots both upper and sole leather. Tight shoes, especially at the toes where the ventilation of the shoe is least, increase the amount of perspiration produced, and consequently the shoe-life is reduced.

Monthly Circular Letters.

The monthly circular letters, which contain reports on research work carried out, replies to problems submitted for investigation, and information on subjects of interest to manufacturers have continued to maintain the interest of the trade. That they fulfil a definite educational function is manifested in the remarks and references made to them on the occasion of the visits of the staff to the factories.

WOOL MANUFACTURERS' RESEARCH ASSOCIATION.

Wool Manufacturers' Research Association Committee.—Mr. W. R. Carey (Chairman), Professor H. G. Denham, Mr. T. E. Donne, Mr. H. Lee, Dr. R. O. Page, Mr. T. C. Ross, Mr. W. L. Wood, Dr. E. Marsden (Secretary).

Director.—Professor F. G. Soper.

Despite the ever-increasing pressure under which industry has been working during the past year, it has shown an excellent co-operative spirit with the Association in its activities. Two committee meetings and a meeting of dyers from mills in the South Island have been held. Quarterly bulletins have been sent to all members.

From a prepared list of suggested investigations members decided, at the beginning of the past year, upon what particular work the Association should concentrate.

Two large-scale mill trials have been carried out in which several woollen batching oils have been compared, and arrangements are in hand for the carrying-out of further trials. Reports of the trials are being circulated to members as the work progresses. The purpose of this work is to find the best New Zealand produced woollen batching oils and to compare these with well-known imported ones. Other work in the mills, in addition to that carried out during the periodic visits, includes a detailed piece-scouring investigation, and the study of variability in woollen carding and spinning.

Some of the important laboratory investigations during the year have related to dyeing and fading, the comparison of unshrinkable treatments, and the analysis of many samples of neatsfoot-oil with the view to mill trials being carried out to test its suitability as a worsted lubricant. The mill trials on the batching oils have also involved much laboratory work.

So that the Association might be of greater service to industry, Mr. R. V. Peryman by courtesy of Imperial Chemical Industries (Australia and New Zealand), Ltd., spent a month in their dyeing laboratories at Melbourne studying the investigation of dyeing problems. As a result, a number of useful connections have also been established with other institutions.

Consulting work carried out in the laboratories has included the investigation of the causes of stains, chemical and physical damage, uneven dyeing, fading, and structural irregularities, and the analysis of products, such as chemicals and oils, used by industry. Sunlight fading tests are being carried out in which the fading properties of many members' samples of dyed fabric are matched against the British Tentative Standards.

During the year a cloth tester has been installed in a constant temperature and humidity room, and recently a shrinkage tester has been acquired. By means of the latter equipment, which is that specified for the British Tentative Standard test, it will be possible to measure the resistance to shrinkage of textiles in the same units as those used for similar tests in the United Kingdom.

RESEARCH WORK AT AGRICULTURAL COLLEGES.

Grants were made by the Department during the year to Massey Agricultural College and to Canterbury Agricultural College for a number of projects, which are reported on below.

CANTERBURY AGRICULTURAL COLLEGE.

Pig Research.

Professor C. P. McMeekan.

Research under this heading was transferred from Massey Agricultural College to this institution as from the 1st January, 1940. The consequent subdivision of the nucleus experimental breeding-stock (Cambridge inbred pigs) and the lack of necessary facilities at Lincoln limited activities during the year. Work has been directed mainly towards multiplying the three breeding-animals obtained, to organizing and developing facilities, to acquiring laboratory and field equipment, and to training technical assistants. At the same time work on several projects has been proceeded with.

Influence of the Sex Glands upon Growth and Development.

These experiments have been advanced to a stage permitting publication, and a full report is in preparation. Significant effects upon the form, anatomical composition, histological structure, and efficiency of feed utilization of the bacon pig have been demonstrated. Many of these have important practical implications.

Inbreeding Studies.

One previously unrecorded lethal condition has turned up in the Cambridge Whites and some indication of mental defects has occurred. The work has been extended to the Tamworth breed and an inbred strain established which already carries a high degree of inbreeding intensity. In general, results to date indicate that inbreeding in pigs is not necessarily characterized by the dangers commonly attributed the practice by farmers.

Factors Influencing "Still Births."

A limited amount of data collected tends to support American work in indicating that posterior presentation in conjunction with prolonged duration of parturition increases the incidence of still-born pigs. Arrangements have been completed to study the effect of pituitrin injections in speeding up the duration of parturition as a means of reducing normal losses.

Development of New Breed.

Working at Lincoln with two strains of Tamworth and the Cambridge Whites, selected sows of the F1 generation are now carrying inbred F2 and back-cross (Tamworth) F2 litters. Carcass-quality data on F1 animals not retained for breeding have been obtained. This project is being undertaken in collaboration with Massey Agricultural College and St. Peters College.

Entomological Investigations.

Mr. L. Morrison.

Insect Pests of Wheat.

Plots were laid down in two areas—namely, Hororata and the Wheat Research Institute land at Lincoln. For general observations twelve varieties of wheat were sown, in three rounds in both areas. For single-plant observations five varieties of wheat were sown, in four beds, in the Lincoln area only. Data were collected in September and October in regard to egg-laying, and in December and January in regard to straw-break. Valuable results were obtained from these trials and a full report was prepared for the Specialists' Committee, Wheat Research Institute. It is intended to carry on this work during the year 1941–42 with varieties of wheat grown in two areas in the Hororata district and one at Lincoln.

Cocksfoot-midge.

Machine dressed and undressed cocksfoot seed samples were obtained through seed-merchants from farms on Bank's Peninsula and in the Ashburton-Eiffelton area. An examination of these samples showed that the number of midge-infested seeds varied from 0·0 per cent. to 1·36 per cent. and was of no economic significance in the 1940 harvest season.

An examination of wild cocksfoot heads from various localities in the South Island was carried out in September and October, 1940. The results showed a very high degree of infestation of midge larvæ overwintering in old seed-heads which had remained standing throughout the winter in the position where they grew.

To determine the degree of infestation of seed crops by the early generations of midges, between the time of their first appearance in October and the cutting date in January, data were collected from field W. 4 on the College Farm at Lincoln. The field was divided into sixteen equal blocks and samples collected at two periods—viz., 3rd December for the first generation, and 24th December for the second generation. The examination of the samples collected on the above dates will occupy a considerable time and have not so far been completed.

A boring caterpillar was observed destroying a fairly large number of seed-heads in fields W. 4 and S.E. 1. Some preliminary information was collected in regard to this boring caterpillar. It would appear as if the caterpillar is responsible for a fairly heavy loss of seed-heads, perhaps equal to or even greater than the loss of seed caused by the gall-midge. More attention will be paid to this aspect of the problem next season.

Red Clover: Fertilization and Seed-setting.

This work is being handled by Mr. D. A. McBurney. Red-clover-seed crops in various parts of Canterbury have been visited in order to assess the numbers of the different species of bumble bees and varieties of honey bees which visit them. Observations upon the cross-pollinating activities of those insects have been made. The yields of seed from the crops which have been examined will be obtained later and compared with the field notes upon the insect visitors.

A collection of bumble bees made in Canterbury during the year is to be sent for identification to Ottawa, Canada. The period of emergence and maximum concentration of the different species of bumble bees has been noted, while the percentage of red-clover seed set throughout the season has been determined. The percentage seed set at different periods will be correlated if possible with the density of bumble-bee populations during those periods.

Clones of red clover grown in cages have been fertilized by *Bombus terrestris*, *B. ruderatus*, and *B. hortorum* by two varieties of honey bee, and by various Lepidopterous insects. The seed-heads will be collected, and the percentage of seed set by fertilization by each of the above insects will be determined and the relative efficiency of the different insects as fertilizing agents of red clover ascertained.

Sheep-dipping Experiments.

Mr. G. B. McLeod has continued his investigations on the relative efficiency of different dipping fluids on sheep parasites. During the year opportunities have been taken to apply the results of laboratory and small-scale pen experiments to large-scale field trials. Several thousands of sheep—lambs, ewes, and rams—have been dipped to date and much data collected. The findings are at present being examined and a report prepared.

Subterranean Clover.

The second grazing season commenced on 6th August, 1940, just prior to lambing. A fair strike of clover had established in the previous autumn, though it was too late to provide any bulk of feed during the winter. By the middle of September the growth on the plots was beginning to get ahead of the sheep, and one series of replicates was shut up at the beginning of October, the intention being to cut these for hay. During October there was as much as 3 in. to 4 in. of dense herbage on the grazed plots. The quadrats on these plots were cut during this period and the yields given in the table below show the amount of growth which developed :—

Showing Yield of Dry Matter up to 30th October, 1940, from Eighteen Square Meter Quadrats from each of the Four Treatments.

Treatment.	Fertilizer.	Total Yield of Dry Matter per Quadrat.	Yield Dry Matter per Acre.
A ..	5 cwt. lime, 1 cwt. super (alternating) ..	5,996 gm.	4,245 lb.
B ..	2 cwt. super annually	4,687 gm.	3,320 lb.
C ..	1 ton lime initial, 2 cwt. super annually	6,829 gm.	4,837 lb.
D ..	1 ton lime initial, 2 cwt. super and ½ cwt. potash annually	6,213 gm.	4,401 lb.

In early November a prolonged period of hot dry north-west winds dried off this herbage. The sheep have been subsisting on this dried-off herbage from the middle of November until the end of March. There has been practically no rain and no growth during this period. The hay plots were not cut, as the herbage was needed for grazing. The quadrats have not been cut as there was no new growth. A shower in February caused a strike of seedlings, many of which have survived the subsequent dry spell, and a good soaking rain towards the end of March has revived this early strike and has promoted another dense strike of seedlings, with the result that the coming season promises to be the best for subterranean clover since the plots were established, though had the rain come three weeks earlier a much better autumn growth would have been assured.

Stocking.

As was suggested in the report for the 1939–40 season, the number of ewes on the different treatments was adjusted to an estimated carrying-capacity based on the results of the first grazing season. The changes are outlined in the following table :—

First Season's Stocking.	Second Season's Stocking.
18 ewes	18 ewes plus 9 hoggets = 1·3 ewes per acre.
24 ewes	18 ewes plus 6 hoggets = 1·2 ewes per acre.
30 ewes	27 ewes plus 12 hoggets = 1·7 ewes per acre.
30 ewes	30 ewes plus 12 hoggets = 2·1 ewes per acre.

The ewes put on weight steadily while rearing the lambs up until the end of December. During January they held their own, but in February and March they lost weight. This was not considered a disadvantage, as they were very fat and it was agreed that they should lose condition prior to tupping.

The Lambs.

The lambs did well with the ewes until 13th January. The wether lambs were taken out and killed when they reached 70 lb. live-weight. The dressed weights and the weights of certain organs were secured and measurements and weights of skeletal structures recorded.

The first lambs were taken out on 28th November and others at weekly intervals up to 13th January, when those left were weaned on to rape. The proportion of lambs, both ewes and wethers, over 70 lb. weight at certain dates is shown in the following table :—

Treatment.	Number of Lambs.	Percentage of Lambs weighing 70 lb.		
		28th November.	23rd December.	13th January.
		Per Cent.	Per Cent.	Per Cent.
A	17	18·8	50·0	62·5
B	17	37·5	100·0	100·0
C	22	18·0	45·4	59·0
D	29	31·0	50·0	71·0

Production.

The production on the four treatments has been computed from the live-weight increase of the ewes and hoggets, the weight of the lambs, and the wool weights of the ewes, hoggets, and lambs, and are summarized in the following table, together with the computed production ratio :-

Treatment.	Ewe Weight-increase.	Hoggett Weight-increase.	Lamb Weight.	Ewe and Hoggett Wool Weight.	Lamb Wool Weight.	Production Ratio.
	lb.	lb.	lb.	lb.	lb.	
A ..	117	508	1,290	170	34	106·0
B ..	170	317	1,327	159	28	100·0
C ..	131	538	1,661	222	47	131·0
D ..	302	652	2,290	285	50	178·0

Mowing Trials.

The mowing trials were cut twice during the season—once in March and again on the 15th October. The plots show distinct differences as a result of the fertilizer treatments, especially during the flush period during the spring. A summary of the weights are given below :-

Treatment No.	Treatment.	Represented in Grazing Trials.	Yields.			
			March.		October.	
			Yield, Eight Plots.	2 cwt. = 100 (Super).	Yield, Eight Plots.	2 cwt. = 100 (Super).
			Gm.		lb.	
1 ..	Lime 1 ton per acre (initial) ..		613	91·1	113·8	83
2 ..	Lime 1 ton per acre (initial) plus 2 cwt. super and ½ cwt. potash (annually)	D	747	108·0	295·25	214
3 ..	Lime 1 ton per acre (initial) plus 2 cwt. super (annually)	C	758	113·0	263·1	191
4 ..	Control		542	80·6	68·9	50
5 ..	2 cwt. super (annually) ..	B	672	100	139·7	100
6 ..	Lime 1 ton per acre (initial) plus 1 cwt. super (annually)		755	113·0	240·0	174·5
7 ..	Lime 5 cwt., alternating with super 1 cwt.	A	693	103·5	236·6	172·5
8 ..	Super 1 cwt. (annually) ..		627	92·7	109·1	79·0

The chemical analysis of the herbage cut from the quadrats on the large plots and of the herbage from the mowing trials is in progress.

Conclusion.

The evidence so far obtained from the grazing trial and the mowing trial points to the fact that under a carefully designed fertilizer programme subterranean clover pastures on the light land of Canterbury are capable of supporting a relatively high sheep-carrying capacity on this class of land over a number of years. Prior to the introduction of the clover, sown pastures rapidly reverted to hair-grass and brown-top. The most economical fertilizer treatment appears to be 5 cwt. of lime and 1 cwt. of super applied in alternate years, though this requires further investigation before a final statement is made. The necessity for an application of lime on this land before a satisfactory subterranean clover pasture can be secured has been definitely established.

MASSEY AGRICULTURAL COLLEGE.

Root-development Studies.

Mr. W. A. Jacques.

As reported in last year's annual report, plants of cocksfoot, Italian, perennial, and false-perennial rye-grass were grown on plaster-of-paris moulds, allowed to retain six roots, and the tops received differential cutting treatment. Italian and false-perennial plants failed to survive the summer, but certified perennial and certified cocksfoot plants showed a relatively low mortality-rate and are now being maintained into the second season (year). Some interesting figures for root-replacement have been obtained. Cocksfoot stood up better than perennial rye-grass to this test. This may be due to the higher root/shoot ratio found in cocksfoot, which is almost double that found in the rye-grass.

The manurial placement trials have been completed after four years' observation, and a report is being prepared for publication.

A number of profile drawings has been added to those made in previous years, and wherever possible root-weights in the different soil-layers have been obtained so that the weights and profiles can be examined together.

The effect of severing the roots of grasses and white clover at different times through the winter has been examined. The effect of such treatment in the early part of the winter is considerably different from that seen from early spring pruning. There is no question but that the statement that root-pruning is advantageous to the grass plant needs modifying.

Herbage cuts are being weighed and root-development measured on plots treated similar to those of Martin Jones at Jealots Hill. Leniency of grazing or cutting at different seasons of the year may have a considerable influence on the root-expansion into the deeper soil-layers, and the work is complementary to that already reported for the herbage production.

A trial was commenced last year in which a pasture is mown to a pre-arranged height from the ground each week or fortnight. By this means it is hoped to be able to determine the most satisfactory level (from the point of view of production of herbage and roots) at which to cease grazing a pasture under the rotational system. Preliminary work carried out by Torstenson in Sweden on behalf of the Swedish Grassland Association shows that marked differences in the amount of root formed follows upon the different methods of grazing. This trial has entered into its second season. Root studies will be undertaken during the summer of 1941–42.

A preliminary attempt to distinguish between the roots of the rye-grass was made during the year, but a more comprehensive effort is planned for the coming season. This will include five rye-grasses, five white clovers, two cocksfoots, two red clovers, and two dogstails.

For the coming season, a continuation of the existing trials and pot trials on the effect of different levels of defoliation on root-development, will be undertaken.

Two papers have been published during the year—

(1) "Crested Dogstail: Its Characteristics and Behaviour under New Zealand Conditions—Part III" (*concluded*). *N.Z. Jour. Sci. & Tech.*, October, 1940.

(2) "Root Development in Some Common New Zealand Pasture Plants—Part I: Perennial Rye-grass." In the press.

Sheep Nutrition.

The experiment on the effect of certain manurial treatments on the feeding value of certified perennial rye-grass and certified white clover as judged by the thrift of ewes and lambs—*i.e.*, rate of body growth, quality and weight of wool produced, fertility and health—has proceeded satisfactorily. Periodical weighings of increases in live-weights of ewes have been carried out, recorded, and analysed. At shearing, the weights of the greasy fleeces were recorded, and also the quality and style and the yield estimated. Samples were drawn and are being scoured to obtain the exact clean scoured yield.

Lambs were tagged at birth and weighed three days later. The lambs were slaughtered on reaching 72 lb. live-weight and weights were recorded on leaving paddock, on reaching slaughter-pen, on following morning prior to slaughter, immediately after slaughter, and after having been in cold chamber overnight. The carcasses were graded by the Government grader and his remarks recorded, a full description of the rejects being recorded. Weekly notes have been made of the health of sheep and lambs, and daily records have been kept on the rate of stocking on the experimental area.

The mortality-rate among lambs was heavy, and examination by the veterinary department revealed that in most cases the thyroid gland was enlarged and hypoplastic. Accordingly, the weights of all lambs arriving at the laboratory were recorded, as also were their age and the weights of the thyroid and thymus glands. The thyroid glands were preserved for sectioning and microscopic examination.

As lambs reached killing-weight a clinical examination was made. The day before the lambs were killed blood-samples were drawn from the jugular vein and examined.

After slaughter the thyroid and thymus glands and adrenol were carefully dissected and weighed and preserved for microscopic examination and for chemical analysis. A careful examination was made of all organs, and any pathological condition was noted. The parasitic fauna of the fourth stomach and small intestine were isolated, counted, and classified as to species and the incidence of the parasites of other organs, including hydatids, was noted.

Blood-samples were drawn from sheep suffering from a form of "grass staggers," and calcium and magnesium estimations carried out on the serum. Both were normal. The cause of the condition is unknown and will be the subject of further work.

Pig Research.

Professor W. Riddet.

Work on the inheritance of length in pigs has been continued during the year 1940–41. The long and short strains that are being developed for the project are being fixed in type by intensive inbreeding, preparatory to studying the effects of crossing loan and short types. This initial work necessarily slows up progress on the major projects and is itself made slow by the need for observing the breeding qualities of relatively large numbers of both male and female animals before selecting them for parent stock so that in efforts to accentuate length or shortness other qualities will not be impaired. For example, difficulty has been experienced in maintaining high litter-numbers in the short strains. The project is also made difficult by the need at all times to avoid the effects of environment which readily influences conformation. Nevertheless, much valuable information has already been accumulated from detailed measurements of the carcasses of progeny slaughtered at bacon weights. A progress report on the first part of the work has been prepared for publication. A considerable amount of further data is available for working up.

In order to achieve more rapid results than may be expected from selection within one breed, an effort is being made, in collaboration with Canterbury Agricultural College Animal Husbandry Department, to develop more length in one breed and simultaneously to fix other desirable characters by first crossing two breeds and thereafter making selections within successive generations of the resulting inbred stock.

During the year a graduate student used stock bred in the herd for a study of the effect of sex on growth in the pig, and another post-graduate student used the same material for studying the "Influence of Sex upon the Composition of the Fat of the Pig." A paper on the latter has been published by A. T. Johns.

Experiments were carried out on the feeding of pigs on roots and meals during winter and on the feeding of copra.

WOOL METROLOGY.

Dr. P. R. McMahon.

During the year work has been continued on the following topics:—

(1) Evolution of techniques for measurement and grading of wool and sheep:
(2) Sheep and wool in relation to their environment:
(3) Sheep and wool improvement through breeding:
(4) Co-operative manufacturing experiment.

Measurement and Grading Techniques.

Analysis of the results of medullation measurements on what are, in effect, repeat samplings of the same animal has shown that for both six months' growth of wool and for a full fleece the present sampling methods of the Fleece Testing and Recording Department give accuracy which is more than adequate. Because the accuracy is more than adequate and because a moderately high correlation between the hairiness of different staples in the same fleece results in relatively less extra information from testing more samples per animal, it may be concluded that the number of staples tested could safely be reduced.

Many of the most valuable characteristics of different types of New Zealand crossbred wools cannot be measured by objective methods, although their recognition by hand and eye, on which evidence our wool is valued and sold, is simple. To increase the reliability of subjective methods, standards of comparison are being evolved and a comprehensive check on accuracy has been carried out. Ninety-three stud Romney ewe hoggets were examined independently by seven trained observers. Analysis of variance gave significant differences between sheep and between observers for all characters studied. Expressing the error term as a percentage of the total, variance gave the following results:—

Count	38 per cent.	Handle	63 per cent.
Length	27 per cent.	Density	69 per cent.
Character	36 per cent.	Lustre	78 per cent.

It is satisfying to note that these figures are roughly in order of their importance to the wool-buyer, and that count, length, and character, which largely determine price, can be judged with reasonable accuracy.

Similar determinations are being made for eye judgments of mutton conformation and breed type.

Environmental Studies.

A preliminary examination of fleece-weight figures showed that individuality—that is, the tendency of individual sheep to be high or low producers—only accounted for about 35 per cent. of the total variation within the flock, which is in good agreement with Swedish figures. Of the remainder, about 14 per cent. was due to seasonal effects common to all animals and about 50 per cent. due to random environmental effects such as foot-rot, lactation, &c. With environment playing such a large part it follows that an immediate and efficient increase in wool-production could be obtained by improved grazing and management.

To determine, similarly, to what extent wool character, mutton-conformation, and breed type are the result of feeding and management rather than individuality, some 700 stud ewe hoggets were examined in 1939 and again in 1940-41. To extend the applicability of the results 250 hill-country ewe hoggets shorn as lambs were examined and tagged in 1939. Re-examination of this group in 1940 has shown a good correlation ($r = 0{\cdot}676 \pm 0{\cdot}037$) in fleece-weight and fair correlation for fleece character, count, breed type, and mutton-conformation. If half of these sheep could have been culled for low fleece-weight in 1939 the remaining sheep would have averaged 0·7 lb. more per head in 1940. In striking contrast is the low correlation between parent and offspring. In a stud flock where records were obtained of the fleece-weights of ewes and their hogget offspring, calculation showed that culling 50 per cent. of the lowest producing ewes from the mates of each ram, would have given no increase at all in the mean fleece-weight of the progeny, although the selected ewes produced fleeces 1·2 lb. above the average.

Briefly, then, we must be clear on how the productivity of our ewes can be modified by culling at the end of their hogget year. If other *economic* characteristics of the sheep are inherited no more strongly than the fleece, and there are good reasons why this should be so, it seems obvious that culling of ewe hoggets should be directed more towards wool, where elimination of low producers will give an immediate return in subsequent years. *Conformation features* should be improved *through the ram*. Correlation studies make it possible to advise culling of Romney ewe hoggets for short wool, bad wool, fine wool, and for small size of animal, neglecting conformation almost entirely, but paying attention to constitution and general thriftiness.

Preliminary Sheep and Wool Survey.

Owing to the importance of environmental effects in changing fleece-characterization it becomes essential, for progressive culling and breeding, to know which types of wool are the most productive on a given environment. To this end the wide range of count and types found in New Zealand Romney flocks is being exploited in the present investigation. Seventeen farms covering a wide range of soil and pasture types and varying in rainfall, altitude, management, and type of sheep were selected in 1940 and visited at shearing-time, when some 30,000 fleeces were weighed, described, and graded for quality. In addition, between 500 and 600 ewe hoggets were tagged and graded for important features of fleece and body in order to provide further data on the effectiveness of culling for production under flock sheep invironment.

Results of one year's work in a project of this kind must be put forward with considerable reserve because of seasonal changes from one year to another, and no detailed analysis will be offered at this stage. From the fleece-weight analyses carried out it would appear likely that Romney fleeces described as of slightly Leicester type are not so well suited to our poorer environments as Romney type fleeces of the same count. The reverse holds under high fertility conditions. Under good environmental conditions ewe-fleeces with counts of about 44/46 would seem to be the most efficient wool-producers. Under hard conditions the corresponding count would be 46/48. There does appear to be a very marked drop in the average weight of Romney fleeces finer than 48/50's—a drop which is less rapid in the case of Corriedale cross-wool which yielded, on scouring, about 6 per cent. less than Romney wool. Hogget fleeces were about one count interval finer than mature sheep, and in selecting ewes at the hogget stage this must be allowed for.

Grade of farm (including soil type, pasture, and management) exerts a marked influence on fleece-weight, in accordance with expectation and general observation. There seems, moreover, to be considerable correlation between locality and general appearance of wool grown. The most important fleece defects encountered in the pooled data are as follows:—Breaks and tender wool, 30 per cent.; cotts (including slight cotts), 20 per cent.; sandy and dingy fleeces, 10 per cent.; hairiness (including slight hairy tip), 8 per cent.; pink-rot, 0·8 per cent. Cotting was more noticeable among coarser fleeces, while breaks were found more among fleeces of 48's count than elsewhere. With the exception of hard cotts, cotted fleeces were generally broken or tender. Hairiness is associated more with lower counts, and since coarser fleeces are generally heavier than fine fleeces this may be the reason for the erroneous opinion, current among farmers, that hairy fleeces are heavier. Actually it has been found that hairy fleeces are slightly lighter than pure fleeces of the same count.

Breeding Studies.

The only systematic parent progeny data available until this last year have been for medullation, and analysis of these gave a relatively low correlation of about $r = 0{\cdot}3$. Since medullation seems much less affected by environment than other economic features of the sheep it is reasonable to expect much lower parent progeny correlations in such features as body-conformation and fleece-weight. As a result, improvement through mass selection, mating best to best can only have a very slow result. To establish the truth of this conclusion fleece data and body-conformation gradings have been collected on some 2,000 ram and ewe hoggets and 1,600 ewes of the Voss flock, and fleece data accumulated on 900 ram hoggets of the Waiorongomai stud.

Thanks are due to Professor C. P. McMeekan, who initiated the work on mutton-conformation gradings. Breed-type gradings have been made by Messrs. M. Voss and A. C. Morton, while certain of the fleece gradings were made by Messrs. R. Webber, J. Sutherland, and the staff of the Fleece Testing and Recording Department. Analysis of the data has only recently been commenced, but for fleece-weight and mutton conformation it is already evident that the parent offspring correlation will be very low, in accordance with expectation, although it is possible that breed type, which depends largely on the grading of the animal's head may be more strongly inherited. These low correlations justify neglect of the characterization of the dam in making progeny tests for features directly affecting production. In view of what has been shown above, progeny testing seems obviously to be the only way of securing improvement beyond the standard of our best strains.

Relatively large differences have been found in the mean fleece-weights of hoggets sired by different rams, the standard deviation between progeny tests being about 0·65 lb. This figure includes a small contribution from variation within sire groups.

In a lecture delivered by the writer to the annual meeting of sheep-farmers held at Massey Agricultural College, and subsequently circularized to registered stud Romney breeders, the overwhelming importance of selection on progeny test was emphasized, and it was pointed out that an increase of 1 lb. in fleece weight would take nearly hundred years if selection among ewes were the only form possible, and twenty-five years for ewes and rams together. By the use of sires selected on what they actually leave, the same improvement could be obtained in the first generation. About twenty sires would need to be tried for every three required for use.

In lieu of a full progeny test programme, a great deal could be done, especially in large flocks, merely by systematic observation of all progeny of the rams normally used each season. Because this is not being done costly mistakes are occurring. For example, a ram valued at 150 guineas and highly regarded by the flockmaster left nearly the worst progeny out of twenty-one tested rams. He was used extensively for several years, and no less than six of his sons were used in the 1938 season alone and left progeny whose average grading was significantly below that of the whole flock.

In the Voss flock full progency tests have been drawn up for thirty-five rams, of which three were consistent improvers on the flock average and have been selected to form the basis of a Hagedoorn nucleus. In collaboration with Mr. R. Waters and Dr. F. W. Dry the following types of matings have been made :—

(1) Matings to their own best daughters and best close relatives as a test of the inbreeding capabilities of the strain and in the hope of fixing desirable genes present :
(2) Mating the remaining daughters and close relatives of one nucleus ram to other nucleus rams to concentrate desirable genes :
(3) Remaining mates for the nucleus rams selected on phenotype as the best from the flock.

Rams born in the nucleus will, in due course, be progeny-tested on the flock as a whole, and only proven sires used to replace those in use.

In the first scientifically-controlled strain trial with sheep to be carried out under hill-country conditions matings have been made of rams from known high fleece-weight strains for comparison with rams chosen on appearance.

Manufacturing Experiment.

In interpreting the requirements of the wool-manufacturer to the wool-producer there is frequently difficulty in determining exactly what the wool trade requires. At the present time a co-operative experiment is being undertaken in conjunction with Dr. S. Townend, of the New Zealand Wool Manufacturers' Research Association, Dunedin, to determine the real importance of medullation occurring in amounts not obvious to hand and eye. Two contrasting lots of wool have been prepared by selecting britch wool from fleeces of known hairiness, precautions being taken to ensure that other characteristics, such as fineness, remain the same for the two lots of wool. The hairiness of these wools is well within the limit tolerated by wool-buyers as determined by submitting a series of composite samples of ascending degree of hairiness to a committee of experts.

It is hoped that this work will open the way for future collaboration on broader lines with the association in providing information not available from other sources.

Grateful acknowledgment is made to all those who have co-operated in this work by allowing examination of their flocks, by assisting in grading or measurement, or by providing data for analysis. Thanks are also due to Massey Agricultural College for facilities provided.

STERILITY INVESTIGATIONS.

By Mr. W. M. Webster.

Sheep-sterility.

During the past year semen samples collected from the "sterility" experimental flock have been examined microscopically with respect to count, motility, and morphology, and the rate of respiration of the samples has been measured and checked by biochemical studies.

Samples of semen were used for artificial insemination, and the results obtained were compared with the laboratory findings on the same samples. The results of this work are to be embodied in two papers, which should be ready for publication as soon as the current season's work is concluded.

The "sterility" rams had previously been divided into four groups which are subjected to different environment conditions. This study is yielding results of considerable interest with respect to changes in fertility.

During the present season further detailed microscopic examinations and respiration measurements are being carried out on semen samples from steriiity rams, and the results are being compared with those of the previous season and with the treatments the rams have received. It has also been possible to make similar observations on some of the College stud rams and rams belonging to a number of breeders who have approached us for advice on the fertility of their rams.

At a breeder's request we have also demonstrated our methods of artificial insemination. We hope to extend this side of the work. We are keeping in as close contact as possible with many of the overseas workers in this field.

Sterility Investigations in Bulls.

During the past season we have been able to extend our investigations to the dairy bull. As material we have used the bulls of the College herd and those of a number of outside dairy-farmers.

The investigations are much of the same nature as those on the ram—detailed microscopic examinations and respiration tests being carried out, also metabolic studies of a biochemical nature. In all cases our results are being compared with breeding results obtained by the farmers themselves, and on the dairy side also we are in close touch with overseas progress.

Following the work of Bottomly at Reading we attempted antuitrin S therapy with two poor breeders in the College herd. The results in one case were promising, but not sufficient improvement occurred to ensure fertility.

Phillips and Lardy at Wisconsin have been reporting to us their progress with vitamin C therapy, which they have found successful with the dairy bull, and we have obtained the necessary materials to try this at the College in the coming season.

SHEEP-BREEDING.

Mr. R. Waters.

Broadly speaking, the objects of the investigations is discovering and demonstrating profitable ways and means of effecting improvement in the quantity and quality of New Zealand mutton and wool. An example of this work is found in one of our major projects—namely, the production of a larger quantity and a better quality of mutton and wool per sheep primarily by breeding methods applied to the stud flocks of New Zealand Romney ram breeders.

Two separate lines of advance are being made:—

(*a*) The Department's field officers visit studmasters throughout the Dominion discussing their breeding problems, and advising and instructing them in the Department's methods of describing and recording the characters and performances of their sheep. This work brings in a considerable volume of practical experience and paves the way for wider co-operation with breeders in future, when specially bred rams may be sent out for trial from studs with which the Department is working more intimately at present:

(*b*) A more intimate study is made of three stud flocks. The Department itself keeps the records of these studs, participates in the mating arrangements, and has full access to the results of all matings. There are few places in the world where investigations can be made amongst such large numbers of stud sheep.

It will be seen that the basis of this work is accurate records. This requires trained assistance for describing and recording the characters and performances of sheep and for interpreting the results of matings. It is here that the grant of the Department of Scientific and Industrial Research has been particularly helpful.

During the past twelve months experiments have been commenced and records made in three studs for securing information which may be considered under the following heads:—

Progeny Testing and Mutton and Wool Standards.—The method of measuring and comparing the genetic influences of different sires by an examination of their progeny has been employed by the Department in connection with hairiness in wool for some years. The successful application of this method to improvement in other characters of sheep depends upon short and accurate methods of description, and upon the establishment of wool and body conformation standards against which to make these descriptions. Methods of description have been devised, and some progress has been made in establishing certain standards for Romneys. A number of sires which have been compared in respect to their progeny are at present being mated in the field for verification of their progeny tests and for further evidence of their capabilities in various important directions as indicated below. The establishment of body and of wool standards for Romneys is well recognized as of fundamental importance to the New Zealand mutton and wool industry. It is certainly essential to any systematic progress in our sheep breeding methods.

Matings for Improved Mutton and Wool Characters.—Some of the sires with progeny testing above the average for body and wool characters are being mated with selected groups—15 in each—of their own daughters or of half-sisters as a test of their capability of close breeding on a larger scale. The same sires are also being mated with selected members of superior daughter groups—not their own—and whenever the mothers or full sisters of such sires as still present in the studs close mating is being attempted to gain further knowledge of the location of useful gene associations in certain individuals with a view to effecting a concentration of them in their progeny.

The 1941 matings are at present in progress, and although several rams are reported as having failed completely, in general the tupping is said to be proceeding fairly well.

Matings for Heavier Wool-production per Sheep.—Selections of heavy-wool-producing ewes are being mated to certain sires, some with progeny testing high for both body and wool characters, others high for body characters only.

Matings for Constitution.—Aged ewes in good condition and with past records showing outstanding constitution have been selected for mating with certain good sires.

Poor Lambing amongst Two-tooth Ewes.—The 1941 records, it is hoped, will throw some light upon the causes of low lambing percentages amongst two-tooth ewes.

There is little or no knowledge concerning the genetic factors associated with the characters of sheep, and it is therefore impossible to establish breeding programmes on genetic lines as might be done in the case of certain other live-stock. In place of this, systematic breeding programmes are being established so that the useful genetic tendencies of individuals or groups of individuals may be detected and utilized to best advantage, and it is reasonable to expect considerable success in this direction. Whether or not our matings under this system will disclose fresh details of the genetic make-up of sheep is, however, not apparent. The recognition and description of the differences amongst the individuals of a breed is of first importance, and it is hoped that our descriptions and subsequent matings will eventually reach a stage where they will shed fresh light upon the genetic factors concerned with sheep-breeding.

MISCELLANEOUS INVESTIGATIONS.

CASEIN AND BENTONITE INVESTIGATIONS.

By W. R. Mummery.

The following investigations were carried out with the aid of laboratory facilities kindly made available by the Director of the Dairy Research Institute, Massey College, Palmerston North:—

Casein Adhesives.—Laboratory work on suitable adhesives was carried out for the Railways Advertising Department and for certain industrial firms.

The useful properties of casein mucilage were brought to the notice of the Government Printer, with the result that an order was placed for the first time with a local firm of adhesive-manufacturers for office paste made from casein.

Another local firm of adhesive-manufacturers was assisted to develop the production of casein adhesives, and several new types have been established successfully—*e.g.*, glue for cardboard-box manufacture and "stiffener" paste for making heels in the boot and shoe industry.

Since the commencement of the year part of the time has been spent in an endeavour to shorten the drying-time of casein adhesive without impairing the tensile strength. This has now been accomplished successfully, and steps will be taken to introduce the new formula to the users of casein adhesive, as the new property should enable casein adhesive to be used successfully as a substitute for certain lines of imported adhesives. The industrial use of liquid-casein adhesives has been impeded heretofore by the lack of suitable preservatives, and an endeavour to remove this limitation is being made in collaboration with Dr. T. R. Vernon, Industrial Microbiologist.

Casein Paint.—The writer was elected a member of the Wellington District Committee for Paint Investigation, and also to the Sub-Committee for Casein Paint.

In accordance with a resolution of the Casein Paint Sub-Committee an investigation on casein paint is being carried out. This investigation is divided into three sections, as follows:—

(1) Preparation of samples of oil-bound casein paint from formulæ supplied by members of the sub-committee. These samples were manufactured at a local paint-factory under the supervision of the foreman, and were then divided, one portion being sent to the Dominion Laboratory and the other used for weathering (durability) tests. Wood panels, concrete tiles, bricks, and pieces of Poilite have been coated with the paint samples and then placed on wooden trestles erected in one of the Massey College fields. Similar test pieces have also been placed in the milk-bottling room at the Massey College dairy factory.

(2) In collaboration with Dr. Vernon, oil-bound casein paint has been prepared with varying proportions of different preservatives in order to ascertain the most suitable for incorporation with this class of paint. The procedure adopted was similar to that mentioned above for weathering tests.

(3) Investigation of casein paint sold in powder form was considered essential, but as this class is represented in New Zealand by one proprietary line (as far as can be ascertained) it was decided to make use of this paint for experimental purposes. By courtesy of the Director of Housing Construction ceilings in two State houses will be coated with this paint, in comparison with a proprietary paint not containing casein. Other tests under observation with the proprietary paint include concrete cow-bails, the interior of a telephone-box, and road-marking stones on the Massey College property.

The writer gave evidence at a meeting of the Paints and Coatings Committee of the New Zealand Standards Institute in connection with white general-service traffic paint for use in connection with air-raid precautions, on kerbs, light standards, telegraph poles, pillar-boxes, railings, &c. As a result of information received from engineers of the Public Works Department the writer considered that a reliable make of casein paint would be suitable for this purpose, thereby conserving natural gums, benzine, and methylated spirit for road-surface work.

Bentonite.—Investigational work on the utilization of bentonite for various purposes has been carried out since July, 1940. In the majority of instances it has been found necessary to encourage the industrialist or the engineer to conduct investigations on his own behalf, and it is gratifying to record that co-operation has been extended to the Department in a considerable measure, despite the fact that the preliminary information that could be provided by the Department was somewhat meagre.

The following list shows the number and scope of the investigations being made by industrial firms, municipal authorities, and Government Departments: metal foundries, 24; concrete, 19; fireclay, 8; plaster, 15; soap, 6; clarifying-agent, 1; electrical uses, 4; polish, 3; sheep-dip, 1; lubricant, 1; absorbent, 1; emulsifying-agent, 1; miscellaneous, 4; municipal and departmental engineers (water impedance), 15.

Experiments have been made on the use of bentonite in putty and paint in collaboration with the foreman of a local paint-factory, and investigational work has also been carried out on the use of bentonite in casein adhesives.

INDUSTRIAL MICROBIOLOGICAL SURVEY.

By Dr. T. R. Vernon.

Many industries are known to have microbiological problems. In some—*e.g.*, the fermentation industries—micro-organisms play an essential and useful part; in others they are the agents of deterioration. To advance from this general realization that problems exist and wastage occurs to a more particular knowledge of New Zealand conditions a survey of the position was undertaken.

The following indicates the scope of the survey and the general conclusions reached. More than sixty varieties of perishable products are manufactured in New Zealand by more than eight hundred manufacturers. In the course of this survey factories have been visited, samples of defective produce collected and examined, and the following products have been considered: meat, bacon, eggs, wheat, wool, paint, starch, starch pastes, casein, casein adhesives, processed cheese, dried fruit, fruit juice, tomato products, essences, vinegar, canned goods, biscuits, confectionery, cakes, icing, coffee, paper, wallboard, cider, and fish.

The problems encountered may be classified into groups, as follows:—

(*a*) *Minor problems—i.e.*, problems of spoilage affecting individual factories rather than an industry as a whole.

(*b*) *Major problems—i.e.*, problems of spoilage that are of general concern to a whole industry.

(*c*) *Research problems—i.e.*, problems of major importance which would involve considerable and possibly long-term research.

The survey showed clearly that there are many minor problems of a biological nature confronting industry, in a number of industries major problems exist, and in some definite research is needed.

No data were available on which could be based useful estimates of actual losses, but statements such as "There is a 10 to 15 per cent. loss in egg storage," or "Thousands of pounds are lost in tomato storage" indicate the important nature of some of the problems.

Generally, it has been demonstrated that (1) the spoilage of perishable goods through the actions of micro-organisms is considerable; (2) this spoilage occurs over a wide range of products; (3) while the wastage for any one product may be relatively small, considered nationally, it involves considerable economic loss; (4) this economic loss would be minimized were biological advice available.

MINERAL RESOURCES COMMITTEE.

A Committee representing the Departments of Scientific and Industrial Research and Mines, and with the following personnel, was set up during the year to promote and co-ordinate more intensive surveys of the Dominion's mineral resources, particularly those of special strategic and industrial importance during wartime, with a view to their greater exploitation:—

Dr. E. Marsden, Department of Scientific and Industrial Research (Chairman); Mr. C. H. Benney, Acting Under-Secretary, Mines Department (Deputy Chairman); Mr. R. L. Andrew, Director, Dominion Laboratory; Mr. W. M. C. Denham, M.P.; Dr. J. Henderson, Director, Geological Survey; Mr. E. O. Macpherson, Geological Survey; Mr. F. J. Brogan, Assistant Secretary, Department of Scientific and Industrial Research (Secretary).

The Committee held six meetings during the year.

Owing to Dr. Marsden's occupation with special defence work, the chair was taken by Mr. C. H. Benney at four of the six meetings.

The Geological Survey has been responsible for the field survey work, comprising the mapping of the deposits and estimates of quantity available, and for the associated mineralogical and petrographical work. Chemical analyses and laboratory experiments on the concentration of certain mineral deposits have been undertaken by the Dominion Laboratory.

The Mines Department has collaborated in the field survey and prospecting work, and has advised the Committee on the mining and general developmental aspects of its work.

Much valuable work has been done by the Committee during the year in obtaining, assembling, and distributing information on the location, quality, and estimated quantities of a wide range of industrial minerals, including the following: Serpentine (for the manufacture of serpentine-superphosphate fertilizer), magnesite, sulphur, oil-shale, scheelite, manganese, mercury, copper, nickel-zircon, talc, quartz crystals (for radio use), boron (from thermal springs), and various industrial clays and sands. The results of these investigations are reported in more detail in the Geological Survey section of this report, and reports on the completed surveys are being written up for publication.

PHYSICAL TESTING LABORATORY.

Director: E. R. Cooper.

1. Present Facilities.

The Laboratory has handled a considerably increased volume of work this year, particularly in connection with the design, construction, alteration, and repair of instruments and with the testing of materials and instruments. The amount of instrument work has more than trebled compared with the previous year, necessitating increases in staff and accommodation, and involving the setting-up of a special design section to relieve the workshop staff of every responsibility other than that of purely mechanical work.

The staff is divided into three sections—viz., (*a*) Workshop, (*b*) Design, (*c*) Laboratory—and it appears that these main divisions will suffice for the future. Additional accommodation adjoining the existing premises has been acquired, and the space available will shortly be doubled.

The functions of the Laboratory are as follows:—

(*a*) To maintain standards of measurement that will be regarded as the ultimate source of reference for service laboratories and workshops in New Zealand:
(*b*) To undertake the physical testing of materials and the testing of instruments:
(*c*) To undertake physical research problems relating to manufacturing and to agricultural production:
(*d*) To provide a precision instrument workshop.

2. Research.

With the development of the war, pure research has had to give place to the more urgent requirements of instrument design and construction and the testing of materials.

3. Summary of Tests made during the Year ended 31st March, 1941.

Department of Industries and Commerce.

(*a*) *Cloth.*—Over seventy-five samples of cloths from New Zealand factories, for uniforms for the three fighting Services, have been subjected to test. The tests, which were carried out for the Factory Controller, involved the measurement of strength, weight, thread content, and shrinkage under standard conditions. A cloth-testing machine, 1,500 lb. capacity, for tensile-strength measurements is now located at the Laboratory, together with a temperature-humidity controlled chamber for air-conditioning of cloth samples.

(*b*) *Cardboard.*—A Mullen bursting-strength machine has been constructed for tests of bursting strength and tensile strength.

(*c*) *Rope.*—Tensile strength.

(*d*) *Catgut.*—Tensile strength, wearing properties, resilience, elasticity, and loss of tension have been determined. New-Zealand-made catgut for tennis-racquets has been shown to possess a tensile strength, wearing-qualities, resilience, and elasticity comparable with those of imported catgut. Acting in conjunction with the Bureau of Industry, visits were paid to the local factory and various proposals for improving the local manufacture of catgut put forward.

(*e*) *Electrical Insulators.*—Various imported electrical insulators were compared with those of local manufacture for compression strength. Taking both weight and strength into account, the imported porcelain insulators were found superior; the local insulators were at least equal in strength to the imported article.

(*f*) *Bricks.*—Compression strength.

Mines Department.

(*a*) *Steel Winding Cable.*—Tensile strength.

(*b*) *Theodolites.*—The overhaul and adjustment of theodolites is now a routine matter for the workshop. Final checking is made by the Laboratory.

Internal Marketing Division.

(*a*) *Thermometers.*—Calibration.

(*b*) *Silicate Cork.*—The thermal conductivity of this new substitute for cork was found to be 0·34.

Post and Telegraph Department.

(*a*) *Cloth.*—Strength, weight, thread content, and shrinkage under standard conditions.

(*b*) *Trench-mortar Scales.*—Calibration by metrology standards. During the year a 10 ft. standard bar and micrometer microscope comparator was lent to the Laboratory by the Surveyor-General. By means of this instrument flat scales up to 10 ft. can be measured correct to 0·001 in. Greater accuracy than this could be obtained if the standard bar could be recalibrated. Although this bar is made of invar, it is well known that this material alters length considerably over a period of years.

Public Works Department.

(*a*) *Barbed Wire.*—Tensile strength.

(*b*) *Cell concrete.*—Moisture and absorption and dimensional changes.

(*c*) *Sextants.*—Adjustment and calibration. Special equipment based on the National Physical Laboratory methods has been built for testing sextants. Two collimators representing distant objects are placed at various angles with respect to the sextant. The method involves the use of an accurate theodolite on loan from the Surveyor-General.

(*d*) *Lamps.*—Tests of illumination of black-out lamps.

Navy Department.

Calibration of ammeters, voltmeters, and pressure gauges.

Army Department.

Calibrations and miscellaneous determinations.

Air Depratment.

Universal Meter.—Calibration.

Miscellaneous.

(*a*) *Watt-hour Meters.*—For Department of Agriculture.

(*b*) *Performance of Amplifiers.*—For Geophysical Survey, New Zealand Geological Survey.

(*c*) *Piston-rings.*—Elasticity and tensile strength.

(*d*) *Felt.*—Compression.

(*e*) *Flax-waste Matting.*—Thermal insulation. Flax-waste matting prepared by a local firm was shown to have a thermal conductivity of 0·46.

(*f*) *Standard Templates for Hide Measurement.*—For Inspector of Weights and Measures. Standard templates for testing planimeters used for rapid measurement of surface areas of hides were made to exact dimensions.

(*g*) *Pyrometers.*

4. Summary of Instrument Construction and Repair Work.

Navy Department.

The work has involved design, construction, and repair—*e.g.*, pressure gauges, ammeters, magnetometers, telescopes, binoculars, lenses, and sextants.

Army Department.

The work has involved a considerable amount of design as well as construction. Certain prototype instruments which the Laboratory constructed are now being produced in quantity by private manufacturers. In addition to these instruments, the Laboratory has undertaken the repair of telescopes, binoculars, signalling-lamps, and range-finders.

Air Department.

A considerable amount of construction and repair of meteorological instruments has been done—viz., balloon-fillers, balloon-rollers, whirling thermometers, aneroids, anemometers, sunshine-recorders, theodolites, illuminated drawing-boards, spirit-levels, clocks, and electrical meters.

Agriculture Department.

A microscope with single objective and binocular eyepieces was adjusted and overhauled, ultra-violet measuring equipment constructed for observations of solar radiation, an experimental appliance for a milking-machine constructed, an evaporimeter for the meteorological station at Ruakura Experimental Farm constructed, also small items of repair.

Lands and Survey Department.

The design section of the Laboratory has been fully engaged for several months on the design of a stereoscopic projector, and the construction of this complicated optical instrument is now well under way in the Hutt workshops and our own workshop. The stereoscopic projector, once built, will no doubt be the subject of considerable but gradual improvement extending over some years.

Public Works.

Two aerial cameras were altered and two sextants repaired and calibrated.

Department of Scientific and Industrial Research.

Dominion Laboratory.—The major work undertaken has been the adjustment and complete overhaul of a Zeiss projection microscope, the construction of an atomizer for fuel injection purposes, and of a paint-testing machine. Numerous small items have also received attention.

Dominion Observatory.—The equipment of the Observatory has received repeated attention throughout the year—viz., clocks, seismographs, and time-signal equipment.

Plant Research Bureau.—A microscope with binocular objectives and eyepieces was adjusted and overhauled, four microscope eyepieces repaired, and several lenses recemented.

Grasslands Division.—A vapour-pressure thermometer for taking temperatures at various positions within ensilage stacks was constructed, its overall length being 8 ft. A torsion balance was repaired, and a temperature-controlled incubator is in course of design.

Geological Survey.—A complete overhaul of the electrical equipment installed on the geophysical truck, including the geophone amplifiers, was made. A machine for grinding rock specimens is in course of design.

The Maintenance of Primary Reference Standards.

The necessity of having certain metrology reference standards in New Zealand to meet special war and general industrial needs has become increasingly apparent. Active consultation with the Australian National Standards Laboratory is in progress with a view to obtaining as soon as possible, the necessary equipment for the establishment of a sub-standards laboratory in New Zealand.

DOMINION LABORATORY.

Director: R. L. Andrew.

The Dominion Laboratory is a service laboratory for Government Departments. As in previous years, there has been an increase in the volume of work and the number of samples dealt with. This has been due largely to conditions created by the war.

Government Departments.

The number of samples received from the various Departments were: Wellington (Main Laboratory), 8,100; Auckland, 6,258; Christchurch, 4,000; Dunedin, 2,153: total, 22,511.

Customs.

A large number and variety of samples were examined. Most of these were for the purpose of providing information to assist in the classification of imports. In other cases analyses were made to ascertain if the samples complied with the regulations under the Sale of Food and Drugs Act.

Police.

Auckland.—Almost all the exhibits received from the police consisted of samples submitted for examination in eight cases involving motor-car collisions. Examinations were made of paint scrapings, human and animal hairs, and glass fragments. It is interesting to note that one motor-car examined had on its chassis five pieces of human hair, one dog's hair, and one horse's hair, as well as several fibres resembling hair, but none of these had any connection with the collision in question. In another case involving glass fragments, a tire-lever had been used for breaking a window and the glass was in the form of a powder embedded in the iron of the lever. Careful examination, using the microscope, showed that the specific gravities and refractive indices were identical with that of the window glass. The accused then pleaded guilty.

Wellington.—A number of exhibits were examined in connection with cases of suspected poisoning. Strychnine, luminal, veronal, carbon monoxide, and a morphine derivative respectively were found in five of the cases. In one case a child obtained possession of a bottle containing a number of 5-grain quinine bisulphate tablets. Eight tablets were swallowed, with fatal results. This is one of the distressing cases which shows the necessity of keeping all drugs out of the reach of young children. A number of samples of blood and urine were examined for alcohol by the Widmarck method, in which only a very small sample is necessary. In two cases, one of alleged manslaughter and the other of alleged murder, the information so obtained was of great value in establishing whether or not the deceased was under the influence of alcohol at time of death. In several investigations connected with fatal motor accidents, a considerable amount of work was done in proving the identity of glass splinters from head-lamps and windscreens. The Hilger quartz spectrograph was found extremely useful for investigating the nature of certain paint marks and of various metals. Numerous exhibits were examined in several cases of unexplained fires. In one case it was shown that some charred sacking had been soaked with methylated spirit. Several pieces of metal thought to have been intentionally contaminated were examined. It was proved that the suspicions were unfounded. Much work was done in attempting to ascertain the cause of some explosions on tram routes in the city.

Christchurch.—The following substances were detected in exhibits submitted for toxicological examination: Strychnine, carbon monoxide, arsenic, and medinal. In connection with two anæsthetic deaths, specimens of ether and ethyl chloride were examined. In both cases the ether contained more than the permitted maximum amount of peroxides, but was otherwise satisfactory. Specimens of blood and urine from victims of fatal traffic accidents were examined for alcohol, and in nine cases alcohol was found to be present. The marketing of "Centennial Shandy" by a local brewery led to an investigation by the Police and Health Departments, the product being advertised as "real beer and lemonade" and sold on unlicensed premises. Some samples slightly exceeded the permitted maximum of 3 per cent. of proof spirit for non-dutiable drinks. Liquid from the petrol-tank of a motor-car was found to be a salt solution which had been added in an attempt to damage the car. Rheumatism "cures" prepared by an itinerant vendor were submitted by the police for examination. These proved to be a solution of Glauber's salts in water (for internal use) and a crudely prepared turpentine emulsion (for external use). The materials, worth a few pence, were sold to several householders at prices ranging from £2 to £7. The vendor was prosecuted, and claimed that his preparations were in the same class as other proprietary lines, but the Magistrate ruled that there had been a definite attempt to defraud. In connection with robbery from a safe which had been blown open, specimens of sawdust collected from the clothing, &c., of the accused were submitted for comparison with the sawdust contained in the lining of the safe. The materials were found to be identical and quite different from local sawdust.

Dunedin.—No poison was found in any of the samples submitted for examination. Traces of capsicum preparation were, however, found in chocolates sent anonymously through the post. The ultra-violet lamp and organic micro-reagents for lead, copper, and nickel were used in establishing the fact that damage to a coat had been caused by a bullet fired from a service rifle. A lachrymatory or tear-producing substance, which was submitted as the cause of a complaint, was probably the work of practical jokers.

Department of Health.

Milk.—The total number of milk samples submitted by the Department of Health and analysed at the four laboratories during the year was 11,846.

Auckland: The total number of milk samples examined was 4,768, of which 3,595 were from Auckland City and suburbs and 1,173 from the Waikato and other parts of the Auckland Province. The position regarding Auckland City milk-supply was fairly satisfactory until near the end of the year, when much trouble was experienced through the sale of stale milk as indicated by the reductase test.

Wellington: The number of samples taken in Wellington City and suburbs was 1,631, of which 7 were low in fat, 2 were stale, and only 1 contained added water. These figures show a further improvement, and Wellington City is to be congratulated on the high standard of its milk-supply. These figures are in marked contrast to those prevailing before the present system was in operation. Of 1,621 samples received from other parts of Wellington Province, Hawke's Bay, Gisborne, Taranaki, Nelson, and Marlborough, 17 were low in fat and 38 contained added water. This somewhat high proportion of adulterated samples cannot be regarded as satisfactory. Numerous samples from milk supplied to schools were examined, and of these only 6 were insufficiently pasteurized.

Christchurch: The total number of milk samples examined during the year was 2,083, of which 1,072 were from Christchurch City and suburbs, 126 from military camps, &c., and the remainder from the Provincial Districts of Canterbury and Westland. During the year there was a great falling off of the number of milk samples submitted from Christchurch City and suburbs, the total being 1,072, as against 2,028 for the previous year. Christchurch is fortunate in having a good milk-supply from farms near the city. Both raw and pasteurized milk are retailed, and five pasteurization plants operate in the metropolitan area. The amended reductase test was introduced during the year, and results indicate that the new and higher standards can easily be attained in this district. The number of samples not complying was small.

The number of milk samples examined from outside districts was 885, of which 493 were from Canterbury and 392 from the West Coast districts. The general quality of the supplies is satisfactory. Some unsatisfactory reductase tests were recorded, resulting largely from the production of milk in farms with inadequate supplies of water for cooling purposes. In most of the cases this position has now been remedied. The school milk-supplies have been examined before and after pasteurization. As in the previous two years, attention has been given to a more efficient control of the pasteurization of milk. A more sensitive form of the phosphatase test has been used, and when applied to eight of the pasteurization plants in the district it was shown that few were operating correctly. Inspections of all the plants were made by the Government Analyst, and it was found that most of the defects were due to the temperatures of pasteurization being too low. Some of the thermometers in use were inaccurate, and these were checked and standardized. For some time now the plants have been operating satisfactorily.

Dunedin: The total number of milk samples examined during the year was 1,743, of which 996 were from Dunedin City and suburbs and 747 from other parts of Otago and from Southland. The number of samples taken in Dunedin City and suburbs was smaller than in the previous year, and it is significant that the fall in numbers was accompanied by a rise in the proportion which failed to comply with the regulations. Of 969 samples to which the reductase test was applied, 27 were reported as stale. This is by no means satisfactory. Fourteen samples were deficient in fat, but only 3 were watered. In Invercargill, of 95 samples from the town supplies, 11 were found to be watered. It is evident that more samples should be taken in Invercargill. As in other recent years, special attention has been given to the testing of milk supplied to the schools, more especially for checking the efficiency of pasteurization. It was found that 3 out of 200 samples of school milk were not efficiently pasteurized. No preservatives were found in any of the samples. Many samples of milk taken at military camps throughout the Dominion were examined.

Water.—A total of 570 samples from existing and projected water-supplies were analysed at the main laboratory and branches. This work is regularly carried out from year to year as a guide to Medical Officers of Health in maintaining the purity of water-supplies. It was found that one supply was causing corrosion of copper piping in both cold- and hot-water systems. In this connection a considerable amount of work has been done, and it is anticipated that it will be possible to suggest means of effectively dealing with the problem.

Sewage.—A number of samples of sewage, particularly in connection with sewage disposal from military camps, were examined at each of the four laboratories.

Miscellaneous.—A very wide range of articles used as food and drink were examined of which the following are selected for special mention:—

Barley-sugar: A sample of barley-sugar labelled as being 100 per cent. "glucose filled" was found to contain not more than 18 per cent. of glucose. The labelling therefore was very misleading, particularly as it was stated that glucose is recommended by the medical profession to promote strength and vitality and increase resistance against fatigue. The barley-sugar would be in no way superior in nutritive value to ordinary boiled sweets.

Almond Substitute: A preparation sold under this name was found to be ground peanut flavoured with oil of bitter almonds. It was quite unlike almond in odour or flavour.

Wheat-germ Bread: The introduction of wheat-germ bread led to the examination of samples of wheat germ; 2 of these contained 34 per cent. and 42 per cent. of bran respectively, and another proved to be semolina, a product quite different from wheat-germ. The proportions of germ in the breads were found in a number of cases to be much below the 10-per cent. recommended by the Wheat Research Institute.

Sausages: A large number of sausages were examined for the preservative sulphur dioxide. In many instances the permitted maximum of 3½ grains to the pound was much exceeded, in several cases there being as much as six times this amount present. In view of the now widespread use of refrigerators, there should be no need to use this or any other chemical preservative. It has also to be taken into account that, apart from the possible harmful action of the preservative itself, the addition of excessive amounts of this preservative encourages the use of stale meat in sausages.

Brawn and Luncheon Sausage: A number of samples of these preparations were found to be artificially coloured with red dyes, in contravention of the regulations under the Sale of Food and Drugs Act.

Iodized Salt: In November, 1939, a regulation increasing the proportion of iodide required in iodized salt to not less than 0·75 nor more than 1·5 parts of iodide in 20,000 parts of salt was brought into force. During the year 64 samples representing all the brands of iodized salt on the market were examined for iodide content. In some cases several samples of the same brand were examined. It was found that some of the brands were being sold at the new iodide content, but that salt at the old iodide content was still on the market. It is intended to examine a further representative set of samples during this year, when only the new strength should be for sale. It was again found, confirming past work, that the salt sold in bags kept its iodide content rather better than that sold in the more expensive tins or cartons. The price was at the rate of 8d. per pound in tins, 6d. in cartons, and 3d. in bags.

Cornflour: It is generally accepted that cornflour is maize starch, but the sale of any wholesome cereal starch as cornflour is now permitted, provided the name of the starch is declared on the label. It was found that finely-ground rice and white maize were being sold as cornflour, the manufacturers apparently being unaware that cornflour was simply starch. These products, although quite wholesome, were quite different in properties from starch prepared from rice and maize respectively and were not suitable for use as cornflour.

Spray Residue on Cabbages: Cabbages and other related vegetables are sometimes sprayed with arsenate of lead, although this is not allowed by law. A number of cabbages, including brussels sprouts, were examined for arsenic. In the case of the cabbages the amounts of arsenic found varied from 1/6000 to 1/40 grain to the pound; the latter amount of arsenic must be regarded as excessive. The greater quantities of arsenic were found in the more open types, the compact types when stripped of their outer leaves containing only minute amounts. With the brussels sprouts the majority of the samples did not contain arsenic and had probably not been treated with arsenical spray at any period of their growth. However, one sample contained $\frac{1}{4}$ grain to the pound, a quantity which would possibly be dangerous to the consumer. It is obvious that in view of the possible danger to consumers that cabbages or any other vegetable should not be treated with arsenical sprays.

Cocoa: A well-known firm placed a so-called iodized cocoa on the market. A sample was examined and found to contain iodides, calculated as potassium iodide, 0·5 parts in 150,000. This is only one-fifteenth the proportion of iodide required in iodized salt and it would have little, if any, effect in the treatment of goitre. The product was withdrawn from the market.

Drugs: Samples of various drugs were examined to ascertain if they complied with the standard of the British Pharmacopœia. Numerous samples of tablets of arecoline hydrobromide were analysed to ascertain if they complied with the standard to which they were purchased. These tablets are administered to dogs in connection with the campaign against hydatids.

Mines Department.

During the year the Laboratory again carried out a considerable amount of analytical and investigational work connected with the mining industry. Prospectors' samples examined for gold and silver were again few in number and disclosed no discoveries of important deposits. The increased demand for tungsten as a result of the war caused a notable rise in the number of determinations made of this metal in samples of ores and concentrates. A considerable number of analyses of serpentines were made in connection with the proposal to incorporate a proportion of this mineral in superphosphate fertilizers. A survey of the sulphur deposits of the Dominion by the Geological Survey necessitated numerous analyses of samples of sulphur-ore from the thermal regions, and a process was also developed for the separation of sulphur from the associated pumice. The investigation of a recently-discovered talc-magnesite ore in the Cobb River area required a number of analyses to be made, and laboratory experiments on the separation of the constituent minerals by flotation and other means were carried out. The systematic survey of the Onekaka iron-ore deposit was again responsible for a large number of determinations of iron being made. Other laboratory work included the examination of samples of mine airs and gases, mine dusting-materials, clays, limestones, antimony-ores, tinstone, nickel-ore, the estimation of zircon in beach sands, and tests on locally-produced soda-lime for use in mine rescue apparatus.

Government Stores.

The number of samples submitted by Government Departments to check up on materials purchased or used by them again showed an increase. Due largely to the activities of the New Zealand Standards Institute, a great proportion of this work is done to ascertain if the materials submitted comply with specifications under which they are purchased. A very large number of miscellaneous samples were examined for the armed Services. Samples submitted by the Public Works, Post and Telegraph, Industries and Commerce, and Railways Departments, the Stores Control Board, and a number of other Departments included cements, concrete, soldering-flux, cloth, floor-oils, creosote and other timber-treating liquids, various alloys, shellac, galvanized iron, building-boards, boiler preservatives, steel conduit, reclaimed oil, cotton-wool, duplicating-fluid, polishing compounds, lacquers, distempers, typewriter ribbons, soap, carbon tetrachloride, lanoline, &c. Many samples of tars and other roading-materials were examined for the Main Highways Board.

Gas Inspection.

The gas-supplies of the four main centres and of most of the other principal towns of the Dominion were regularly examined for calorific value, freedom from sulphuretted hydrogen, and for pressure. In three cases the average calorific value for the year was slightly below the declared value. The systematic testing of the accuracy of all gas-meters passed for service was carried out as in previous years.

Research and other Activities.

Gas Storage of Apples.

The work in the small experimental store has been continued, and two varieties are now being tried out in an experimental commercial store. For fuller details, see the section "Fruit Cold Storage Committee."

Timber Preservation Research.

Some chemical work has been carried out for the Timber Protection Research Committee

In connection with experiments on wood-preservation, many samples of rimu and kahikatea were tested for copper to ascertain the degree of penetration of copper naphthenates dissolved in petroleum oil.

Coal Survey.

The work of the Physical and Chemical Survey of the coal resources of the Dominion has been somewhat restricted during the year owing to the necessity of concentrating on urgent fuel problems connected with the national emergency. The main problem was the investigation of producer fuels. A large number of charcoals, cokes, chars, and anthracites was examined, and the estimation of reactivity and tar-content involved much laboratory work. The Coal Survey Committee continued to advise the Iron and Steel Department concerning the reserves and suitability of coals for manufacturing metallurgical coke. The necessity for conserving the rapidly-diminishing supplies of high-class bituminous coals was emphasized and special reports on the matter forwarded to the Departments concerned. A preliminary survey was made of the possibilities of obtaining a local supply of wax from native peats and lignites. Chatham Island peat is rich in wax, and further investigations are proceeding. A number of Otago oil-shales was examined in collaboration with the Geological Survey. As the result of an extensive sampling programme of all working mines in New Zealand, about one hundred and seventy samples representing seam, run-of-mine, and slack coal from the various areas were obtained for analysis. These samples have already proved of value in connection with the utilization of coal for special purposes.

Paint Investigations.

A feature of the work carried out on paints and allied materials was the marked increase in the number of samples (mostly mixed paints) submitted for analysis by Government Departments. The Department of Housing Construction and the State Advances Corporation in particular are keeping a regular check on paint used by them. Red-lead paint for steelwork made up to a standard formula has continued to give trouble. Analyses of various samples were made, as well as brushing-out tests upon glazed paper and sand-blasted steel. The information obtained was sent to the Director of the Paint Research Station, Teddington, England, who made recommendations which should meet the position. The question of a revised specification for red-lead paint is now under consideration by the New Zealand Standards Institute, this Laboratory being represented on the Committee concerned. In connection with the painting of steel, a number of proprietary cover-coat paints were examined in collaboration with the Hydro-electric Branch of the Public Works Department, which has under way practical trials of the various paints on pipe-lines. Assistance was also given in the drawing-up of a specification for a coal-tar underwater paint for steelwork; the paint is already under test. Officers of the Laboratory again assisted in tests carried out during the year by the Inter-departmental Committee for Paint Investigation. The main object of the present work is to ascertain by practical painting trials on houses the best type of paint for use on exterior woodwork. Useful information has already been obtained.

Corrosion Problems.

Many corrosion problems were investigated during the year. Included among them were corrosion of lead cable sheathings, galvanized tower steel, corrugated galvanized iron, and an aluminium bushing-screw. Perhaps the most interesting case was that of 4-gallon tinplate containers used for the transport and storage of vegetable turpentine. The corrosion was so severe that the tins were perforated with numerous tiny holes, and a very considerable amount of yellow corrosion product was found in the tins. Corrosion was proved to be due to the presence of free water. Turpentine stored in the presence of free water tends to decompose with the formation of formic and other organic acids. Formic acid was present in the turpentine and was the cause of the corrosion of the containers. In an investigation carried out for the Post and Telegraph Department into the formation of an excessive amount of solid deposit on the bottom of nickel-iron Edison cells, the cause of the trouble was found to be due to attack by chloride on the iron plates resulting in deposition of hydrated iron oxide. The potassium hydroxide used as electrolyte in the cells was found to contain an excessive amount of chloride. Following on recommendations made by the Laboratory to the Public Works Department as a result of the investigation of a particularly severe case of corrosion of cast iron cylinder jackets of Diesel engines by the circulating cooling-water, the Laboratory prepared a large quantity of sodium dichromate-caustic soda solution for use as a corrosion inhibitor.

Substitute Materials.

Electrolyte.—An analysis was made for the Railways Department of electrolyte taken from a D.C. 1,500 volt lightning-arrester on one of the Wellington electrification substations. This fluid, formerly imported, was urgently required. As a result of the analysis it became possible to duplicate the fluid and to supply the quantity required.

Ceramics.—Owing to war conditions, the necessity has arisen of finding local substitutes for imported materials required for the ceramic industry. The possibility of the use of pottery materials of local origin in place of imported china-clay, flint, feldspar, and Cornish stone was investigated for the

Department of Industries and Commerce. In this connection a large number of feldspathic clays from the Nelson District, collected by the Geological Survey in the course of a systematic survey of the clay resources of the area, were examined for value as pottery fluxes. The results of both investigations are published in the *New Zealand Journal of Science and Technology, 22*, p. 230B.

Stone-preservation.

In connection with cleaning operations being carried out by the Public Works Department on a large public building in Wellington, several analyses were made of proprietary stone-preservative materials. These were classified as (*a*) surface-hardeners, and (*b*) surface-waterproofers, respectively. In view of the results of numerous tests carried out by the Building Research Board, Great Britain, it was considered doubtful whether any of the treatments would have any permanent beneficial effect, and, indeed, might in some cases accelerate any natural tendency of the stone to decay by flaking.

Chemical Engineering.

The staff of the Chemical Engineering Section has been largely occupied during the year on an investigation of the application of producer-gas as an emergency fuel for motor-vehicles. This work has been carried out on behalf of the technical committee appointed by the Oil Fuel Controller. The committee consists of representatives of the Transport Department and the Public Works Department and the Chemical Engineer. Preliminary investigations revealed the desirability of designing an emergency plant suitable for New Zealand conditions which would combine the advantages of simplicity and cheapness with reliability and reasonably good performance. Particular attention has been paid to the gas-cleaning equipment, which requires to be especially efficient when charcoals from certain New Zealand timbers are employed as fuel. During the whole investigation close contact has been maintained, as far as possible, with developments here and overseas. The staff has collaborated in the production of a brochure on producer-gas in which is given some general information on the use of producer-gas and designs for emergency equipment. Since the publication of this brochure much further work has been done, with the result that the original designs, especially those relating to the gas-cleaning equipment, have had to be considerably modified. Some thousands of miles of road test work have been run, in addition to laboratory tests. As well as the work outlined above, a number of commercial plants have been tested for the Factory Controller for the purposes of granting manufacturing licenses. The test employed comprises a filter test and a road test of approximately ninety-five miles. The filter test is an adaptation of that developed by Beresinsky at the University of Melbourne. Particular importance is attached to the necessity for ensuring efficient dust removal from the gas, and although a number of plants have fulfilled the requirements without difficulty others have done so only after certain alterations had been made in the gas-cleaning equipment. An important branch of the work of the section is the testing of the knock rating of aviation fuels. During the year many samples have been examined.

The development of an experimental dryer for Chewing's fescue seed was mentioned in the Seventy-second annual report of this Laboratory. This plant was used to provide material for trial shipments of dried seed, in commercial containers, to Great Britain and United States of America. The trials warranted consideration of the erection of a larger plant for operation under commercial conditions. It is hoped to have such a plant in operation for next season. One of the staff has designed a moisture-tester for Chewing's fescue seed. The method employed takes advantage of the well-known fact that the di-electric constant of a mass of seed varies with the moisture content of the seed. A series of tests have shown the method to be rapid, reliable, and sufficiently accurate for the purpose of controlling drying operations. Designs have been worked out for drying equipment for medicinal plants, grass samples, and grass for stock-feeding experiments being made by the Department of Agriculture. The last was designed in collaboration with the Public Works Department. Throughout the year the staff has acted in a consultative capacity in relation to various chemical-engineering problems.

Spray Materials.

Analyses of spray materials from the Plant Research Bureau covered most of the common insecticides and fungicides. A series of Pyrethrum flowers gave pyrethrins 1 and 2 varying from 0·8 per cent. to 2·4 per cent. when determined by the method of Gnadinger and Corl. Oranges and lemons were tested for the effect of arsenate sprays on the citric-acid content. With a view to obtaining more consistent results, considerable work was carried out on an investigation into the determination of rotenone in diluted derris dusts. This is still proceeding.

Locally-grown Medicinal Plants.

Further analyses have been carried out for the Botany Division of various samples of the following medicinal plants: *Belladonna, Hyoscyamus, Stramonium, Digitalis.* The results showed that these drugs can be grown in New Zealand of a quality complying with the standards laid down in the British Pharmacopœia. Samples of lavender flowers from Nelson and from Taranaki were found to give yields of oil comparing favourably with those obtained in Europe. The properties of the oils were comparable with those of a high-grade French oil and were in agreement with the constants specified in the British Pharmacopœia for foreign lavender-oil.

Ergot from Grasses.—As ergot of rye is not now available from European countries, increasing attention has been paid to the value of certain grass ergots from Empire countries. Ergots collected last summer in various parts of New Zealand from tall fescue and from marram grass were examined for their active constituents. Ergot analyses have also been carried out for the Plant Diseases Division in connection with experiments on the commercial production of ergot on rye.

Spectrographic Analyses.

During the year the large quartz spectrograph was in regular use for the examination of general laboratory samples. The majority of these were components of ammunition for the Defence Department, but miscellaneous samples included metals (among them shell splinters), paint, potassium hydroxide for Edison batteries, corrosion product, and ores. Several minor investigations were undertaken. The examination of water and milk from an area where cows were affected by a wasting disease did not indicate either a poisonous element or give definite evidence of a deficiency disease, although it is suggested that manganese might be deficient. The examination of milk does not seem to be a satisfactory method of investigating deficiencies in minor elements. In view of the suggested use of seaweed as a potash fertilizer, the ash of *Macrocystis pyrifera* was examined spectrographically. In comparison with land plants, the high content of arsenic was noteworthy. The estimation of eighteen trace elements did not indicate that the material would be of value in agriculture as a source of minor elements. A large number of samples were examined in connection with an investigation on metallic impurities present in the water from electric hot-water installations. Thirty samples of schist from the neighbourhood of scheelite lodes were examined for the Geological Survey. In this case, spectrographic methods alone were not sufficiently sensitive for the estimation of tungsten, but a combination of chemical concentration and spectrographic analysis showed that the tungsten content of the schist was usually about 0·00015 per cent. Spectrographic analysis was also applied for the first time in forensic work. Scrapings of paint from the bumper of a car, giving on ignition about one-tenth of a milligram of ash, were examined in connection with the alleged collision of the car with a bicycle.

During the year a Hilger non-recording photo-electric micro-photometer was obtained. The apparatus is being used instead of the logarithmic sector in the evaluation of spectrograms for the quantitative analysis of certain alloys. It is hoped to use it in the examination of samples of biological material. Greater accuracy should be obtained and less time need be spent in the preparation of standard samples. A method has been worked out for the determination of boron in plant ash, as this element is not included in the general spectrographical examination. A Spekker photometer has been provided by the Chemical Section of the Department of Agriculture. This instrument has been used by the staff of that laboratory in conjunction with the large quartz spectrograph for measurement of absorption as a means of determining vitamin A in oils and fats. The apparatus has also been used to examine the absorption spectra of two new compounds prepared by the Organic Section of the Dominion Laboratory.

Tinning of Copper Hot-water Cylinders.

A large number of samples of waters from electric hot-water systems in three districts where the water was soft and would be expected to be aggressive were examined for the Department of Health. The amounts of copper were never seriously high, and after a year's service harmless. Undesirable amounts of lead were present in water from tinned cylinders recently installed, but after a year the lead was down to a safe limit. It was concluded that the extra cost of tinning was justified only where the water is decidedly aggressive or in systems where a large surface of hot water was exposed to the air. If tinning is necessary, the tin used should be free from lead and the tin coating should be complete over the whole inner surface of the finished article. Attention should be drawn to the risk of using the hot water from a new cylinder for culinary purposes until some months after its installation.

Thermal Regions.

A member of the staff, in co-operation with an officer of the Geological Survey, collected various samples from the active areas of the Tokaanu district. The method previously devised for the collection of samples of condensed steam and gas from fumaroles was applied for the collection of samples from the steam vents of the Waihi fault scarp and the Tokaanu acid area. Samples of the condensed steam were examined at Wellington for boric acid and ammonia. Although boron is high in the alkaline waters of Tokaanu, the steam was not particularly high in boric acid. Advantage was taken of the opportunity to make a thorough collection of the gases from hot springs in the vicinity of Tokaanu. The low content of hydrogen sulphide is a marked characteristic of the whole area. A large number of samples from the Tokaanu alkaline area were examined in Wellington for boric acid and ammonia. Complete analyses were made of samples of water from the most active springs of the Waihi and Tokaanu acid areas.

Photoelectric Colorimeter.

A Hilger photoelectric absorptiometer was obtained during the year. It will be used where colorimetric analyses of greater accuracy than that obtained with the usual visual methods are required. At present it meets a definite need in the more accurate colorimetric determination of titanium in rock analyses.

LIBRARY.

The library has been kept up to date by additions of the latest text-books, particularly those dealing with chemistry in relation to industry, and also a wide range of technical journals. The system of indexing useful articles as read by members of the staff in periodicals and journals is proving of great value, in view of the wide range of inquiries received on matters connected with applied chemistry.

ADVISORY AND CONSULTING WORK.

The Director and other senior members of the staff have been consulted frequently on scientific and industrial matters. They have also represented the Laboratory on various inter-Department committees, including those in connection with the New Zealand Standards Institute.

RETIREMENT OF DIRECTOR.

Mr. W. Donovan, M.Sc., F.I.C., retired from the positions of Dominion Analyst, Director of the Dominion Laboratory, and Chief Gas Examiner at the end of March, 1941, after occupying these positions for eleven years and a total service on the staff of the Laboratory of thirty-six years. This report deals with the work of the Laboratory during the last year of his service as Director.

GEOLOGICAL SURVEY (35th ANNUAL REPORT).

REPORT OF DIRECTOR (Dr. J. Henderson).

During the year ended 31st March, 1941, official visits were made to Whangarei, Kaka, Kakahu, and Benhar to see deposits of clay occurring in those districts; to Wakamarina, Macraes, and Glenorchy to examine scheelite-bearing lodes; to Reefton to report on the Golden Treasure - Perseverance Claim; and to Onekaka to estimate the amount of iron ore. Gisborne was also visited, where the structure maps and the cores of the oil-well being drilled on the Opoutama structure in north-eastern Hawke's Bay were examined and discussed with the geologists of the New Zealand Petroleum Co.

Mr. M. Ongley and Mr. E. O. Macpherson also visited Gisborne and, with geologists of the New Zealand Petroleum Co., examined critical sections in the Waiapu, Waitangi, and Hawke's Bay districts. Mr. Ongley, in collaboration with Dr. Finlay, will prepare an account of Upper Cretaceous and Lower Tertiary strata exposed along Te Uri and Tangaruhe streams near Wanstead, Hawke's Bay. Mr. Ongley later was two months in the Wairoa district, and is now preparing an account of the geology of that area.

Dr. J. Marwick identified fossils in many collections made by field officers, chiefly in the Dannevirke Subdivision. He visited the Woodville area while mapping was in progress and examined several important sections. He also visited the Manawatu and Taranaki districts and discussed the sequence of the Tertiary strata in their respective areas with geologists of the Superior and New Zealand Petroleum companies.

Dr. H. J. Finlay continued his work on the foraminifera of New Zealand and determined the microfaunas in many samples collected by field officers and forwarded by oil companies.

Mr. E. O. Macpherson devoted a good deal of time to examining the several small masses of serpentine outcropping in the Kaukapakapa-Wade district, north of Auckland. He spent some weeks on D'Urville Island and mapped the serpentines outcropping there extensively. With Mr. R. F. Landreth, he explored the north end of Great Barrier Island, where widespread stainings suggest the possible presence of a commercial copper deposit. He also examined the copper deposits of Kawau Island. Later he visited the Chatham Islands to examine the extensive peat moors, which contain a montan wax. At the beginning of the year Mr. B. L. Taylor, under Mr. Macpherson's direction, carried out prospecting in the Kaka and Baton areas of Nelson in order to get some idea of the amount of feldspathic clays available.

Dr. C. O. Hutton continued the petrological examination of the rocks of New Zealand. He examined beds of greensand in South Canterbury and North Otago, and spent three months in the Takaka district, where he sampled lenses of talc-magnesite rock and collected extensively from the large exposures of basic and ultrabasic rocks of the Upper Takaka, Cobb, and Rameka basins. He spent a few days on the basic masses of Riwaka, and Dun Mountain. He also made brief reports on the rock crystal found near Pupu Springs and in the Cobb valley.

Mr. J. Healy studied the hot springs at Tokaanu, which contain boron in notable amount. He mapped the area in detail, took many samples, and estimated the discharge. He also visited the Waihi Springs. Later he examined the Ohakuri area, a few miles up the Waikato from Atiamuri, where the Public Works Department is exploring a dam-site by means of drilling.

Dr. A. R. Lillie and Mr. C. A. Fleming continued the mapping of the Dannevirke Subdivision, which they expect to finish this season. During the winter Dr. Lillie worked on the manuscript of the Dannevirke Subdivision and prepared an account on the uses and properties of bentonite.

Mr. H. W. Wellman mapped the Cobb magnestic deposits and made a magnetic survey of the pyrrhotite lenses recently found in the area. He also examined a number of other mineral deposits of possible economic value in this and other parts of the Nelson district. These included talc at Takaka, Glengyle, and Taipo, dolomite at Collingwood, rock crystal at Canaan, magnesite in the Maruia, and kaolinite feldspar and beryl at Charleston.

Mr. R. W. Willett continued the mapping of the Orepuki district, but much of his time was taken up in examining sundry deposits of possible economic value in different parts of Otago. These were oil-shale at Dunedin, Cambrians, Idaburn, and Nevis, sands at Green Island, iron-ore in the Catlins district, fuller's earth at Alexandra and Clinton, scheelite at Blackstone Hill and Glenorchy, fireclay at Mako, and rock crystal at Potter Creek and other localities.

Mr. H. E. Fyfe, assisted by Messrs. R. J. Bagge, M. Gage, and W. E. Hall, continued the detailed mapping in the Greymouth Coalfield, though Mr. Fyfe for much of the year was engaged in other work. Messrs. N. Pratt and A. M. Quennell also assisted for part of the time, till the former resigned and the latter joined the military forces. Mr. Pratt made a preliminary survey of the area about the Tatu Mine, near Ohura, and Mr. Gage made a similar survey of the Mangapehi Mine.

Mr. N. Modriniak continued the geophysical examination of the Ohakuri dam-site, using magnetic, seismic, and electrical methods. Later he began work at Whakamaru, a dam-site some twelve miles down the Waikato from Atiamuri. Mr. P. T. Evans assisted for several months, Mr. F. A. McNeill being engaged on other work.

Mr. A. W. Hampton prepared photolitho drawings for 6 maps, 6 plans, and sections to accompany the Reefton Bulletin as well as making many miscellaneous drawings.

Mr. D. H. K. Ross attended to the different sections of the office work, as well as giving general supervision to the library.

During the year Mr. C. A. Fleming joined the staff as Assistant Geologist, and Mr. P. T. Evans (since resigned) as Assistant Geophysicist. Mr. A. M. Quennell, after two years' work with the Shell Co., rejoined the staff, but shortly went into camp and is now overseas. The Army authorities granted leave of absence to Mr. D. A. Brown from duty in order that he might complete the manuscript of the bulletin on the Moeraki Subdivision, which he had mapped two years ago.

Last year the thirty-fourth annual report of the Geological Survey was published. Members of the staff contributed the papers on geological subjects listed below, all being published in the *New Zealand Journal of Science and Technology* but the last, which appeared in the "Transactions of the Royal Society of New Zealand": "The Geology of the Iron-ores of the Collingwood District" (M. Gage); "What do 'Traces of Oil' indicate?" (M. Ongley); "Air Photography and Geology" (R. W. Willett); "Note on Coastal Benches formed by Spray-weathering" (M. Ongley); "Geophysical Surveying in Top Valley, Marlborough" (F. A. McNeill); "Geological and Geophysical Surveys, Cobb Valley, Nelson" (H. W. Wellman); "The Oil-shale Deposit of Orepuki, Southland" (R. W. Willett and H. W. Wellman); and "Trias-Jura?" (M. Ongley).

DANNEVIRKE SUBDIVISION.

By A. R. Lillie and C. A. Fleming.

Between November, 1940, and the middle of March, 1941, the writers have mapped approximately 230 square miles of country, chiefly in Woodville, Tahoraiti, and Norsewood survey districts. They were assisted from November to February by Mr. M. Te Punga, of Victoria College. Dr. Marwick paid a visit during the month of February and examined critical Pliocene localities. The stratigraphical details given below owe much to his determinations and discussions with him in the field.

Structure.

The greywacke forming the Waewaepa Range is covered by Tertiary beds, ranging in age from Opoitian to Nukumaruan and striking N. 40° E. with a general westward dip. West of these dip-slopes and east of the Manawatu River an anticlinal rise can be followed from Trig. Waitapu, in Te Aute beds, through Mount Smith, in Opoiti beds, to Trig. B in the vicinity of the Otope Road, where only Petane beds are visible. South of Kumeroa, near Mount Smith, a small greywacke inlier represents the core of this fold, which is probably complex. This structure is the continuation of the fault along the Tiraumea River mapped in the Eketahuna Subdivision. West of the Manawatu River a fault-line scarp bounds the eastern edge of the abruptly rising Morgan's Hill, which is formed of greywackes and termed the "Kumeroa High." This in turn is covered to the west by Tertiary beds of the series already cited. The greywacke mass is the faulted core of an anticline and marks the maximum axial swelling along the axis of the structure. The same anticlinal axis is probably prolonged north-north-east through the Dannevirke Anticline in Petane limestones to the west of the brick-works, and through Mangatarata beds on the Norsewood Road at the crossing of the Mangatewainui and Mangatewai-iti streams.

East of Range Road, near Woodville, a small elongated dome visible in the Te Aute limestones shows good closure to the north and south.

Another anticlinal axis also striking approximately north-north-east or north-east probably runs through the country west of the Dannevirke–Woodville railway, but much of this locality is obscured by flats. To the west there is a clear syncline of Petane beds, its western limb faulted against the greywackes of the Ruahine Range. This syncline is the continuation of the Pahiatua Syncline of Eketahuna Subdivision.

In the vicinity of the Manawatu Gorge there is a marked axial depression of the axis assumed to run along the Ruahine greywacke "high." This axial depression coincides approximately with a local north-west strike in the Hokonui formation. A broad arch of Tertiary beds, described by Ongley, can be followed across this sag from east to west across the range. South of Whariti Mountain a clear erosion plane on the greywacke strikes approximately east and dips south at about 15° towards the point of maximum axial depression of the greywacke surface situated just north of Saddle Road. The structure at the point of maximum axial depression is not sufficiently established for discussion; there are probably cross-faults, but it is likely that they are not of great throw. On the other hand, it is clear that in the country south of Saddle Road the axial descent northwards would appear to be very gradual and unaffected by faults. Saddle Road skirts approximately the south edge of the Tertiary arch. The beds of the arch are mostly of the Te Aute Series; along their eastern edge the limestones of this series are probably folded into a pitching syncline and thrust over the Petane beds of the Pahiatua Syncline.

The greywacke-Tertiary contact along the foot of the Ruahine Range north from Woodville is difficult to follow; there is probably a single reverse fault along the western edge of the Pahiatua Syncline. North of Manga-atua Stream the contact is extremely sinuous and has not yet been completely examined. There is believed to be echelon faulting with at least one fault running some distance into the highlands. At one or two points there is also appearance of stratigraphic contact between the Mangatarata and Petane beds and the greywacke.

Stratigraphy.

The following notes are additional to what has been written on the stratigraphy in preceding years:—

Opoiti Series.

The basal Tertiary beds on the west flank of the Waewaepa Range are of Opoitian age. Molluscan collections have not given very decisive results, but foraminiferal samples have confirmed this correlation. The base of the Opoiti Series on the Waewaepas and at the Kumeroa High consists of very coarse pebble beds, rarely fossiliferous, usually poorly consolidated, and interstratified with sandstones. These pass on ascending the succession into blue-grey muddy sandstones with occasional limestone concretions.

Te Aute Series.

The beds of this series consist largely of argillaceous micaceous sandstones. Towards the base of the series calcareous layers are present, and usually there is a marked limestone band made up of shelly detrital matter, often conglomeratic. This limestone has been usually accepted as a basal marker, but it would appear to be about 300 ft. to 400 ft. above the base of the Waitotaran as defined palæontologically. The limestone band, although discontinuous in places, is probably of fairly constant horizon and is a valuable indicator. The age of this band has been checked at all localities by the presence of the characteristic Waitotaran faunule—namely, dominant *Phialopecten triphooki*, *Mesopeplon crawfordi*, *Cardium spatuosum*, and *Ostrea ingens*. Overlying the limestone marker are some 400 ft., in the Mangakokako Road section, and some 900 ft. to 1,000 ft. in the Totara Road section, of argillaceous micaceous sandstones enclosing a sandy incipient limestone band. In Tahoraiti Survey District the highest Waitotaran fauna has an ancient appearance, and, indeed, in Takapau Survey District has been confounded with the Opoitian. The beds containing this fauna are occasionally pumiceous. They are overlain by the basal Nukumaruan limestone.

The thickness of the Waitotaran Series ranges from 800 ft. to 1,300 ft., it does not attain a thickness of 2,500 ft. in Tahoraiti and Mangatoro survey districts (correction to last year's report).

The Te Aute Series as represented at the Manawatu Gorge deserves special mention. The base of the series is marked by thick pebbly sandstones and conglomerates, often with calcareous concretions yielding good Waitotaran fossils. On Whariti Road resting on the greywacke erosion plane there is a thick boulder bed, the boulders, rounded and sub-angular, attaining diameters of 2 ft. and 3 ft. The middle part of the Te Aute Series is represented by muddy sandstones and overlain by one or more limestone bands. The pebbly and bouldery nature of a large part of the beds representing the Waitotaran, Nukumaruan, and Castlecliffian stages on Whariti and Saddle roads indicates marked emergence during these periods of part of the Ruahines north of the Gorge.

Petane Series (Sensu lato).

The Petane Series is here used provisionally to cover all beds of Nukumaruan age. Detailed work in Tahoraiti Survey District, in co-operation with Dr. Marwick and Dr. Finlay, has resulted in greater precision in the field identification and subdivision of beds of this stage. It is now possible to separate a lower Nukumaruan horizon from the upper horizon, which corresponds faunally to Petane (*sensu stricto*).

In the Totara Road section the highest Waitotaran beds are overlain with slight angular unconformity by a sandy detrital limestone characterized by abundant *Panopea zelandica*, *Anomia undata*, *Chlamys delicatula*, *Pelicaria acuminata*, and other Nukumaruan fossils. This limestone band has been found in other parts of the subdivision. Accompanying this lower Nukumaruan faunule at the Totara Road and other localities are occasional specimens of *Pecten triphooki*.

In the Totara Road section, some 300 ft. higher, occurs a fauna more akin to the typical Petane: *Pelicaria convexa* has replaced *P. acuminata*, but *Chlamys delicatula* persists. In the upper Nukumaruan beds of true Petane age *Chlamys delicatula* is not found. The evidence of foraminifera has substantiated this molluscan zoning.

The thickness of the Petane Series (*sensu lato*) would appear to be approximately 1,500 ft. to 1,600 ft.

OREPUKI SUBDIVISION.

By R. W. Willett.

As numerous mineral surveys occupied the early part of the 1940–41 field season, geological mapping was not commenced at Clifden until 5th February, 1941. Up to the 31st March, 1941, about 50 square miles of the Lillburn, Alton, and Waiau survey districts had been mapped in detail. Work in the subdivision ceased for about two weeks in March to enable several additional mineral surveys in eastern Southland and South Otago to be completed.

Topography.

The Clifden area consists of a series of well-preserved river terraces cut in part in the Tertiary beds and in part in the gravels of an old flood-plain of the Waiau River. These terraces occur on both sides of the Waiau valley and can be traced along the valleys of its larger tributaries.

On the western side of the Waiau valley these terraces are well developed at six different levels—namely, 25 ft., 55 ft., 110 ft., 210 ft., and 455 ft. above the river; and terraces at these levels can also be traced up the Lillburn and Alton valleys. On the eastern side of the Waiau River the 455ft. terrace extends from the limestone escarpment at Clifden north to Wairaki River. The 210 ft. and 110 ft. terraces are missing on the eastern side of the Waiau valley, but the 25 ft. and 55 ft. levels are cut in gravels. South of the limestone escarpment these terraces can be traced to the coast. In some places intermediate terraces occur, but do not persist over any great distance. This is especially the case in the lower terrace levels. The most striking feature of the topography at Clifden is a limestone escarpment that extends from Trig. F, in Waiau Survey District, to Trig. D, in Alton Survey District, a distance of six miles. Both the Waiau River and the Alton Burn have cut through this escarpment. The beds dip to the west-north-west at an angle of 20° and the dip-slope is especially well marked just east of Clifden Township, where the limestone forms a 260 ft. bluff above the river extending north-east to Trig. F, 710 ft. above sea-level. On the western side of the river the limestone forms a line of bluffs about 260 ft. high.

Structure.

In the Clifden area the Tertiary beds dip to the west-north-west at about 18°. Toward the south the direction of dip changes to north and the angle lessens until, at the junction of the Orawia and Waiau rivers, the dip is as low as 6°. Farther south, however, the dip steepens and is to the south-west and west-south-west. The structure suggests a pitching anticline, the pitch being to the west. So far no faults of major significance have been observed, though a few small bedding faults occur in the Tertiary beds exposed in the Waiau River.

Stratigraphy.

Tertiary.

The following sequence of richly fossiliferous Tertiary beds is based largely on the exposures near Clifden, on the western bank of the Waiau River. Pending detailed palæontological work, no Tertiary stage names have been assigned to these beds. The sequence in descending order is:—

15. Blue-grey marly mudstone with concretionary bands. Fossiliferous.
14. Grey-blue sandstone containing concretions and fossils, which are in places replaced by limonitic casts.
13. Massive grey-white mudstone. Unfossiliferous.
12. Dark-grey slightly argillaceous sandstone with abundant fossils and some concretions.
11. Thinly bedded mudstone with some lenses of fine-grained sandstone. Unfossiliferous.
10. Blue-grey hard sandy clay with concretions and a few fossils.
9. Blue-grey sandy clay with abundant fossils but no concretions.
8. Hard shelly calcareous band rich in polyzoan fragments and abundant brachiopods.
7. Light rusty-brown soft sandstone. Unfossiliferous.
6. Clifden limestone. Fossiliferous.
5. Slightly glauconitic sandy limestone with some gritty bands.
4. Calcareous sandstone containing brachiopods.
3. Grey hard argillaceous sandstone, slightly glauconitic.
2. Fine-grained light-blue marly mudstone. Fossiliferous. Similar to the Waihoka Series described in last year's annual report.
1. Mudstone with concretionary bands passing down into sandstone with leaf impressions.

This sequence is also exposed in Alton Burn, but the Clifden limestone thins out to the south-west. Beds Nos. 15 and 14 outcrop at several points over the western part of Lillburn and Alton survey districts, and have been traced along the Waiau valley to Wairaki River, the northern boundary of the subdivision.

Recent and Pleistocene.

The lower terraces along the margins of the Waiau valley and its tributaries are composed of well-rounded and fairly well-consolidated gravels. Overlying these, especially in the wider parts of the valley, is 3 ft. to 5 ft. of fine even-textured clay similar to the loess that occurs in the Orepuki district.

Economic Geology.

The Clifden limestone forms the only deposit of economic importance in the area, and is at present being quarried at the junction on the Eastern Bush and Orawia roads. Here the escarpment rises to about 600 ft. above the roadway, and as it is being quarried along the strike there are ample reserves. Samples from different parts of the deposit were tested (*N.Z.G.S. Bull. No. 23*, 1921, p. 67) and showed a calcium carbonate content ranging from 75·6 per cent. to 93·5 per cent.

Analyses of the fine-grained blue-grey marly mudstone at the top of the Tertiary sequence show it to be suitable for the manufacture of Portland cement (*idem*, p. 71). This mudstone is exposed over a distance of about five miles along the Lillburn Rover from Bryce Burn westwards.

Terrace gravels are quarried in several places for use as road-metal.

GREYMOUTH COALFIELD.

By H. E. Fyfe, R. J. Bagge, M. Gage, and W. E. Hall.

Though field-work was continuous throughout the past twelve months the regional survey of the Greymouth Coalfield was considerably retarded owing to frequent calls upon the staff for assistance and advice by the coal industry. This assistance was chiefly directed to the solving of fault problems, penetration of faults, the most advantageous location of boreholes, and recommendations concerning possible new productive areas. This assistance has been availed of by the State and private collieries and by co-operative parties throughout the field. Only a small amount of additional field-work was required in most of these cases to supplement the foundation of knowledge already obtained, but a good deal of time was taken up in the preparation of the reports and plans.

Field-work.

South-eastern Area.

Work in the Seven Mile Valley was rounded off by surveys in the area north of the Seven Mile Stream, west of Spring Creek and on the flanks of the Ikes Peak Ridge overlooking Spring Creek. The area between Seven Mile Stream and Coal Creek, west of Trig. A, has also been covered, including the environs of the old Point Elizabeth Colliery. McLean Creek, the last stream remaining to be surveyed in the Coal Creek basin, is now being traversed.

North-western Area.

Surface work in the area between the Ten Mile Stream and Nine Mile Valley is nearly finished. South of this the detailed study of about half the area between Rocky Creek and the coast, including the James Mine, is now completed.

Brunner Area.

Work begun here by Mr. N. Pratt in April ceased early in July, when he was transferred to other work. During that period he was able to throw a good deal of light on faulting and stratigraphic problems in the area, but considerably more field-work still remains to be done.

STRUCTURE.

Little requires to be added to the fairly full statement given in the 1939–40 annual report, but some of the earlier statements require modifying in view of later results.

South-eastern Area.

A synclinal area between the two dominant asymmetrical anticlines described previously, and with its axis along Spring Creek, was referred to as a complex depressed and faulted belt. Later work has shown that a true syncline exists here, and that the most severe and close-spaced faults actually involve the over-steepened east limb of the neighbouring anticline. Complex faulting also appears east of the syncline and in places, as, for example, the Runanga water-supply tunnel, actually eliminates the synclinal axis altogether.

A close study has been made of the Dunollie Fault and associated faults of the Old Point Elizabeth Mine area, in view of the fact that the Upper "Paparoa" coal-seams may be workable beneath the old workings here. The throw of the Dunollie Fault is much greater than the figure given last year. Near the top of the rise workings of the Point Elizabeth No. 1 Mine it is well established as being about 550 ft. It is traceable throughout the old mine workings and north-eastward as far as the bluffs above Baddeley and party's abandoned lease, where it has diminished considerably in throw. The throw of the Boote Fault, between Boote and party and the old Point Elizabeth No. 2 Mine, decreases steadily southward from the cliff above the railway-line, where it is 145 ft., to its junction with the Dunollie Fault, where it has almost dried out. The Point Elizabeth No. 2 Fault, west of the Point Elizabeth No. 2 Mine, has a throw of 135 ft. on the cliff face, and Clarke Fault (west of the old Clarke and party Mine) has a throw of at least 100 ft., but no data could be gathered on the southward extension of these faults. The fault bounding Moody Creek Mine to the east has a displacement of about 130 ft., at the Seven-mile Stream, but it cannot be traced on the cliffs below Trig. A; it is thought to die out southward. The chief member of the group of faults disturbing the syncline, referred to earlier, has been followed south-south-westward for nearly a mile. The displacement is at least 300 ft. near the abandoned Baddeley and party Mine (Bend Creek).

Reference was made in the last annual report to the disturbed country west of Denston Fault. These remarks are correct as regards the vicinity of the Seven-mile Stream, but it now appears that a considerable untroubled area extends northward beneath Ikes Peak.

North-western Area.

In the last annual report it was stated: "The smaller folds which occur sporadically through the area and never extend for any distance approximate more nearly" (than the broad, open syncline which passes through the Strongman State Mine) "the strike of the faulting system . . ." (being approximately between 25° and 30° east of north). It is now considered that a system of smaller folds striking about north-west is quite well defined.

It was stated in last year's annual report that: "The evidence so far collected shows that compressional faulting is subordinate to tensional." Present information supports this to the extent that, with the exception of the Roa Fault-zone, the compressional faults are in general of less displacement than the tension faults. In some cases there is evidence of two periods of movement.

The throw in the main Doherty Fault is negligible in Nine Mile Stream and Kiwi Creek, but small subparallel displacements continue, and these in turn tend to die out southward. The largest of these, at first thought to be the Doherty Fault, is visible in the cliffs south of Nine Mile Stream, where it has a displacement of about 175 ft. It also traverses Mudstone Creek and Nine Mile Stream. This fault has now been encountered in the south-level workings of the Strongman State Mine, and is about to be prospected. Nearby outcrop information, which discloses the fault, indicates that it will be found to have considerably diminished in throw.

There is now more information concerning the fault on the west side of the Westport Road bridge over Nine Mile Stream. Ten chains south-west of this bridge the fault has a downthrow to the *east* of about 400 ft., north-eastward it dies out rapidly into a small fold before reaching the Ten-mile Bluffs. It seems to have died out before reaching the S bend in the Westport Road, and a short distance south-west of this on the approximate projection of the strike of this fault there is a rapidly increasing displacement with downthrow to the *west*. The throw on this fault is about 350 ft. between the Cain and party Mine and the Main Road, whence it commences to die out. It is possible that these two opposite displacements may represent a scissors-fault.

Fred Fault, as noted in the previous annual report, downthrows to the west. Places where its displacement was estimated are as follows: Ten Mile Stream, 170 ft.; immediately south of Moore and party Mine, 300 ft.; Nine Mile Road, 195 ft.; Cannel Creek, 45 ft.

Stratigraphy.

It is now established that the massive mudstone overlying the Strongman seams is equivalent to the Upper Mudstone of the Seven Mile Valley, bringing the stratigraphic columns separately worked out in the two areas into complete agreement, and the two columns given in the previous report may now be merged.

Coal-seam Correlation.

Little requires to be added to the statements of the last report. The upper portion of the coal measures beneath the Upper Paparoa Shale is now correlated with the horizon of the Strongman seams, although it is not suggested that any one seam is continuous between the areas.

The dirty coal with slate bands that outcrops in Bishop and Doherty creeks below the Lower Paparoa Shale is correlated with the Morgan seam, and the thick seam above the Lower Paparoa Shale is about the horizon of the Kimbell seam.

Clearly Boote and party are working a lower split of the old Point Elizabeth State Mine seam, and the seam of the Currie and party new lease is the same horizon

The James Mine, Moore and party, Cain and party, Pinn and party (old and new mines), Currie and party (old mine), Hadcroft and party (old and new mines), Smith and party, Castlepoint and Baddeley and party (Rocky Creek), all worked or are working the same seam, known as the James seam and occurring at the base of the Island Sandstone. This seam has been an important horizon marker in the stratigraphic correlations of this field.

No further light has been thrown on the possibility of an obscure unconformity within the Paparoa beds. These correlations, at least as regards the lower part of the section, would need modification if it exists.

Mining Problems.

South-eastern Area.

Liverpool State Mine.—Additional surveys demonstrate that the Anderson dip-workings have advanced nearly into the apex of a wedge between two large faults. A new stone drive to connect with the foot of the dip workings is proposed, for these faults will form the southern limit of this section of the mine. The new access will permit the development of the Morgan seam to the rise, together with any other seam above the Kimbell, proved to be workable by the borehole to be drilled upward from workings in the latter seam.

Goldlight Mine.—On the recommendation of the Survey, the party penetrated a small fault east of the old workings, and have already developed a considerable tonnage. A report was prepared covering four alternative schemes for a stone drive to serve as return airway. This work is now under way.

Hunter and Party, Seven Mile Stream.—On a site suggested by the Survey, a borehole was drilled locating coal near the estimated depth. Assistance was given in the laying-out of a stone drive to tap the new area.

Currie and Party, New Area.—An officer of the Survey was invited to attend a conference between representatives of the Mines Department and the Runanga Borough Council concerning the laying-out of Currie and party's new lease in such a way as to safeguard the Coal Creek water-supply scheme from pollution.

Baddeley and Party, Abandoned Area.—Visits were paid to the drive by means of which the party hoped to open a new mine. It was shown by following the outcrop that the coal rapidly thinned, and when this was proved also in the mine the area was abandoned.

Moody Creek Mine.—Several visits have been paid to this mine, where complex, close-spaced faulting occurs. The present dip workings are likely to encounter increasing steepness of dip, crushing of the coal, and faulting, and it has been recommended that efforts be diverted to reopening the western section of the mine. There are indications that the Moody Fault, bounding the mine to the west, is dying out toward the dip, and that it may be easily penetrated from the present mine, enabling the development of what promises to be a large block of trouble-free ground.

New Point Elizabeth Mine.—The present area is approaching exhaustion, and the Superintendent of State Collieries, having been approached by the party concerning a prospecting-bore, requested information about the chances of success. An unfavourable report was presented, and it is understood that the proposal is abandoned.

Castlepoint Mine.—The Survey was asked to advise on the site of a borehole within the mine to prospect lower measures.

Boote and Party.—A comparative report was prepared dealing with possible routes for a new stone drive to simplify the present costly haulage. In view of the state of development of the mine, which is almost ready for pillar-extraction in the dip, the required expenditure seemed unjustifiable.

North-western Area.

Strongman State Mine.—In the North-dip workings a fault, known as the 90-foot Fault, was encountered and passed through in coal. This is explained by the fact that at this point the displacement of the fault and the interval between the two State seams are approximately the same. This fault had previously been encountered farther south in the same section of the mine, where a full face of stone was found. This discrepancy is probably due as much to difference in the interval between the two seams as to change in the fault-displacement.

In the South Level, 18 chains from its junction with the east heading, a stone face was encountered. Indications suggested that this fault was a small one, and prospecting soon disclosed that the floor of the seam beyond the fault was immediately above the roof of the level. This is the southward, dying-out continuation of the Doherty Fault encountered in the east heading.

In the South Dip the workings were stopped beneath Kiwi Creek on account of the complicated structure existing there, which made the winning of coal too costly.

The East-heading workings have passed through the faulted country near the south end of the Doherty Fault, and are proceeding with a full height of coal once more. It is estimated that these workings will encounter the 175-foot Fault approximately 15 chains east of the Doherty Fault. Probably changes in the hade of the fault make this estimate uncertain.

Hunter and Party, Ten Mile.—On the recommendation of the Survey, the transverse fault, which cuts off these workings to the south, was bored and proved to have a vertical displacement of about 30 ft. A stone drive through this fault is now in coal.

Stuart and Party, Ten Mile.—The Survey recommended boring the fault which cuts off this mine to the east. This was carried out, and the coal found to be upthrown 50 ft. to the east. This was within the estimated limits.

Baddeley and Party Lease, Rocky Creek.—The advice of the Survey was requested regarding the structure and boring of this lease, which is situated between Rocky Creek and the James Mine. The structure is not complicated and no boring is necessary. A drive is being put in from the surface as suggested in the report.

McTaggart and Party, Cannel Creek.—A report was prepared for a part of the area north-east of the James Mine and traversed by Cannel Creek, where a lease was granted to this party. This report discussed the stratigraphy and structure, with special reference to the James Seam, and recommended a borehole-site that would have given information on the area to the north in addition to being a guide for the construction of the stone drive. One borehole was put down, but not at the point recommended in the report, and encountered 4 ft. 3 in. of coal at a depth of 57 ft.

Geophysical Work.

Experiments were conducted in the Seven Mile Stream, at Taylorville, and at the Ten Mile Bluffs to determine whether the ratiometer might be used to trace the continuation of known faults beyond the points where they can be fixed from outcrop information.

It is sufficient to state that the experiments were unsuccessful. The results are affected to so great an extent by superficial factors—for example, depth of overburden and its degree of water-saturation—that the method could be of use only over terrain where the solid rock is exposed. Geophysical work would obviously not be necessary in such circumstances. The resistivity anomalies detected were, in every case, capable of alternative interpretations involving only changes in the superficial layers.

Surveying.

When the initial trigonometrical work was done it was difficult to predetermine the extent of geological work necessary in certain areas, and during the year several additional stations were determined in order that the stadia traverses might be effectively controlled.

In two of the co-operative mines it has been necessary to run accurate theodolite and chain traverses, as the information asked for could not be given with sufficient accuracy by the usual methods.

A number of plans to accompany reports have been prepared. A plan of the mines of the Brunner area has been compiled, but owing to the lack of accurate mine plans of abandoned areas this compilation has entailed some field-work, the fixing of old adits, shafts, &c., and the searching through old files for information not shown on the old mine plans.

Charming Creek Field.

A visit was made to Charming Creek Mine to examine borehole-cores, and at the request of the Senior Inspector of Mines, Greymouth, a survey was made of the boreholes, and part of the workings was fixed in relation to the lease boundary pegs. Serious discrepancies were disclosed in the positions and heights of most of the bores, as shown on existing plans, as well as in the mine plan.

Mangapehi and Ohura Fields.

Work in the central North Island fields was begun in July, beginning at Tatu. A report has been prepared on the geology of the Mangapehi area, and bore-sites suggested in order to determine the extent of the coalfield and the feasibility of a stone-drive to give direct access to the mine from the railway of a timber company.

The Mangapehi coal-measures underly marine beds of the Te Kuiti Series, which overlap upon an undulating greywacke basement. From the outcrops in Mangapehi Stream they dip north-westwards beneath younger formations, and are not seen again nearer than Te Kuiti. It is known that the coal thins rapidly to the south and east of the mine, but its extent to the north and west can only be determined by boring. The structure appears to be generally simple, although local complexity is seen in the vicinity of upstanding ridges of the greywacke under-surface and small faults and rolls affect the seam in the workings. No faults of large throw were detected near the mine, the largest seen having a throw of about 50 ft. The average thickness of coal in the Mangapehi State Mine is about 15 ft.

At Tatu (Ohura) the seam is within the Mokau Series, a formation which is coal-bearing at many places in the Taranaki Province. The seam now being developed appears to outcrop at few places, and the recent work was able to do no more than determine the structure and faulting of the area. This was possible owing to a persistent conglomerate band overlying the seam at Tatu, forming cliffs which could readily be followed. Throughout the area dealt with the structure is uniform and simple. The direction of dip is everywhere within a few degrees of west, and at angles seldom greater than 5°. Faults are rare, the general trend of those seen being roughly north-east. Only the Whittlestone Fault, with a downthrow to the north-west of 18 ft., has yet been encountered underground. The Cunningham Fault, approximately 10 chains north-west from the Whittlestone Fault, displaces the seam about 40 ft. up to the north-west. The length of these faults cannot be predicted. A fault with a downthrow to the north-west of at least 70 ft. was seen about one mile and a half south-east of the mine-mouth. The average height of the coal is 6 ft.

Mines Sampling.

During the winter run-of-mine samples were taken from the principal producing mines throughout the Dominion, and mine samples obtained from those mines not previously sampled, chiefly in Southland, Otago, Taranaki, and Auckland. It will be necessary to pursue a sampling programme as the different mines develop so that complete information may be available to those concerned in the use of our coal.

Microscopic Examination of Coal.

A microscopic study of the different coals has been commenced, and a preliminary examination of a few specimens suggests that this method of correlation will be decidedly useful. On account of the friability of most New Zealand coal, pillar samples such as are obtained in England and the United States cannot be taken from the seams, but a satisfactory method of sampling has been evolved.

TYPE SECTIONS.

By M. Ongley.

The writer examined the type sections of the Mangatu, Wanstead, Weber, and Wheao series, and found the first two rather too difficult for use as standards of reference, except on broad lithology. In the other two the type sections are satisfactory and afford enough evidence to draw up vertical columns.

Mangatu Section.

The type locality of the Mangatu Series in Mangatu Survey District, along the Waipaoa, Mangataikapua, Mangatu, Te Hua, and Mangatahu streams, was examined and sixty-one specimens were collected for foraminifera work. The thickness and sequence of the beds were not established.

Wanstead Series.

Along with Dr. Lillie, the writer examined the type section of the Wanstead Series along the road for two miles both east and west of Wanstead. Eighteen samples were taken for foraminifera work. The outcrops were too obscure for a section or vertical column to be prepared.

Wheao Series.

The Wheao Series was examined in the type locality along Wheao and Waikohu streams in Waikohu Survey District, and forty-eight samples were collected for foraminifera work. A plan, a section, and vertical column of the beds showing the position of the samples, were prepared.

Weber Series.

With Dr. Lillie and Mr. Oliver the writer examined the Weber Series in the type locality in the Akitio Stream at Weber, extending four miles up-stream from the Mangatu argillite in Ossa Ridge, the "Ossa Series" of Washburn. Twenty samples were taken for foraminifera investigation. A plan, section, and vertical column showing the position of the specimens have been prepared.

Te Uri-Tangaruhe Section.

To get more evidence on the geology of the possible oilfields, Mr. Macpherson and the writer, in co-operation with Dr. L. B. Kellum, A. A. Weymouth, and J. M. Bruce, of the New Zealand Petroleum Co., examined the structure and stratigraphy of several parts of the East Coast, including Te Uri-Tangaruhe, Kenealy Cutting, and McLennan Stream at Porangahau, Awanui, Puketoro, Te Hua, Waitangi, Whangara, Hokoroa, and Panikau. Nearly all the differences of opinion and nomenclature were overcome; but plain evidence of the position and sequence of the "Quarry beds"* was not found, so that Mr. Macpherson still regards the outcrops as outliers and the writer regards them as inliers.

Easily the most continuous and least complicated section is that in the Te Uri and Tangaruhe streams, west of Porangahau. This was first geologized in 1936 by Messrs. Quennell, Brown, Mason, and the writer, and described in the annual report for 1936–37 as containing these series of beds in downward sequence:—

Tutamoe.
Ihungia.
Weber.
Wanstead.
Mangatu (Whangai).
Tapuwaeroa.
Raukumara.

Much work has been done on this section since by the geologists of the oil companies, foraminifera samples for micro-faunal examination have been closely collected, and are still being worked out. On this visit another set of lithologically distinct beds were separated off between the Whangai and Wanstead series; and the foraminifera, worked on by the oil company palæontologists and still being worked out by Dr. Finlay, are yielding important evidence for stratigraphy and correlation. Unfortunately, in this section no beds were found acceptable as the "Quarry beds." Still, it affords far the best standard section as a basis for future work and can profitably be reworked in more and more detail. Samples of the Tapuwaeroa beds with *Ostrea lapillicola* in McLennan Stream were collected; but so far no foraminifera have been found in them. The unconformity between these and the overlying Weber beds exposed in Kenealy Cutting and the stream to the north was re-examined, and it was confirmed that the basal conglomerate interbedded with the white Weber mudstone contains not only blocks with *Inoceramus* and *Ostrea lapillicola* in them, but also *Belemnites* in the matrix. This section affords satisfactory evidence of the break below the Weber.

* An MS. name of E. O. Macpherson for beds exposed at the county quarry, Whangara.

Raukumara District.

The beds at Awanui were examined and found to correspond fairly well in lithology with the Tapuwaeroa near the old hotel-site followed by Mangatu (Whangai) argillite to the south, passing under a syncline of Tertiary conglomerate and coarse green sandstone.

The Puketoro section showed—

Ihungia mudstone with the igneous conglomerate at the base.
Te Hua hard light mudstone.
Mangatu beds.
Tapuwaeroa beds.
Mangaotane mudstone with a red bed prominent near the top.
Raukumara alternating sandstone and argillite.

From Waitangi Hill fifteen specimens were collected for foraminifera work, and eight from Hokoroa; but detailed mapping is necessary to show the structure, and even with close work it may not be possible to find enough evidence. For instance, the small isolated outcrops of the "Quarry beds" have given trouble, and the red bed, or red beds, are difficult.

The structural highs of Waitangi, Whangara, Hokoroa, and Panikau, surrounded by the younger stronger beds that dip outward in long continuous homoclines, need detailed mapping, and for such work no other method can give as useful results as photo-geology, which shows and co-ordinates every scrap of surface information. As stated by Fenneman in his paper on "The Rise of Physiography," published in the Bulletin of the Geological Society of America, Vol. 50, p. 358, 1939.

> "To whatever extent surface forms are determined by underlying structures, to the same extent structure is revealed by topographic forms. Now, topography is the first thing in evidence. The structure may be about equally evident (if seen by the right man) or it may require weeks of patient plodding. Both surface forms and structural forms may be too large to be comprehended in a single view. Not until they have been laboriously measured, plotted, and correlated does the mind's eye see them in their true relations.
>
> "These statements were literally true a few years ago. They are not less so now since both topography and structure are beginning to be studied from the air. The form of the surface is, of course, the main thing seen, often the only thing. But the degree to which that form reflects structures is one of the surprises among recent developments."

PALÆONTOLOGICAL WORK.

By J. Marwick.

During the past year fossil mollusca collected by the field geologists of the Survey and of oil-prospecting companies have been examined and classified. The districts represented were chiefly Dannevirke Subdivision, Taranaki, and Orepuki.

Visits were made to Taranaki, Martinborough, Woodville, and Palmerston North - Wangaehu districts.

As far as time permitted, work was continued on the fossil collections of the Survey, the carrying-out of exchanges, the preparation of card indexes, &c.

A wall chart showing correlations of the Cretaceous and Tertiary sedimentary formations in different districts throughout New Zealand was prepared.

MICROPALÆONTOLOGICAL WORK.

By H. J. Finlay.

Most of the field officers have sent in samples for age determination. Mr. Gage's samples from Cobden Survey District included Kaiata Mudstone with an Omuotumotu fauna at the base (this is a correlative of the Lorne Waiarekan), underlain by Island Sandstone with molluscan fragments, but no micro-fauna. Later he sent samples from the Mangapehi Coal-mine from which it was determined that the sandstone at the mine is Duntroonian and the mudstone above Waitakian (no genuine Mahoenui appeared); the succeeding sandstone, mapped as Mokau, shows a Tongaporutuan micro-fauna, a gap in sedimentation quite unsuspected in earlier mapping. Mr. Willett's collections from Longwood Survey District, Southland, provided very important facies of Whaingaroan and Duntroonian (no other ages yet seen from this area), which are usually limestone and glauconitic sandstone respectively; though here the facies of the series is mudstone, the key species of both ages remain restricted. Dr. Hutton obtained material near McCollough's Bridge, Waimate, showing these two stages again in contact, both as soft limestones, the upper alone with brachiopods; McKay's "marly clay" above the Tahuian at McCollough's Bridge has a Whaingaroan micro-fauna like the lower limestone.

Dr. Lillie has forwarded very numerous samples from the Dannevirke area, mostly in the Pliocene, and much intensive work was carried out to find a basis for separating Opoitian, Waitotaran, and Nukumaruan faunally. In this connection a visit to the sequence at Martinborough by Dr. Marwick and Mr. Ongley proved vital, as these three Pliocene stages occur in sequence there in compressed form very fossiliferous, and readily separable on micro-faunas. Here and in the Dannevirke area the practice was continued of mounting as often as possible micro-faunas definitely associated with molluscan macro-faunas, to enable a direct tie-up of evidence. The detailed work done in both lines shows that the Nukumaruan is divisible into an upper and lower part, and that the general results are in remarkable agreement with independent work done by the Superior Oil Co. on the 10,000 ft. Rangitikei River section.

Work for the oil companies has again occupied much time. The Shell Co.'s vital sections at Tangaruhe and Te Uri streams—which will be designated in an account now in preparation as the standard sections in New Zealand for the whole Upper Cretaceous and Eocene deposition—have been the subject of continued study, some two hundred samples from Ruakumara to Ihungia having been carefully washed and examined and extensive range charts prepared. This section and a complementary one throughout the Waipawa black shales and associated beds has been of critical value in determining the age of the various beds in the Katiki-Moeraki-Hampden section, where there are large gaps in the record; the correlations will appear in a bulletin in preparation.

The Superior Oil Co. has now also entered into a contract for part-time use of the micro-palæontologist's services; several consultations have been held with members of their staff, and much Pliocene material reported on.

The Vacuum Oil Co. has sent down a complete set of cores from its Midhirst Well No. 1 for examination and report, and determination of the formations drilled and the contact points have already been made. Many surface samples from Whitianga and Waitewhenua areas, eastern Taranaki, have been examined in connection with the erroneous use of Mohakatino for certain inland formations; the study of these in conjunction with type Mokau and Mohakatino leads to the interesting conclusion that the inland sandstone and tuffaceous mudstone members are not of the same age as their coastal lithologic counterparts. The coastal Mokau has Hutchinsonian micro-faunas, and it is suggested the Mahoenui corresponds to the Lower Ihungia (below the "d-sandstone" down to and including Wheao), the type Mokau to the more sandy Ihungia and the type Mohakatino to the Tutamoe (Morere facies)' Inland, the Hutchinsonian is uncertain, the "Mokau" sandstone has Awamoan mollusca and micro-faunas, and the succeeding taffaceous mudstone universally shows Tongaporutuan micro-faunas corresponding to the Mapiri facies.

New methods of washing have been developed, and Mr. Baker now prepares excellent faunas from all but the worst material.

Owing to increasing commitments with the oil companies it has been necessary to obtain a micropalæontological assistant, who had already gained considerable experience in the New Zealand Petroleum Co.'s laboratory in Gisborne.

PETROLOGICAL AND MINERALOGICAL WORK.

By C. O. Hutton.

Progress continues to be maintained with the rock and mineral museum, and to date 6,172 specimens are available; many of these hand-specimens have corresponding thin-sections also available. In addition to the hand-specimens described by Professor Sollas and A. McKay in "The Rocks of Cape Colville Peninsula, New Zealand," there are five hundred thin sections of these rocks. Considerable time has been spent in labelling and indexing the collections. Acknowledgment is made of the gift by Dr. A. L. Parsons, Director of the Royal Ontario Museum of Mineralogy, of a large polished specimen of the beautiful blue mineral sodalite from the well-known locality of Bancroft, Ontario.

A visit was made, in company with an officer of the Public Works Department, to Wereroa to report on some proposed water schemes to augment the existing supply to the Air Training School.

Some time was spent grading and elutriating Kaka clays for subsequent treatment at the Dominion Laboratory. Work was carried out on bentonite samples in an attempt to determine the cause of some ambiguity in the results of swelling tests.

The investigations into the possible use of glauconite as a potash fertilizer were continued, and a field survey was made of the quantities of greensand available in the Waihao basin, at Waianakarua, Tumai, and Waipara River. The Waianakarua deposits proved to be very satisfactory from the point of view of accessibility, quantity, and K_2O content. The investigation has been carried out in collaboration with the Department of Agriculture, and for their field trials in the Waihi, New Plymouth, and Invercargill districts, greensand was collected at Waianakarua and from an old quarry near McCollough's Bridge, in the Waihao district.

Thirty-five determinations were carried out on material forwarded by the Dominion Laboratory, as well as numerous routine determinations on material sent in by field officers.

In October the writer accompanied the Hon. the Minister of Scientific and Industrial Research on a visit to the Upper Waitati valley, near Dunedin, and the Haast Pass road. In the former locality oil-shale, occurring in lenses in the phonolitic conglomerate, was inspected.

Much of this year has been occupied, in company with Mr. H. W. Wellman, in a survey and estimation of the magnesite bodies in the Takaka River - Cobb River area. A field laboratory was established at Upper Takaka for the purpose of analysing the material collected in the field. In addition to the main investigation, work was carried out on a nickeliferous pyrrhotite lode occurring in the Flora Survey District. A summary of the chemical determinations made with the assistance of Mr. H. W. Henderson and Mr. G. H. Green is as follows: 250 analyses for MgO, 28 for Ni; 14 for FeO, and 3 for CaO: a total of 295 analyses.

Visits were made to Bubu Springs, Kill Devil Ridge, and Caanan in search of quartz crystals, but, unfortunately, nothing of any value was obtained at any of these localities.

Two short visits were paid to the granite-marble contact at Rameka Creek, Takaka Survey District, and numerous specimens were collected from this area. It is the writer's belief that the dark amphibolites and hornblende-epidote rocks are mainly metasomatic in origin and closely comparable to the feather-amphibolites and contact rocks described by F. D. Adams and A. E. Barlow in the "Geology of the Haliburton and Bancroft Areas, Province of Ontario" (1910).

Two collections of New Zealand rocks and minerals have been made up this year, one consisting of eighty-nine specimens for the Rununga School of Mines, and a second consisting of ninety-three specimens, for the United States Natural History Museum, New York.

GEOPHYSICAL WORK.

By N. Modriniak.

The entire field season was devoted to the investigation of proposed dam-sites for the development of hydro-electric schemes along the Waikato River.

Ohakuri, situated between Atiamuri and Orakei Korako, was investigated in detail. Work was discontinued in this area towards the end of December, 1940, when the investigation of Whakamaru was taken in hand and continued to the end of March. Two supplementary seismic sections were also studied at Karapiro.

Ohakuri is in an area of compact fragmental rhyolitic rocks that in part are silicified. The geophysical methods used in the investigation were magnetic, seismic, and electric. The magnetic investigation was carried out with a magnetic balance, and the vertical magnetic intensity was measured. The lowest values were associated with intense hydro-thermal activities in the western portion of the area. The magnetic observations suggest the lateral extent as well as the intensity of the thermal action, which, in turn, is probably a measure of rock silicification. The nature and depth of the rock were studied seismically. The observed surface velocity ranged between 1,200 ft. and 1,500 ft. per second, and for the underlying rock a velocity ranging between 4,500 ft. and 7,000 ft. per second was recorded. Electric anomalies were also observed, which were interpreted as being due to structural weaknesses.

At Whakamaru the Waikato River in times past smothered with loose sands an old land surface, carved from compact but unsilicified fragmental rhyolitic rocks, and has now cut its new bed as deeply as formerly. The problems are to trace the valleys of the old land under the sand and to determine the depths of the contacts of the different layers of the compact rocks.

Special Examinations.

Several officers spent the whole or a large part of their time in examining deposits of possible economic value and made preliminary reports. As accounts will be published, as opportunity offers, in the *Journal of Science and Technology* when draughting and laboratory work is completed, only the briefest of summaries are given here. Mr. E. O. Macpherson prepared summaries 1 to 5; Mr. J. Healy, 6; Mr. H. W. Wellman, 7 and 8; and Mr. R. W. Willett the remainder:—

(1) *Serpentine.*—With the Inspector of Mines the small serpentine masses of the Silverdale district were examined and sampled. Estimates of the tonnage available were made. The largest body of the rock, that on Gordon's property, requires further prospecting.

In two visits to D'Urville Island the serpentine belt was mapped and in parts sampled.

(2) *Sulphides.*—A zone or zones of rock heavily mineralized with pryite and other sulphides outcrops in localities six or seven miles apart along the western side of D'Urville Island. In places it is 100 ft. to 150 ft. wide, and it may extend continuously or be in large lenses. In general it lies along or near the contact of gabbro and ultra-basic rock. Geological examination and mapping may disclose areas on the zone worth prospecting by trenches and adits for copper, chromium, or other minerals.

(3) *Talc.*—A band of good-quality talc, 3 ft. to 5 ft. thick, outcrops on the south shore of Catherine Cove, D'Urville Island. The relations are not clear, but it seems to lie between serpentine and subschistose rock.

Many fragments of clean, good-grade talc occur on the hillslope north of Catherine Cove, and an outcrop could probably readily be found.

Talc was observed at Tarata Point, on the east shore of Admiralty Bay, and there are large masses of impure material along the foreshore. Residents know of better material in place.

(4) *Copper.*—During September and October, with Mr. R. F. Landreth, of the Mines Department, a reconnaissance was made of the north end of Great Barrier Island and on Kawau Island to see if there was any extension of the copper deposits worked many years ago. Nothing hopeful was observed. Geophysical prospecting at Kawau is recommended.

The old copper-mine in the hills overlooking Copper Mine Bay in the south part of D'Urville was also examined, but nothing can be added to Cox's excellent accounts made seventy years ago when prospecting was in full swing.

(5) *Montan Wax.*—The peat beds of Chatham Islands contain a solid hydro carbon very similar to montan wax, which has important uses in industry, and as early as 1868 peat from these parts was tested by the Dominion Laboratory and shown to contain attractive amounts of wax. Since 1868 further samples of peat from Chatham Islands have been tested, and from all a commercial percentage of wax was extracted. This, and the failure of wax-supplies from Germany, decided the Mineral Resources Committee to do some preliminary research on the wax content of the peat.

About one month was spent on this work during March and April, 1941, and peat areas were sampled at Kaingaroa, on the north-east of the island, at Ouenga, on the south-east, and at Port Hutt and Waitangi West, on the north-west. It was thought necessary to obtain information on the regional persistence of the wax and also if any particular horizon in the peat contained a high percentage of wax. The peat areas were mapped and channel samples cut from exposed peat faces at these localities. About a hundred and fifty samples were taken, and these are at present being examined by the Dominion Analyst.

(6) *Boron.*—During September and October, 1940, a detailed investigation of the hot springs at Tokaanu was made with the object of determining the total flow of water and the possibility of extracting the minerals of economic value. These springs have a high content of boron, present as sodium borate, a fact noted by Grange in the Bulletin on the Geology of the Rotorua-Taupo Subdivision. The area was mapped in detail, and a complete round of temperatures was taken, akalinity measured, and samples collected, while a magnetometer survey was carried out in addition. Mr. S. H. Wilson, of the Dominion Laboratory, collected samples of steam from several of the fumaroles towards the end of the work. The Waihi area was included in the survey, as well as other adjacent areas showing thermal activity. A full report, accompanied by maps, has been prepared, and will shortly be published in the *New Zealand Journal of Science and Technology.*

(7) *Magnesite.*—During the past field season a detailed survey was made in the Cobb-Takaka district of the deposits of talc-magnesite. A large number of samples were taken for analyses from surveyed points, and mapping was done on a scale of 6 chains to an inch.

The greater part of the talc-magnesite occurs in four lenses elongated in a north-south direction and dipping east at the same angle as the enclosing schists (from 45° to 70°). They consist of about 50 per cent. magnesite. Their downward extent is likely to be considerable, and their approximate surface areas are as follows :—

		Square Yards.
Lens No. 1 :	North bank of the Takaka River, one mile and a half upstream from the Takaka-Cobb junction	25,000
Lens No. 2 :	Ridge between Cobb and Takaka Rivers, 60 chains from junction	200,000
Lens No. 3 :	Takaka River two miles above Cobb-Takaka junction ..	13,000
Lens No. 4 :	West side of Cobb River north-west corner Flora Survey District	1,000,000

(8) *Pyrrhotite.*—A detailed survey was made of the sulphide zone which crosses the Takaka River two miles and a half from the Cobb-Takaka junction. Sufficient of the sulphide consists of pyrrhotite to enable the material to be traced with the magnetometer, and several lenses were located by this means. The lenses are up to 10 ft. wide, but have small linear extent.

In January deposits of kaolin clay near Charleston, talc near Taipo River, and talc-magnesite near Springs Junction, Maruia, were examined and samples collected.

(9) *Clays.*—Samples of the schist-residual clays were obtained from old gold workings and from outcrops near the Conroy Dam close to Alexandra. The clay has fulling properties.

The clay from the Mako pit, near Winton, is used in the manufacture of fire-bricks and in stone-ware goods, one seam about 5 ft. thick being particularly suitable. Samples of the different clays were obtained and an examination made of the possibilities of extending the workings.

The Pomahaka clays are part of the younger Tertiaries that cover the northern half of Pomahaka Survey District. On the property visited there were two exposures showing 5 ft. of clay from which samples were obtained. These outcrops are adjacent to a road a few miles from Waipahi, and the field evidence suggests that there is an abundant supply of clay available. The clay has fulling properties.

(10) *Iron-ore.*—Two outcrops of a cemented blacksand near the head of the Catlins River were visited and samples were obtained. The iron-ore, which is similar to that found at Lochindorb, appears to occur as small lenses interbedded in the Jurassic sandstones. There is no evidence to suggest the presence of a large body of ore.

(11) *Quartz Crystals.*—Several people were interviewed regarding deposits of quartz crystals, and the various localities visited. Searches were made at Oturehua, Blackstone Hill, Cromwell, and Potter Gully, but none of the crystals found came anywhere near the specifications demanded by the Imperial Institute.

(12) *Sands.*—Samples were obtained from the various sand-pits and outcrops of quartz sand of the Taratu Series that are found in the Dunedin and East Taieri survey districts. The purpose of this survey was to locate an area of quartz sand suitable as a substitute for the Leighton Buzzard standard sand.

(13) *Oil-shale.*—A quantitative survey of the Cambrians oil-shale deposit revealed that it was of no great extent, having a minimum of about 26,000 tons and a probable maximum of 500,000 tons. Samples were taken from several points, and the results of the laboratory tests showed an average of 54·5 gallons per ton of crude oil and 10·7 cwt. per ton of residue (Gray King assay, 600° C.).

A sample of shale similar to that of Cambrians was obtained from the Idaburn coal-pit, and yielded 52·9 gallons crude oil per ton and 7·7 cwt. per ton of residue (Gray King assay).

A reconnaissance was made of the oil-shale deposits in the lower Nevis valley, and numerous samples taken for testing purposes. No attempt was made to carry out detailed quantitative work, this being dependent upon the results of the laboratory tests of the oil-yield of the shale. This is by far the largest and most extensive oil-shale deposit in New Zealand, probably of the order of 150,000,000 tons and if laboratory tests show sufficient yield of oil this, together with the ease of open-cast working, should attract further attention to the deposit.

An examination was made of the oil-shale deposit interbedded with phonolithic conglomerate in Leith Valley, Waitati Saddle, near Dunedin. The sample obtained showed a poor yield of oil—namely, 8·1 gallons per ton—and the field evidence shows that the shale is of no great extent.

(14) *Scheelite.*—Examination was made of a small quartz lode carrying a little scheelite on Blackstone Hill. This was not strongly developed and appeared to thin out laterally. The lode dips to the north-east at about 75°.

DOMINION OBSERVATORY.

Acting-Director: R. C. Hayes.

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1940.

Buildings and Grounds.

The Observatory buildings have been kept in good order. The grounds have been attended to periodically by the Wellington City Council.

Time Service.

Control of Standard Clock.—During 1940, six hundred short-wave radio time signals were received from abroad for checking the standard mean time clock. Difficulties were experienced towards the end of the year owing to erratic behaviour of the clocks, and occasional gaps in the daily checking. The radio time signal checks were supplemented by fifty-one star transits.

Time Signals sent out.—The usual time service has been maintained. It includes (*a*) radio time signals through ZLW daily at 10.30 a.m., N.Z.M.T.; (*b*) signals supplied to the National Broadcasting Service for transmission through station 2YA (four times on week-days, and twice on Sundays); (*c*) telegraph time signals to the General Post Office and Railways Department at 9 a.m. daily, except Sundays; and (*d*) time signals supplied by telephone in response to calls. During 1940 the number of telephone signals averaged five per week, calls being most frequent in August and September.

On 1st January, 1940, the Onogo modified system of time signals replaced the old system for transmission of time through station ZLW. The preliminary and intermediate signals are sent by hand-key, pending the construction of a new transmitter.

The following table summarizes the errors of the ZLW radio time signals during the year 1940:—

Number of times error did not exceed 0·25 sec.	351
Number of times error between 0·25 and 0·50 sec.	10
Number of times error between 0·50 and 1·00 sec.	1
Number of times error exceeded 1·00 sec.	0
Total number of signals sent out	362

The ZLW signals failed on four occasions owing to trouble at the radio station. The signals were faulty on three occasions, and on one day they were sent at reduced strength owing to trouble at ZLW.

On 12th November, extra time signals were sent out through station 2YA to provide accurate time for observers of the transit of Mercury.

Public Clocks.—The Government Buildings and General Post Office clocks are checked daily at 9 a.m. or 10 a.m. The maximum errors of the Government Buildings clock during 1940 were 40 seconds fast and 65 seconds slow. The latter error was, however, due to an error in setting the clock, and no error exceeding 56 seconds was normally observed. The maximum errors of the General Post Office clock were 7 seconds fast and 7 seconds slow.

The synchronous electric clock is checked twice daily. The largest uninterrupted run of the clock was forty-five days; during that period the maximum variation observed was 16 seconds. The performance of the clock varied considerably, for over another period of only twenty-seven days a maximum variation of 37 seconds was observed.

Precision Pendulum.—Experiments are in progress with the precision pendulum, which was originally installed in the cellar in 1926. The original method of drive proved unsatisfactory, and it is hoped to evolve a satisfactory drive so that the pendulum, which is a good one, can be employed as a timepiece.

Transit of Mercury.—Observations of the transit of Mercury on 12th November were made with the transit instrument. The results were forwarded to the Carter Observatory for incorporation with the other observations of the transit. In addition, a member of the staff was made available to the Carter Observatory to assist in their observations, and some of the time-service equipment was placed at their disposal.

Seismology.

Seismic Activity in New Zealand in 1940.—During February and March, 1940, there was considerable seismic activity in the Hawke's Bay - Bay of Plenty region, but otherwise activity was below normal. The total number of shocks reported felt was 120, the lowest number for several years. However, instrumental records showed that considerable minor activity was maintained in parts of the North Island. The maximum intensity reported felt was R.-F. 7.

The main features of the activity in 1940 may be summarized as follows:—

(1) Two strong shocks centred in the Gisborne coastal regions on 2nd August (No. 48 and 49 on map).

(2) Fairly continuous activity beneath the volcanic zone (extending from near White Island to the region south-west of Lake Taupo) from March onwards, with a particularly strong shock on 7th October (No. 71 on map; see also inset map). This shock had a focal depth of 160 km. to 170 km. (100 miles ca.) and was widely felt. Shocks at intervals centred in the Taumarunui region are considered to be part of the activity connected with the volcanic zone.

(3) Activity in Hawke's Bay region reached a climax with a shock of R.-F. 7 on 20th March (No. 23 on map; see also inset map). It was followed by a swarm of minor aftershocks recorded at Tuai, most of which were too weak to be felt. Following this disturbance there was a steady decline in the intensity and frequency of shocks, and between August and the end of the year only one shock was definitely located in Hawke's Bay.

(4) Occasional minor activity centred in north-eastern Taranaki, probably associated with the shocks in the Taumarunui region, mentioned in section (2).

(5) Fairly frequent slight or moderate shocks in the Wanganui-Rangitikei region, many of which were centred in the Wanganui Bight.

(6) Rather frequent shocks in the Wairarapa, Wellington, Marlborough, and West Nelson regions during the latter half of the year, none of which exceeded R.-F. 5. The coincidence of renewed activity in all these regions about June points to some common cause affecting shock activity in the whole area.

(7) Activity in the submarine region east and north-east of the North Island in July-August, and again from October to December.

The accompanying map shows the distribution of earthquake activity in 1940. The approximate isoseismals for the two largest shocks during the year are shown as inset maps.

A monthly summary of earthquakes reported felt during 1940 is given in the following table:—

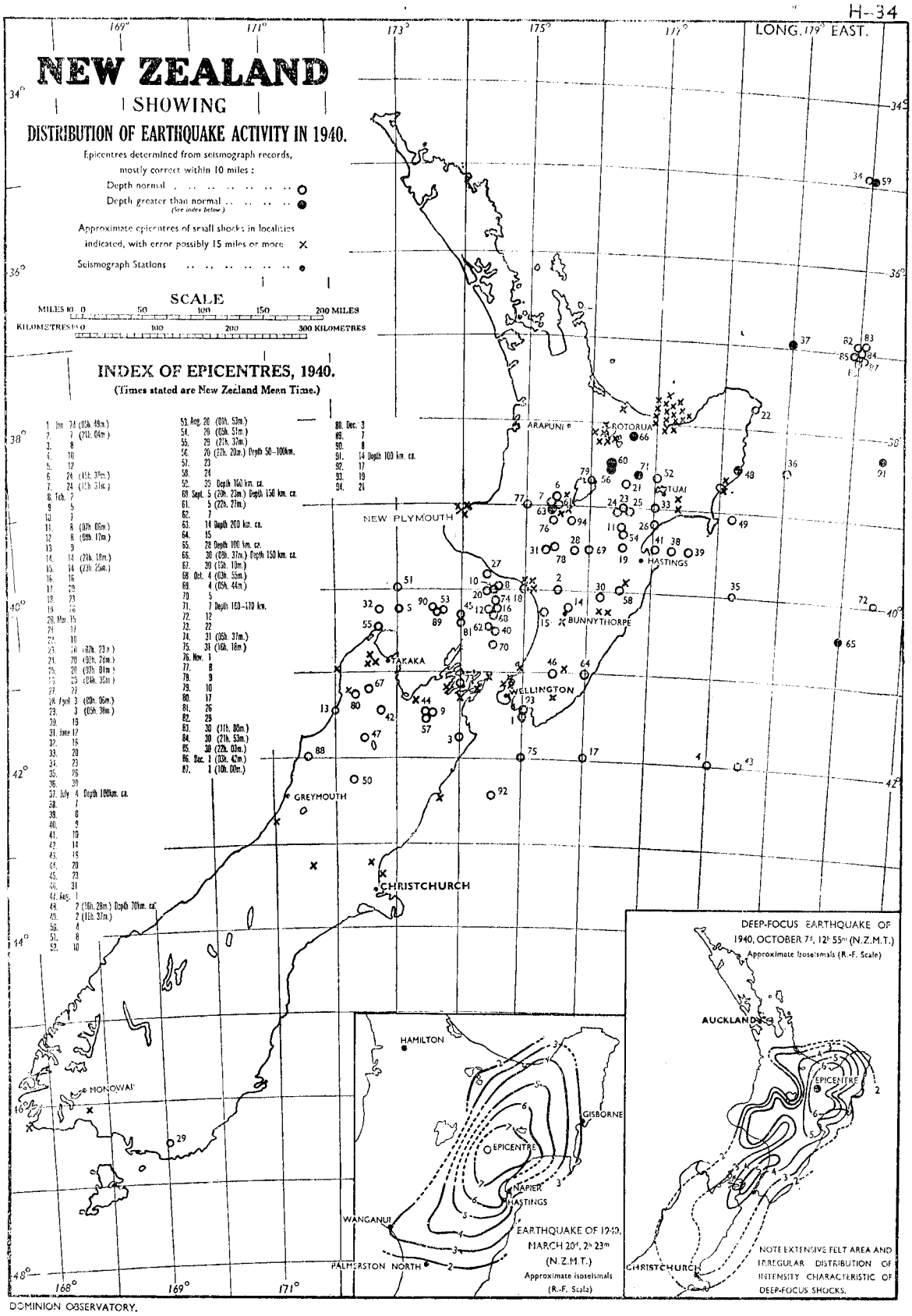
Month, 1940.	Number of Earthquakes reported felt.				Maximum Felt Intensity (R.-F.).	Locality of Maximum.
	North Island.	South Island.	Both Islands.	Whole of New Zealand.		
January	5	6	3	8	5	Wanganui, Blenheim, Puysegur Point.
February	8	7	2	13	6+	Hastings.
March	14	4	2	16	7	Hawke's Bay.
April	6	2	0	8	6	Dannevirke.
May	5	2	0	7	5	Rotorua.
June	8	2	0	10	5	Dannevirke.
July	16	6	1	21	6	Whakatane.
August	11	0	0	11	6	Gisborne.
September	2	4	0	6	3	Upper Takaka, Karamea.
October	7	3	2	8	6–7	Opotiki, Brother's Lighthouse.
November	4	1	0	5	4	Taumarunui, Ohakune.
December	4	3	0	7	6	Waipawa.
Totals	90	40	10	120	..	

With the co-operation of the Post and Telegraph Department, several new non-instrumental reporting stations were established during the year, in order to provide better coverage in the reporting of felt earthquakes.

Apart from the non-instrumental stations in New Zealand, periodic reports of felt earthquakes are furnished from the Solomon Islands (by Dr. C. E. Fox) and from the Kermedecs. These reports from other parts of the south-west Pacific are greatly appreciated.

The following list gives some particulars of the most important New Zealand earthquakes in 1940:—

New Zealand Mean Time of Shock.	Approximate Epicentre.		Focal Depth (km.): N = Normal.	Magnitude.	Maximum Felt Intensity (R.-F.).	Remarks.
	Latitude S.	Longitude E.				
1940. d. h. m.	°	°				
January 12 00 05·4	40¼	173	..	4½	5	Felt extensively from Hawera to Akaroa, with maximum at Wanganui and Blenheim.
February 26 17 46·6	39·5	176·5	..	5	6+	Felt throughout Hawke's Bay, with maximum at Hastings; also felt at Taihape and Wanganui.
March 20 02 23·5	39	176½	..	5	7	Felt in most eastern districts of North Island as far south as Dannevirke, with maximum in North Hawke's Bay. Also felt in parts of Wanganui and Manawatu districts (see inset map).
April 19 18 11·5	40·1	176·2	..	4½	6	Felt widely in North Island south of Napier, Taihape, and Hawera, with maximum at Dannevirke. Records and reports suggest that there were possibly two shocks of nearly equal magnitude within one minute.
July 10 05 28·1	(Near Whakatane)		..	4	6	Felt at Whakatane.
July 23 01 01·5	40⅓	174	..	4½	4	Felt in western areas of North Island from New Plymouth to Wellington, and at isolated points in northern part of South Island.
August 2 04 28·8	38·5	178·3	70 ca.	5	6	Felt in Gisborne region and parts of northern Hawke's Bay.
August 2 04 37·4	39·1	178·2	..	5	6	Felt in Gisborne region and parts of northern Hawke's Bay.
October 7 12 55·65	38·6	176·7	160–170	6+	6–7	Felt widely in North Island, except Auckland Peninsula; also at isolated places in South Island to Banks Peninsula. Maximum in region between Opotiki and Hawke's Bay (see inset map).
October 22 06 16·9	41·2	174·0	N	4½	6	Felt about Cook Strait.


H-34
LONG. 179° EAST.
NEW ZEALAND
SHOWING
DISTRIBUTION OF EARTHQUAKE ACTIVITY IN 1940.
Epicentres determined from seismograph records, mostly correct within 10 miles:
Depth normal
Depth greater than normal (see index below)
Approximate epicentres of small shocks in localities indicated, with error possibly 15 miles or more
Seismograph Stations
SCALE
MILES 0 50 100 150 200 MILES
KILOMETRES 0 100 200 300 KILOMETRES
INDEX OF EPICENTRES, 1940.
(Times stated are New Zealand Mean Time.)
1 Jan 7d (02h. 48m.)
2. 7 (21h. 04m.)
3. 8
4. 10
5. 12
6. 24 (15h. 39m.)
7. 24 (15h. 51m.)
8. Feb. 7
9. 5
10. 7
11. 8 (07h. 06m.)
12. 8 (09h. 12m.)
13. 9
14. 14 (21h. 18m.)
15. 14 (23h. 25m.)
16. 16
17. 22
18. 23
19. 26
20. Mar. 15
21. 17
22. 20
23. 20 (02h. 23m.)
24. 20 (02h. 26m.)
25. 20 (03h. 01m.)
26. 20 (04h. 35m.)
27. 21
28. April 3 (00h. 06m.)
29. 3 (05h. 39m.)
30. 19
31. June 12
32. 16
33. 28
34. 23
35. 26
36. 28
37. July 4 Depth 100km. ca.
38. 7
39. 8
40. 9
41. 10
42. 14
43. 19
44. 20
45. 23
46. 31
47. Aug. 1
48. 2 (16h. 28m.) Depth 70km. ca.
49. 2 (18h. 37m.)
50. 4
51. 8
52. 10
53. Aug. 20 (01h. 53m.)
54. 26 (05h. 51m.)
55. 29 (21h. 37m.)
56. 29 (22h. 28m.) Depth 50–100km.
57. 23
58. 24
59. 29 Depth 160 km. ca.
60. Sept. 5 (20h. 23m.) Depth 150 km. ca.
61. 5 (22h. 27m.)
62. 7
63. 14 Depth 200 km. ca.
64. 15
65. 28 Depth 100 km. ca.
66. 30 (09h. 37m.) Depth 150 km. ca.
67. 30 (15h. 10m.)
68. Oct. 4 (03h. 55m.)
69. 4 (05h. 44m.)
70. 5
71. 7 Depth 150–170 km.
72. 12
73. 22
74. 31 (05h. 37m.)
75. 31 (16h. 16m.)
76. Nov. 1
77. 8
78. 9
79. 10
80. 17
81. 26
82. 29
83. 30 (11h. 00m.)
84. 30 (21h. 53m.)
85. 30 (22h. 08m.)
86. Dec. 1 (03h. 42m.)
87. 1 (10h. 09m.)
88. Dec. 3
89. 7
90. 8
91. 14 Depth 100 km. ca.
92. 17
93. 19
94. 21
ARAPUNI
ROTORUA
TUAI
NEW PLYMOUTH
HASTINGS
BUNNYTHORPE
TAKAKA
WELLINGTON
GREYMOUTH
CHRISTCHURCH
HOKITIKA
HAMILTON
GISBORNE
EPICENTRE
NAPIER
HASTINGS
WANGANUI
PALMERSTON NORTH
EARTHQUAKE OF 1940, MARCH 20d, 2h 23m (N.Z.M.T.)
Approximate isoseismals (R.-F. Scale)
DEEP-FOCUS EARTHQUAKE OF 1940, OCTOBER 7d, 12h 55m (N.Z.M.T.)
Approximate isoseismals (R.-F. Scale)
AUCKLAND
EPICENTRE
CHRISTCHURCH
NOTE EXTENSIVE FELT AREA AND IRREGULAR DISTRIBUTION OF INTENSITY CHARACTERISTIC OF DEEP-FOCUS SHOCKS.
DOMINION OBSERVATORY.

The magnitudes given in the above table are determined from Wood-Anderson seismograms by the method employed at Pasadena, California. The interpretation of this instrumental magnitude scale has required some modification in New Zealand owing to the different conditions. From October, 1940, onwards instrumental magnitudes of all important shocks are given in the routine monthly seismological reports.

Seismograph Stations.—The following table shows the number of earthquakes recorded by the various types of seismographs in New Zealand during 1940. Type I refers to sensitive local recorders of Wood-Anderson design, Type II to local strong-motion recorders (mostly Jaggar seismographs), and Type III to teleseismic instruments of varying sensitivity.

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
Type I.													
Tuai	11	15	94	29	14	18	12	31	23	24	31	13	315
New Plymouth ..	15	18	21	1	..	32	27	50	25	18	24	15	246
Wellington	28	34	33	45	22	29	40	30	23	30	31	24	369
Christchurch ..	7	14	7	5	1	7	8	13	5	11	8	7	93
Type II.													
Rotorua	0	0	..	0	5	0	0	0	0	1	0	1	
Hastings	1	1	10	3	1	2	2	5	1	2	1	0	29
Bunnythorpe ..	0	1	1	1	0	3	1	0	0	1	0	0	8
Takaka	0	0	0	0	0	0	0	0	0	0	0	0	0
Greymouth	0	0	0	0	0	0	0	0	0	0	0	0	0
Monowai	0	1	3	1	2	0	0	0	0	1	0	0	8
Type III.													
Arapuni	14	11	18	10	15	18	16	13	9	11	22	10	167
Wellington	29	19	28	17	28	23	24	16	18	34	19	25	280
Christchurch ..	27	15	22	19	25	19	25	16	20	36	29	30	283
Chatham Islands ..	2	1	5	..	..	..	..	..	..	..	..	..	..

During the first part of 1940, Christchurch Observatory carried out tests near Greymouth and at Monowai with Milne-Shaw and Wood-Anderson seismographs. While both places proved to be unsuitable for a Milne-Shaw instrument, the test records showed that a Wood-Anderson instrument would operate satisfactorily at either place. Consequently, the co-operation of the Public Works Department has been sought with a view to establishing a Wood-Anderson near Greymouth.

The Milne-Shaw seismograph No. 36, which was lent to the Christchurch Observatory in 1939, was returned to this Observatory in August, 1940, and steps were taken to arrange for its installation in Auckland as a separate teleseismic station.

Land Movements.—Recording of tilt in the Observatory basement has been carried on continuously by the Ishimoto tiltometer and the Milne-Shaw seismograph. A comprehensive study of the tilt records over a number of years has been completed and published.

In November the Lands and Survey Department furnished information on levels taken across geological faults at various points in the Wellington District during the period 1930–40. A study of these level readings, together with seismic data, indicates that certain level changes may have been associated with definite seismic disturbances; more frequent level readings will be required to confirm this.

Since 1936, systematic observations of the north and south meridian marks have been made with the transit instrument. Relative horizontal movements of any one of these points would be revealed by the observations; no appreciable displacements have so far been detected.

Research in Seismology.—Time available for research was employed in completing the investigations on tilt, and a general revision of local earthquakes for the period 1931–40 was commenced. Some research work was also necessary in connection with the adoption of the Pasadena instrumental magnitude scale for comparison of the magnitudes of local shocks in New Zealand.

Assistance in seismological research work was given to the following research workers: Dr. K. E. Bullen and Mr. J. F. de Lisle, of Auckland; Dr. L. Bastings and Mr. L. A. C. Warner, of Wellington; and Mr. R. D. Thompson, of Stratford.

Library.

Early in the year the rearrangement and cataloguing of the library was completed.

Publications.

Monthly provisional seismological reports were published regularly. Owing to the war, the overseas mailing list has been considerably reduced. The number of reports and bulletins received from abroad has also fallen off considerably.

In addition to the routine seismological reports, the following special bulletins were issued during 1940:—

Bulletin S.–56.—Earthquakes in New Zealand; with summaries for the year 1938.
Bulletin R.–25.—Annual Report of the Dominion Observatory for the year 1939.
Bulletin S.–57.—The Wairarapa Earthquake of 1917 August 5 (K. E. Bullen).
Bulletin S.–59.—The Deep-focus Earthquakes of the South-west Pacific (R. C. Hayes).
Bulletin T.–16.—New Zealand Mean Time, and Time Service Arrangements (1940).

MAGNETIC OBSERVATORY, CHRISTCHURCH.

Director: H. F. Baird.

SUMMARY OF OPERATIONS FOR THE YEAR ENDED 31st MARCH, 1941.

The usual programmes of terrestrial magnetic, seismological, atmospheric electric, cosmic radiation, and climatological observations have been maintained. Rapid progress was made towards commencing a magnetic resurvey of New Zealand.

Terrestrial Magnetism.

The three types of photographic variometers by Eschenhagen, Adie, and La Cour gave continuous record of the magnetic elements at the substation in Amberley Domain. They were calibrated at ten-daily intervals by absolute observations, while scale-values of the horizontal and the vertical force photographic records were obtained frequently by special coils and a balanced standard cell. Illumination from storage batteries superseded kerosene lamps.

The mean hourly values for declination (variation), (D), horizontal force (H), and vertical force (Z) have been measured and corrected to standard conditions, in which form they have been tabulated. The mean monthly values of the magnetic elements obtained from the mean hourly values for all days in 1940 are tabulated below.

1940.	D.	H.	Z.	ϕ
	° ′			° ′
January	18 26·8E.	22259γ	−55209γ	−68 02·5
February	18 27·2	22258	55219	68 02·8
March	18 28·3	22231	55226	68 04·4
April	18 29·8	22234	55224	68 04·2
May	18 29·9	22245	55220	68 03·5
June	18 30·0	22247	55226	68 03·5
July	18 30·6	22248	55225	68 03·4
August	18 31·3	22251	55224	68 03·3
September	18 31·9	22246	55221	68 03·4
October	18 31·8	22246	55219	68 03·4
November	18 32·1	22249	55218	68 03·2
December	18 32·6	22256	55208	68 02·6
Year	18 30·2	22247·5	55219·8	68 03·35
Δ from 1939	+5·5	−7·8	−20·1	−0·80
	Y.	X.	T.	G. c.g.s. units.
Year	07060·4γ	21097·5γ	59532·9γ	0·35458
Δ from 1939	+31·0γ	−18·6γ	+15·6γ	+0·00003

Included in the table are yearly averages contrasted with the preceeding year, together with similarly arranged information about Y, the easterly component of magnetic force, X, the northerly component, and T, the total force along the line of dip, together with similar details about G, a magnetic quantity which is proportional to the magnetic moment of the earth, and is indicative of local regional changes in the earth's magnetic field.

After some uncertainty, due to the invasion of the Netherlands, local data of international magnetic character figures were finally supplied to Carnegie Institution, Washington, instead of to De Bilt as hitherto. The first instalment of "K" values, or the three-hour range index of geomagnetic activity, has been sent to the International Association of Terrestrial Magnetism and Electricity at Washington, D.C., U.S.A. Presentation of the details of geomagnetic activity in this manner is a new departure arranged to characterize the variation in the degree of irregular magnetic activity throughout each day, especially in order to meet the requests made by the International Union of Scientific Radiotelegraphy and other bodies for information concerning detailed magnetic activity not otherwise readily obtainable. It is planned to maintain continued co-operation in this most useful scheme.

Magnetic Resurvey.

Dr. V. Bush, President of the Carnegie Institution, Washington, has granted a loan of C.I.W. magnetometer-inductor No. DTMCIW 27 to the Government of New Zealand, so that officers of this Observatory may reoccupy magnetic stations. The instrument arrived in February, and will be used as soon as possible for reobserving the magnetic elements, in order to establish the amount of secular variation which has taken place since stations were last occupied. As it is approximately forty years since these stations were last occupied, an inspection was made to see how many stations were still available. A large number of original stations in the main cities and what are now main towns, together with those affected either by erosion or accretion of river-banks and coasts, are no longer suitable or easy of relocation. However, when a station was placed on a recreation reserve, or on private property in a district which has not become closely settled, it is usually easy to locate, and is frequently still suitable for reoccupation. A number of stations of this class have already been

found between Kawakawa and Balclutha. In future, with one or two minor exceptions where it is either too laborious or not necessary, magnetic survey stations will be tied to standard blocks, tubes, spikes, or pegs, of land surveys in the vicinity by means of bearings and traverses given in links. This is very necessary, as too frequently what were prominent buildings, corner posts, highways, and the like forty years ago either no longer exist or have been modified beyond possible recognition from descriptions of their salient features given forty years ago. To this end tracings or plans of surveys have been, and are being obtained in the vicinity of those old magnetic survey stations which can still be used. The resurvey work will be done by the Director and Physicist, with the assistance of a qualified chainman, and is likely to last at least for two years. Besides the obtaining of secular variation data it is anticipated that data required by the Navy, Army, and Air Departments, quite often through the Lands and Survey Department or the Public Works Department, will become available by suitable observations throughout the Dominion.

Regions of anomalous magnetic properties are likely to be of particular interest because of industrial, developmental, or other reasons. The work on regions of this nature is being collated, and a detailed investigation of anomalies in the Banks Peninsula area, particularly in the Wigram, Harewood and Lyttelton Harbour districts, is already being made. It is planned to extend these investigations to other important districts of close population throughout New Zealand. In due course it is expected to delineate all regions where magnetic properties are anomalous because of past intrusion of highly magnetic igneous rocks, or where subterranean temperatures are now permitting, or no longer permitting intrusive rocks to display magnetic properties. When the temperature of these rocks exceeds a certain amount (the Curie Point), magnetization is destroyed; an indication of this may be symptomatic of potential volcanic activity.

Electric Potential Gradient.

The Bendorf electrograph has been kept in operation and its performance improved by an overhaul. Recently the collector arm was made removable by provision for unscrewing from just inside the cowl; this increased the amount of apparatus whose insulation could be tested regularly. C.I.W. kindly supplied two fresh collectors and some suspension wire. A greater amount of useful record has thus become available, but it has not yet been possible to clear up the arrears of measurement in this programme. Past records are in good condition and accumulation is not very great.

Seismological.

The single component Wood-Anderson has continued to record the larger near shocks, while the three-component Galitzin seismographs have supplied records of distant shocks. In February a shock of moderate intensity was recorded from the Lake Coleridge district. Because most earthquakes recorded here have their origins towards the north-west, and because microseisms appear to come mainly from the south-east, the horizontal components of the Galitzin seismographs were in January placed to record the N.E.–S.W. and N.W.–S.E. components instead of the N.–S. and E.–W. components as previously.

Cosmic-ray Meter.

The Compton-Bennett Cosmic-ray meter No. 5 in the Carnegie Institution's international network has continued to operate satisfactorily. Records obtained therefrom have been measured regularly, and for proper collation the resulting data have been sent to Carnegie Institution, Washington.

METEOROLOGICAL BRANCH.

Consequent on the outbreak of war, the Meteorological Branch of the Department, together with the Apia Observatory, was transferred to the Air Department for the duration of the war.

The report of the Meteorological Branch during the past year is contained in the annual report of the Air Department.

RESEARCH SCHOLARSHIPS.

Two National Research Scholarships of an annual value of £100 each were awarded during the year. The holders of the scholarships and the researches upon which they are engaged are as follows:—

Mr. M. D. Sutherland (Auckland University College): "The Essential Oils of the Scented Fern."

Mr. L. R. Wallace (Canterbury Agricultural College): "A study of the Factors affecting the Quality of New Zealand Meat Exports, with Special Reference to Fat Lambs."

IMPERIAL AGRICULTURAL BUREAUX.

The Imperial Agricultural Bureaux were established to act as clearing-houses for the interchange of information between research workers in various fields of agricultural science throughout the world, but more particularly within the various countries of the British Commonwealth.

In New Zealand co-operation with the Bureaux is maintained through the Department of Scientific and Industrial Research, for which purpose there is a special liaison officer. In addition, contacts with individual Bureaux and the appropriate fields of research are maintained by official correspondents, who deal with specific inquiries. The following is the list of Bureaux and the official correspondents in New Zealand :—

Bureau.	Official Correspondent.
1. Soil Science	Dr. L. I. Grange, Director, Soil Survey Division, Department of Scientific and Industrial Research.
2. Animal Health	Dr. C. S. M. Hopkirk, Officer in Charge, Veterinary Laboratory, Department of Agriculture, Wallaceville.
3. Animal Nutrition	Dr. I. J. Cunningham, Veterinary Laboratory, Department of Agriculture, Wallaceville.
4. Plant Breeding and Genetics ..	Dr. F. W. Hilgendorf, Wheat Research Institute, Christchurch.
5. Pastures and Forage Crops	Mr. E. B. Levy, Director, Grasslands Division, Palmerston North.
6. Horticulture and Plantation Crops ..	Mr. W. K. Dallas, Director, Horticulture Division, Department of Agriculture, Wellington.
7. Animal Breeding and Genetics ..	Dr. F. W. Dry, Massey Agricultural College, Palmerston North.
8. Agricultural Parasitology	Dr. C. S. M. Hopkirk, Officer in Charge, Veterinary Laboratory, Department of Agriculture, Wallaceville, and Dr. D. Miller, Entomology Division, Plant Research Bureau, Cawthron Institute, Nelson (joint correspondents).
9. Forestry	(To be appointed.)
10. Dairy Science	Dr. H. Whitehead, Dairy Research Institute, Palmerston North.
New Zealand Liaison Officer for Imperial Agriculture Bureaux	Mr. F. J. A. Brogan, Department of Scientific and Industrial Research, Wellington. (Acting.)

PUBLICATIONS.

The monthly publication of the *New Zealand Journal of Science and Technology* has been continued during the year, alternate numbers being devoted to two different classes of papers. Section A of the *Journal* is composed entirely of agricultural-science articles, while Section B deals with general subjects apart from agricultural, and includes papers on chemistry, physics, geology, seismology, economics, and industrial technology.

Apart from the *Journal*, further departmental bulletins have been issued during the year as follow :—

No. 75 : " A Survey of the Standards of Life of New Zealand Dairy-farmers," by W. T. Doig.
No. 82 : " Botanical Aspects of Ragwort (*Senecio jacobaea* L.) Control," by A. L. Poole and D. Cairns.
No. 83 : " A Handbook of the Naturalized Flora of New Zealand," by H. H. Allan.
No. 84 : " Wheat Research Institute : Seventh Annual Report."

Approximate Cost of Paper.—Preparation, not given ; printing (885 copies), £135.

By Authority: E. V. Paul, Government Printer, Wellington,—1941.

Price 1s. 9d.]