effects of NH_4 and NO_3 with *Aspergillus*, excised roots and attached roots were discussed in relation to redox systems.

The practical application of trace element investigations to crop-producing problems was discussed in the contributions of Dr. L. Gisiger (Switzerland), Prof. F. Steenbjerg (Denmark), Dr. Marie P. Löhnis (Holland), Prof. E. A. Jamalainen (Finland), and Dr. D. Mulder (Wilhelminadorp; this last being communicated by Dr. Löhnis).

Dr. Gisiger described investigations relating to crop failures in Switzerland during the War resulting from over-liming associated with deficiencies of boron and manganese. From his experiments he concludes that the damage from excess liming is due to the hydrating action of the $OH^{\cdot}$ anion. Boron tends to counteract this effect by dehydrating action, this being an alternative hypothesis to the fixation of boron by lime action. The $OH^{\cdot}$ ion is regarded as causing the unavailability of manganese over an intermediate range of *p*H, availability increasing at low and high *p*H values. The range of low availability is similar to that shown by Quastel *et al.*, at which soil organisms are active in the oxidation of soil manganese.

Prof. Steenbjerg outlined the main problems of trace elements investigated in Danish agriculture. Iron and manganese deficiencies are common in horticultural crops and copper deficiency occurs in crops on the sandy soils of Jutland. Cobalt deficiency in cattle has also been recognized. Investigations have largely concerned deficiencies of manganese and copper. With manganese the problems differ for sands and clays, and soil methods have been devised for advisory purposes. Organic matter is an important cause of copper deficiency, and the availability is greatly influenced by preceding crops. Grass is regarded as important in mobilizing soil copper. The copper content of plants has been shown not to be an infallible guide in the diagnosis of copper deficiency, since when growth is severely stunted the total copper content of the plant material (as percentage dry matter) may not be unduly low. A characteristic S-shaped curve is obtained relating dry matter production and total copper content. Deficiency values occur up to the point of inflexion.

Discussion of this paper showed that many problems concerned in availability of manganese and its relations to other elements in plants, for example, Mn/N, require further study.

Dr. Löhnis described her researches on the toxicity of manganese to crops in acid soils in the Netherlands. *Phaseolus vulgaris* and *Vicia sativa* were found to be highly susceptible, whereas oats and strawberries were resistant to damage. Resistance to excess manganese and susceptibility to manganese deficiency (as shown by oats) cannot be explained on the simple basis of 'ease of absorption of manganese' from the soil, since some crops are susceptible (for example, *Phaseolus*) and others resistant (for example, strawberry) to both excess and deficiency of the element.

Prof. Jamalainen gave an account of the occurrence of deficiencies of boron, copper and manganese in crops of Finland. Boron deficiency is prevalent in sugar beet, swedes and apples, and occurs even on strongly acid soils, though the deficiency is accentuated by liming. Other crops affected are clover, celery, turnips and white mustard.

Copper deficiency is also an important problem, particularly on peats, but also on sands. Clay soils are less affected. Cereals, hay crops, potatoes and root crops have all responded to copper dressings.

As the soils of Finland are mainly acid, manganese deficiency is rare, though marsh spot of peas has been noted in Aland. The deficiency may occur on over-limed soils.

The contribution sent by Dr. D. Mulder concerned the occurrence of zinc deficiency in fruit trees in Europe and referred in particular to apples, pears and cherries in the Zeeland province of the Netherlands and to reported instances in apples in Hungary, Denmark and Switzerland. The Dutch examples occur on highly calcareous sands, and the deficiency can be cured by winter or summer sprays of zinc sulphate.

A novel paper of the symposium was contributed by Prof. L. Seekles (Holland), in that it referred to trace-element problems in farm stock. The contribution showed clearly the similarity in plants and animals of many of the fundamental problems concerned with trace elements. Thus in both there appear to be direct and induced (or 'conditioned') deficiencies, and relationships between elements may be of great importance. Moreover, as Prof. Seekles pointed out, trace elements are concerned with many linked series of enzyme reactions in plants and animals, and the breaking of these series at different points from different deficiencies may result in varied or similar pathological conditions.

At the conclusion of the conference, Dr. D. I. Arnon proposed that an endeavour should be made to adopt a term for universal use to replace the numerous current expressions used by different workers, namely, 'trace elements', 'trace nutrients', 'minor elements', 'oligo elements', 'spuren-elements'. He was prepared to suggest the term 'micro nutrient elements' as a basis for discussion and agreed to prepare a memorandum on the subject.

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1946–47

THE twenty-first annual report of the Department of Scientific and Industrial Research, New Zealand (Wellington: Gov. Printer. 1*s.* 9*d.*), includes the Minister's statement, the secretary's report for the year 1946–47, reports of the various research committees and of the Cawthron Institute, as well as reports from branches and on research work at Canterbury and Massey Agricultural Colleges. The three main new activities noted by the secretary are the establishment of a Fuel Efficiency Service in an effort to reduce the consumption of coal in industry; the extension of the Information Bureau to deal more systematically with the exchange of information for scientific workers of the Department and the Dominion generally, and its dissemination among interested Departments and the public; and a start on the use of radioactive tracer elements in certain biological and chemical problems associated with soil processes. Building research included investigations on lightweight concrete and pumice concrete and the testing of properties of new materials, while the Plant Diseases Division examined the toxicity of wood preservatives and the treatment of infested buildings, as well as the testing of preservatives against fungi. The

Dominion Physical Laboratory undertook measurements of thermal transmittance on two types of concrete construction and also on a weatherboard house.

The work of the Dairy Research Institute was focused upon further improvement in the quality of New Zealand dairy products for export, reducing losses in manufacture, utilizing skim milk to the best advantage in feeding calves in New Zealand, and the influence of the plane of nutrition of the dairy cow during its normal dry period on the quality and quantity of milk produced in the subsequent lactation. The finding that cress-taint does not appear in the butter if cream from cows that have consumed cress is pasteurized below 180° F. was confirmed. Attempts were made to determine the relative influences of fat and casein on the moisture-holding properties of cheese-curd, while the Fats Research Laboratory established on April 1, 1946, initiated research on the nature of fats, particularly those occurring in dairy products.

Fruit cold-storage research covered the influence of root-stock and intermediate scion on core-flush in Granny Smith apples and the effect of a pre-harvest, fruit-fixing spray or superficial scald. Trials with 'Pliofilm' wraps in the shipment of oranges indicated that the percentage of sound fruit was substantially increased, but the high cost of the material outweighed the saving; use of paper wraps impregnated with diphenyl proved highly economic in reducing losses from fungous rots. Fruit research included manurial investigations and root-stock trials on apples, variety trials on apples, peaches and citrus fruit, investigations on codling moth control, tests on new products such as 'Gammexane', 'Dittane', 'Fermate' and 'Phygon', magnesium deficiency investigations, studies of the effect of penicillin on fruit fungi and of the control of black-spot of apples and pears with 'Elgetol' spray, raspberry investigations and a disease survey of orchards.

The Industrial Psychology Division made a survey of eye-strain in two clothing factories, and commenced an investigation into the adjustment of youth in industry as well as carrying out many vocational examinations. The Leather Research Association's studies of the quality of sole leather indicated that the wear life of a sole bears a definite relation to the amount of hide substance per unit area. Some of the fundamental properties of water-pigment finishes in use were examined, as well as difficulties experienced in curing and storing calf-skins. The Shoe Research Association commenced an investigation on the types of leather most suitable for insoles, and continued its work on the effect of perspiration on leather. The Fertilizer Manufacturers' Research Association drew up a programme of work and was selecting a site for its laboratory. The Pottery and Ceramic Research Association carried out preliminary work on the differential thermal analysis of New Zealand clays and completed preliminary work on a similar method for determining free quartz in clays. The Woollen Mills Research Association continued its control work on unshrinkable finishes, as well as further trials of 'Gammexane' against carpet beetles, and completed the mill tests on the manufacturing trial of hairy wool and the combing trial of exported scoured wool.

Under the Tobacco Research Committee, fertilizer experiments led to a general increase in yield, magnesium having a beneficial effect on both yield and quality. Surveys were made of both mosaic disease and black root-rot in the seedling beds of many growers, and experiments to control collar-rot continued, while the Cawthron Institute continued soil mapping of tobacco lands. Other work at the Cawthron Institute related to land utilization, soil analysis and investigations on tomatoes, including the treatment of soil with steam, formalin and chloropicrin, the effect of cocoa-bean husks, compost, etc., on yield, tomato 'cloud' and 'hard-core'.

Research work at Canterbury Agricultural College included sheep-dipping trials with *D.D.T.* and 'Gammexane', studies in copper deficiencies, on insect pests of wheat crops and on subterranean clover, as well as farm-machinery research, microbiological investigations of ear blight and frost damage, eyespot disease, the efficiency of commercial seed-wheat dusting and the seed disinfection of peas. At Massey Agricultural College studies on hairy sheep (N type) added to our understanding of the fleeces of both hairy and non-hairy sheep. Other work was concerned with the propagation of cuttings, drainage and the internal parasites of sheep, while the Biochemistry Department studied the wear of sheep's teeth and the milk supply of Romney ewes.

Since the reversion of the control of the geophysical work at the Apia Observatory to the Department, efforts have been made to provide modern buildings suitable for tropical conditions, modern equipment, adequate scientific staff and congenial living conditions.

The Auckland Industrial Development Laboratories report an increase in the number, variety and complexity of the industrial problems in which assistance has been sought, while the first annual report of the Biometric Section indicates that, in addition to facilitating basic statistical and biometrical control of agricultural trials, the Section was concerned mainly with the collection of an adequate library of technical literature, the recruitment and training of staff, the exploration of methods, such as the punched card technique, of handling extensive collections of data, as well as research and consultative work.

At the Dominion Observatory the method of controlling the standard clocks was unchanged, and the time-service arrangements were continued as previously, except for special time signals which had been sent out for war purposes up to January 31. The chief seismic event was the disturbance in the Lake Coleridge region on June 26; but 306 earthquakes were felt during the year in some part of New Zealand, 87 in the North Island and 219 in the South Island.

Lack of accommodation is still a great hindrance to the work of the Dominion Laboratory where, in addition to the examination of 25,103 samples, research was carried out on New Zealand woods, and special coatings were applied to experimental boxes in an effort to overcome the tainting of butter by boxes made of *Pinus radiata* timber. Much spectrographic examination of metals was carried out for industry, and the Coal Survey Laboratory co-operated with the field staffs of the Geological Survey and the Mines Department in a continuation of the physical and chemical survey of the coal resources of the Dominion. Equipment on a pilot-plant scale for the production of penicillin and other antibiotics was designed for installation at the Plant Chemistry Laboratory, and an experimental tray dryer was also designed and installed. A complete survey of all certified plant therapeutic compounds on the market was also undertaken.

The Dominion Physical Laboratory has assisted many New Zealand manufacturing firms with tests

on materials and equipment, the design and supply of special measuring apparatus, replacement parts for machinery and small precision tools, and about half the time of the Laboratory has been spent on similar work for Government Departments. Major investigations during the year included vacuum-pressure impregnation of timber with synthetic resins, the moulding of plywood, the thermal efficiency of open-hearth fires and the design and construction of micro-wave meteorological radar. In addition to its butter-fat investigations, the Fats Research Laboratory has used a molecular still of novel design for the preparation of fish liver-oil concentrates. In addition to vitamin analyses, the Plant Chemistry Laboratory has conducted a successful trial of new hormone weed-killers. Work under the Plant Research Bureau included an extensive breeding programme for garden peas and field peas, as well as for barley and other field crops. A vegetable research section was established, and the Botany Division made further surveys of vegetation and extended its collections of agar seaweed and of carrageen (Irish moss). The Grasslands Division carried out further work on pedigree strains of pasture species, blind-seed disease of rye-grass and soil conservation, while in addition to therapeutic testing the Plant Diseases Division studied tree-tomato mosaic, lettuce mosaic, halo-blight of beans, and soil disinfection. An investigation was also commenced on boron and its relation to the incidence of yellow leaf.

PHOTO-ELASTIC INVESTIGATION OF INTERNAL STRESSES IN SILVER CHLORIDE CAUSED BY PLASTIC DEFORMATION

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INTERNAL stresses in cold-worked metals cannot be investigated fully by means of X-ray diffraction because in most cases the stresses vary considerably in distances comparable with the cross-section of the X-ray beam. For this reason, X-ray methods can indicate only the presence and magnitude of internal stresses, but not their distribution in space. A more powerful and direct method of approach is provided by the photo-elastic effect in transparent crystals. Cubic crystals are particularly suitable, since they are optically isotropic when unstressed; the magnitude and orientation of their birefringence, and its distribution over the crystals, thus give a direct picture of the distribution of internal stress. There is no reason at present for supposing that the plastic deformation of transparent crystals differs fundamentally from that of other crystalline substances, and one may reasonably expect that results derived from experiments on such materials will also be applicable to metals.

Since December 1946 a series of observations has been made on polycrystalline silver chloride, a material that is transparent, cubic in structure, and also very ductile. Rolled sheets, of thicknesses from 0·3 to 1 mm., supplied by the Harshaw Chemical Company of Cleveland, Ohio, showed patches of birefringence when placed between crossed nicols. These patches disappeared when strips cut from the sheets were recrystallized by heating for two hours at 400° C. and cooled slowly. (The melting point of silver chloride is 455° C.). Subsequent plastic deformation of such flat strips gave patterns of birefringence of which an example is shown in Fig. 1. This photograph was taken in white light between the crossed nicols of a polarizing microscope after unloading the strip; the polarization directions of the nicols are horizontal and vertical. Light areas indicate residual stresses. The pattern is not coloured because, with sheets of this thickness, the path differences due to the stress birefringence are smaller than the wave-length of light. The average width of the grains is large compared with the thickness of the sheet. Most of the grains are crossed by one, or sometimes two, sets of light and dark bands, similar to those observed in transparent single crystals by Brewster[1], by Reusch[2], and by Obreimow and Schubnikoff[3]. They appear to be the result of deformation by glide or by kinking[4]. Other interesting points are visible: for example, plastic distortion in grain *A* has evidently contributed to the stress pattern seen in the neighbouring grain *B*. When an external stress is applied to the strip the grains lighten and the progress of further plastic deformation can be watched. (I gave a demonstration of these phenomena at a conversazione held by the Royal Society on May 29, 1947.) A small portion of another strip is illustrated in Fig. 2, also photographed between crossed nicols; several intersecting sets of bands are shown. In Fig. 3 a grain boundary *XX* separates two grains, each of which is crossed by a particularly sharp set of birefringent bands, produced in this case by bending. The polarization directions of the nicols are again horizontal and vertical. If the nicols are turned through 45° the light stripes become dark and the contrast of the pattern is much reduced. Such observations combined with the use of a compensator make it possible to calculate the distribution of stress within the bands.

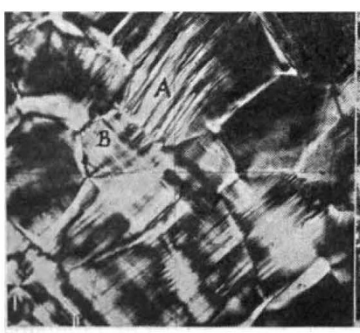

Fig. 1. × 13

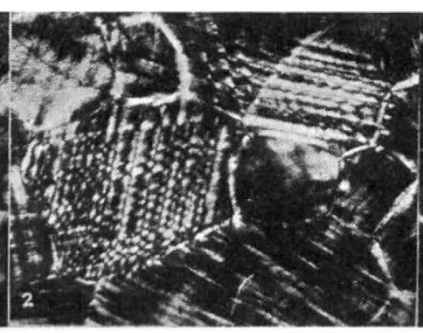

Fig. 2. × 25.

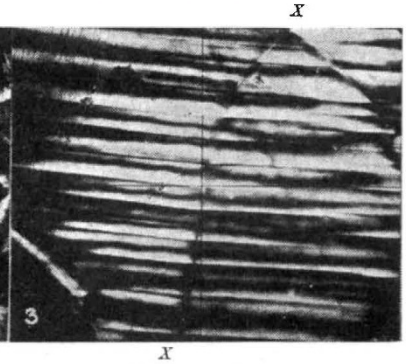

Fig. 3. × 41